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Instruction Manual

Model LC-2

Single Channel Datalogger

CE*

*Waterproof Single-Channel Dataloggers Models 8002-WP-1 and 8002-WP-2 are not CE Approved.

(Doc Rev KK, 8/15/22)

Warranty Statement

GEOKON warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by GEOKON, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of GEOKON's control. Components which wear or which are damaged by misuse are not warranted. This includes fuses and batteries.

GEOKON manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. GEOKON is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by GEOKON or any breach of any warranty by GEOKON shall not exceed the purchase price paid by the purchaser to GEOKON for the unit or units, or equipment directly affected by such breach. Under no circumstances will GEOKON reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, GEOKON neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.

TABLE of CONTENTS

FIGURES

TABLES

EQUATIONS

1. INTRODUCTION

The Model LC-2 Single Channel Datalogger is a low cost, battery powered and easy to use measurement instrument designed to read vibrating wire sensors equipped with thermistors.

The 320K standard memory provides storage for 16000 data. Each array consists of an optional datalogger ID string (16 characters maximum), a timestamp consisting of the year, date (Julian day or month/day format), time (hhmm or hours/minutes format) and seconds when the reading was taken. Also included in the data is the internal 3V (or external 12V) battery voltage, the datalogger temperature, the vibrating wire reading, the temperature at the transducer and the array number in memory.

Internal math is calculated using 32-bit floating point notation (IEEE). Math operations on the instrument reading, such as application of a zero reading, gauge factor (or calibration factor) and offset when using a linear conversion technique or polynomial coefficients when using the polynomial conversion, provide output directly in engineering units.

All data, both readings and configuration, are stored in nonvolatile EEPROM with a typical storage life of 10 years (minimum). The internal temperature compensated real-time clock, used to provide timekeeping and triggering of readings, is accurate to plus or minus two minutes per year.

The comma delineated ASCII output format allows for easy importing into popular spreadsheet programs such as Lotus 1-2-3™ or Microsoft Excel™. See Appendix C for sample data files.

For more information regarding setup and operation of the RS-485 LC-2 models, refer to Appendix E.

2. LC-2 MODEL TYPES

2.1 RS-232 Interface (8002-1-1, 8002-1A-1)

The datalogger's internal configuration is defined through communication with a computer using the supplied RS-232 interface cable and Agent software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows HyperTerminal™. (See Appendix K if using terminal emulator software to interface to the datalogger.)

Sensors connect to model 8002-1-1 by means of an internal terminal block (see Table 1) and to model 8002-1A-1 by means of a 10-pin connector. Refer to Section 3.1 to connect the vibrating wire transducer to the LC-2 datalogger.

2.2 USB Interface (8002-1-2, 8002-1A-2)

The datalogger's internal configuration is defined through communication with a computer using the supplied USB 2.0 interface cable and Agent software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows

HyperTerminal™ or GEOKON's Terminal Window Software. (See Appendix K if using terminal emulator software to interface to the datalogger.)

When connected to a computer via the USB port, the LC-2 appears to the computer as a "virtual" COM port. The LC-2 datalogger also receives its operating power from the computer, thus extending the internal 3V (or external 12V) battery life. When disconnected from the USB port, the datalogger automatically switches to the internal 3V (or external 12V) battery pack.

LC-2 model 8002-1-2 provides hard-wired transducer connection by means of an internal terminal block (see Table 1).LC-2 model 8002-1A-2 provides transducer connection by means of a 10-pin connector. Refer to Section 3.1 to connect the vibrating wire transducer to the LC-2 datalogger.

2.3 RS-485 Interface (8002-1-3, 8002-1A-3)

The datalogger's internal configuration is defined through communication with a computer using the supplied RS-485 interface cable and Agent software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows HyperTerminal™ or GEOKON's Terminal Window Software. (See Appendix K if using terminal emulator software to interface to the datalogger.)

When connected to a computer via the 8001-5 (RS-232) or 8002-5(USB) RS-485 interface, up to 256 LC-2 dataloggers may be networked (daisy chained) together over one RS-485 communications cable.

LC-2 model 8002-1-3 provides hardwired sensor connection by means of an internal terminal block (see Table 1). LC-2 model 8002-1A-3 provides transducer connection by means of a 10-pin connector. Refer to Section 3.1 to connect the vibrating wire transducer to the LC-2 datalogger.

2.4 Waterproof (8002-WP-1, 8002-WP-2)

GEOKON's Model LC-2WP is a waterproof version of the Single Channel LC-2 Datalogger. It is housed in a rugged PVC enclosure, with a Swagelok cable fitting and 10-pin bulkhead communications port.

The LC-2WP is available with internal configurations to communicate via RS-232 (8002-WP-1) or USB (8002-WP-2).

For operating instructions for the LC-2WP, please see Appendix H.

3. GETTING STARTED

This section will outline the basic steps needed to install the communications software, establish communication with the Model LC-2 and configure the datalogger in the context of water level monitoring using a GEOKON model 4500S Vibrating Wire Pressure Transducer.

The following equipment will arrive with the Model LC-2 datalogger:

- Set of two alkaline D cell batteries.
- Set of four desiccant packs packaged with the batteries.
- Set of two screwdrivers, one Phillips Head and one Flat Head.
- 9-pin Dsub to 10-pin Bendix RS-232 cable (included with models 8002-1-1, 8002-1A-1), or, USB-A to 10-pin Bendix USB cable (included with models 8002-1-2, 8002-1A-2).
- Model LC-2 Single Channel Datalogger Instruction Manual.

The following are optional accessories:

- Model 8002-7 aluminum mounting bracket kit (See section 3.3 for installation instructions.)
- Vibrating Wire Sensor with built-in thermistor.

3.1 Transducer Installation

3.1.1 Cable Gland Models (8002-1-1, 8002-1-2, 8002-1-3)

1) Open the datalogger by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**

2) Loosen the nut on the cable fitting and remove the white plastic dowel.

3) Thread the transducer cable through the cable fitting.

4) Wire each conductor of the cable into the correct position in the terminal block by pressing down on the corresponding orange tab at the back, inserting the conductor, and then releasing the orange tab. Refer to Figure 1 and Table 1 for transducer wiring information. (See also Appendix B.)

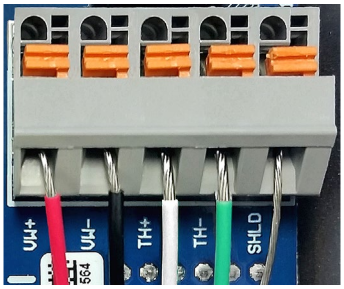

Figure 1 - Terminal Connections

Position	Color	Description
VW+	RED	Vibrating Wire +
VW-	BLACK	Vibrating Wire -
TH+	WHITE	Thermistor +
TH-	GREEN	Thermistor -
SHLD	BARE	Analog Ground (shields)

Table 1 - Transducer Wiring

5) Tighten the nut on the cable fitting so that it securely grips the cable. **This must be done to ensure that water does not enter the enclosure. (Beware of overtightening, which may damage the plastic threads.)**

3.1.2 10-pin Bulkhead Models (8002-1A-1, 8002-1A-2, 8002-1A-3)

Sensors are attached to the datalogger with a 10-pin Bulkhead connector. Align the grooves on the transducer connector (male), with the connector on the unit (female). Push the connector into place and then twist the outer ring of the male connector until it locks.

3.2 Battery Installation

Install the batteries as follows:
(For units manufactured prior to September 2018 refer to Appendix G.)

1) Open the device by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**

2) Install the batteries by aligning the positive (+) side of the D cells with the left side of the battery holder. Push the batteries straight down into the holder.

Figure 2 - Battery Detail

3) The battery select switch (located to the right of the battery holder) is set to "Alkaline" at the factory. Always use the Alkaline position, even when lithium batteries are installed.

If the optional 8002-8 aluminum mounting bracket has been purchased, follow the instructions in Section 3.3, otherwise continue to Section 3.4.

3.3 Optional 8002-7 Mounting Bracket

(See Appendix I. for mounting bracket dimensions)

If the optional 8002-7 aluminum mounting bracket has been purchased install it as follows:

1) Insert the four cap screws provided into the large holes located on the top rim of the enclosure. (When fully inserted the end of each cap screw will protrude from the bottom of the enclosure.)
2) Slide a nylon washer onto the end of each cap screw.

3) Screw the cap screws into the threaded holes in the mounting bracket using the provided hex key.

Figure 3 shows the completed installation

Figure 3 - Aluminum Mounting Bracket Installed

3.4 Final Steps

After the batteries have been installed:

2) Remove the desiccant packs from the plastic seal top bag they were shipped in and place them inside the enclosure.

3) Reinstall the cover. Ensure that the rubber gasket clean and properly seated in the groove on the underside of the cover. Tighten the screws a little at a time, working in a diagonal pattern. Make sure the cover seals tightly and evenly.

3.5 PC Connection

3.5.1 RS-232 Connection (8002-1-1, 8002-1A-1, 8002-WP-1)

Connect the supplied LC-2x16 RS-232 Communications cable (S-8001-6) to the COM port of the LC-2x16 datalogger. The protective cap on the datalogger COM connector is removed by pushing in and turning. Plug the DB-9 end of the RS-232 Communications cable into the host computer's RS-232 port (either internal or external via a USB to Serial converter).

3.5.2 USB Connection (8002-1-2, 8002-1A-2, 8002-WP-2)

Remove the protective cap from the 10-pin Bendix connector by turning it counterclockwise. (For waterproof models, the 10-pin Bendix connector is located inside the logger, on the bottom of the PCB assembly.) Connect the supplied LC-2x4 USB Communications cable (COM-109) to the USB port of the LC-2 datalogger. Connect the USB-A end of the USB cable into an available USB-2.0 port on the host computer.

NOTE: On certain PCs with operating systems older than XP, Service Pack 3, the LC-2 may require the installation of a driver to properly communicate with the PC. If the PC does not recognize the datalogger's internal USB to serial converter then the *USB driver for GEOKON devices* may need to be installed from the GEOKON website.

3.5.3 RS-485 Connection (8002-1-3)

Make the COM port connection per Section 2.4.1 (RS-232) or 2.4.2 (USB), and then refer to Appendix F, Networking, to establish communications.

3.6 Software Installation and Setup

Agent software is used to setup, communicate, and download data from the LC-2. Agent can be down loaded from the GEOKON website. Please refer to the Agent Instruction manual for further instructions.

4. MAINTENANCE

Although Model LC-2 Datalogger is designed to operate in field environments, nevertheless there are some basic maintenance procedures that should be followed to insure maximum reliability and functionality.

4.1 Keeping the Inside of the Box Dry

The LC-2 datalogger is designed to be splash proof and rain proof but is not designed to be submersible under water. The LC-2 enclosure lid is sealed by a gasket, which will remain sealed so long as the lid screws are kept tight. Most important is to make sure that the Hubble connector around the cable entry is securely tightened so that the internal grommet grips and seals around the cable. LC-2 models that use a 10-pin connector as a cable entry are equipped with sealing caps, which must be kept tightened to the connector when the connector is not in use.

Despite all these precautions, the LC-2 may encounter leakage along the cable if the cable is cut, and/or condensation problems especially in humid environments. In these environments, it is recommended that the internal desiccant pack be replaced at the necessary intervals to prevent condensation from corroding or shorting out the internal electronics.

4.2 Cleaning

The outside of the box can be cleaned using a cloth dampened with soap and water. DO NOT USE ANY TYPES OF SOLVENTS OR SCOURING AGENTS!

The connector sockets can be cleaned using a small stiff brush (small painters brush) dipped in soap and water. The sockets are water resistant; the internal electronics will not be adversely affected by them filling with water or other liquids. Be aware however, readings could be affected by shorting or other effects of an improper connection due to fluids being present in the connector. Dry connections thoroughly before use.

4.3 Batteries

When the unit is not in use, especially for extended periods of time, the batteries should be removed to prevent damage due to leakage. The warranty does not cover damage due to battery leakage. The table below details the approximate operating times for the various types of D cell batteries that may be used with the Model LC-2.

Battery Chemistry (Two D cells)	Battery Pack Voltage	Battery Capacity	Three Second Scan Rate	One Minute Scan Rate	One Hour Scan Rate	One Day Scan Rate
Lithium	7.2V	17 AHr	26.1 days	1.3 years	11.3 years	12.9 years
Alkaline	3V	13 AHr	8.9 days	157.3 days	2.9 years	3.3 years
Carbon-Zinc	3V	5 AHr	3.5 days	60.5 days	1.1 years	1.3 years

Table 2 - Approximate Operating Times

The above table assumes a constant temperature environment of 25 °C (not field conditions!). Battery life is shortened by temperature extremes. For models 8002-1-2 and 8002-1A-2, if the datalogger is continuously connected to an active computers USB port, all operating power will be supplied via the USB port. As soon as USB power is lost, the datalogger will immediately switch over to its internal 3V (or external 12V) battery pack.

Batteries should be replaced when the measured voltage drops below 1.8 VDC (internal D cells) or 10.5 VDC (external 12 VDC battery)[1]. All data and operating parameters are retained when removing batteries, even for an extended period (years) of time due to non-volatile EEPROM memory. If the datalogger stopped logging due to low battery voltage, it will resume logging as soon as new batteries are installed.

[1]The datalogger electronics will stop the datalogger from logging and disable RS-485 communications if the battery goes below 1.6 VDC (internal D cells) or 5.5 VDC (external 12V battery).

5. TROUBLESHOOTING

Listed below are a few commonly experienced problems and remedial action. Contact the factory should a problem arise not explained herein or additional information be needed.

Symptom: Unit will not respond to communications:

- ✓ Wrong COM port selected.
- ✓ If RS-232 or RS-485 communications are being used, the internal batteries of the datalogger may be low, dead, or inserted incorrectly. Replace/check the batteries. (Units manufactured before September 2018 were supplied with an aluminum battery holder, which may need adjusting; refer to Appendix I.)
- ✓ If RS-485 communications is being used, the **<ENTER>**,**<ENTER>**, **#**,**datalogger address**, **<ENTER>** key sequence is not being sent. Refer to Appendix E for further information.

Symptom: Vibrating wire gauge measurement reads -999999.0:

- ✓ Using an ohmmeter, check connections to the vibrating wire gauge leads (Usually the red and black conductors, or pins A and B on a 10-pin bulkhead connector.) Resistance should be between 90 and 180 ohms. Remember to add the cable resistance at approximately 14.7Ω per 1000 ft. or 48.5Ω per km at 20 °C. Multiply this factor by two to account for both directions. If the resistance is very high or infinite (megohms), the cable is probably broken or cut. If the resistance is very low (<20Ω), the gauge conductors may be shorted.
- ✓ Check the datalogger with another gauge. If it reads okay, the datalogger may be malfunctioning.
- ✓ Check that the proper gauge type is selected and connected properly. (See Table 1 in Section 3.1.)

Symptom: Gauge measurement (analog or vibrating wire) reads -999999.9:

- ✓ A mathematical overrange has occurred. Check the magnitude of the reading, zero reading, multiplier, and offset. The result must be in the range of 1.0×10^{-7} to 1.0×10^{7}.

Symptom: Vibrating wire gauge reading is unstable:

- ✓ Is there a source of electrical noise nearby? Likely candidates are generators, motors, arc welding equipment, high voltage lines, etc. If possible, move the datalogger and transducer cable away from the power lines or electrical equipment.
- ✓ Check if the proper gauge type is selected. (See Table 1 in Section 3.1.)

Symptom: Thermistor measurement shows -99.9 degrees Celsius:

- ✓ Indicates open circuit to thermistor leads. Check connections from datalogger to thermistor leads. If okay, check thermistor with ohmmeter. Appendix D details the resistance versus temperature relationship. It should read between 10K ohms and 2.4K ohms (0 to +30 °C). If thermistor checks out okay, consult the factory to schedule repair of unit.

APPENDIX A. SPECIFICATIONS

A.1 Measurement Capability

- Vibrating Wire (all types).
- External temperature (thermistor).
- Internal temperature (thermistor).
- Main battery voltage (3V and 12V)
- RTC lithium battery voltage.

A.2 Power

Power supply:	Internal 3 VDC (7.5Vmax) or External 12 VDC (15Vmax)
Processing/communication current:	<100 mA
VW measurement current:	<250 mA
Quiescent current:	<600 µA
RTC battery type:	Panasonic CR2032 3V lithium coin cell: 20mm, 225 mAHr
RTC battery life:	>10 years
Operating temperature range:	–30 to +50° C

A.3 Memory

Data memory:	320K EEPROM
Program memory:	24K EEPROM
Array storage	8000 or 16000
Data memory type:	ring (oldest overwrite)
Array elements:	ID (optional) Year Julian day (or month,day) Time (hhmm or hh,mm) Seconds Battery voltage Datalogger temperature Transducer reading Transducer temperature Array #

A.4 Clock

Features:	full calendar
Time format:	12 or 24 hour (selectable)
Date Format:	mm,dd or Julian (selectable)
Accuracy:	±2 minutes per year

A.5 Serial Interface (All LC-2 Models)

Speed: 9600 and 115,200 bps (version 5.2.X and later)
Parameters: Eight Data bits
One Stop bit
No Parity
No Flow Control
Data output format: ASCII text

A.6 RS-485 Network

Maximum nodes: 256
Maximum cable length: 4000', 1.22 km

A.7 Vibrating Wire Measurement

Excitation sweep range:	400 Hz to 4500 Hz
Frequency Measurement Technique:	Adaptive Multiple Period Averaging
Accuracy:	0.05% F.S.R. (450-4000 Hz)
Resolution:	0.001 digit

A.8 Internal/External Temperature Measurement

Thermistor:	Dale #1C3001-B3 (YSI 44005)	(Standard)
	Thermometrics BR55KAKA822J	(High Temp 1)
	U.S. Sensor 103JL1A	(High Temp 2)
Transducer accuracy:	±0.5° C	
Measurement accuracy:	0.5% FSR	
Resolution:	0.01° C (Internal)	
	0.1° C (External)	
Linearization error:	0.02% FSR	
Temperature range:	–40 to +60° C Standard Thermistor	
	0 to +200º C High Temp Thermistor	
Overall accuracy:	1.0% FSR (±1°)	

A.9 Main Battery Measurement

3V Battery:		**12V Battery:**	
Range:	0 to 7.5 VDC	Range:	0 to 15 VDC
Accuracy:	±1.83mV	Accuracy:	±3.662mV
Resolution:	0.01 VDC	Resolution:	0.01 VD

APPENDIX B. CONNECTOR PINOUTS

B.1 Transducer Connections

B.1.1 Transducer Cable Connections (8002-1-2)

Terminal block Position	Internal Wire Color	PCB connector J7 pin	Description	Cable Wire Color
VW+	Brown	1	Vibrating Wire +	RED
VW-	Red	2	Vibrating Wire -	BLACK
TH+	Orange	3	Thermistor +	WHITE
TH-	Yellow	4	Thermistor -	GREEN
S	Green	5	Analog Ground (shields)	BARE WIRE

Table 3 - Transducer Cable Connections (USB Datalogger)

B.1.2 Transducer Cable Connections (8002-1-1)

Terminal block Position	Internal Wire Color	PCB connector J6 pin	Description	Cable Wire Color
VW+	Brown	1	Vibrating Wire +	RED
VW-	Red	2	Vibrating Wire -	BLACK
TH+	Orange	3	Thermistor +	WHITE
TH-	Yellow	4	Thermistor -	GREEN
S	Green	5	Analog Ground (shields)	BARE WIRE

Table 4 - Transducer Cable Connections (Serial Datalogger)

B.2 Sensor Connector Pin-out (8002-1A-1, 8002-2A-1)

The mating 10 pin Bendix plug is part number PT06F-12-10P.

10 Pin Bendix	Inside Color	Description	Transducer Wire Color
A	Brown	Vibrating Wire +	Red
B	Red	Vibrating Wire -	Black
C	Orange	Thermistor +	White
D	Yellow	Thermistor -	Green
E	Green	Analog Ground (shields)	Shield
F	Blue	+5VDC Supply (switched)	N/A
G	Violet	Digital Ground	N/A
H	Grey	Mux Reset	N/A
J	White	Mux Clock	N/A
K	Black	Digital Ground	N/A

Table 5 - Sensor Connector Pin-out

B.3 COM Connector Pin-out

The mating 10 pin Bendix plug is part number PT06F-12-10P.

10 Pin Bendix	Internal Wire Color	PCB connector J5 pin	Description USB	RS-232
A	Brown	1	USB VCC	Digital Ground
B	Red	2	USB DM	Tx
C	Orange	3	USB DP	Rx
D	Yellow	4	Digital Ground	RTS
E	Green	5	RS-485 RX	CTS
F	Blue	6	RS-485 /RX	n.c.
G	Violet	7	RS-485 TX	DTR
H	Grey	8	RS-485 /TX	+5V
J	White	9	RS-485 +12V	n.c.
K	Black	10	RS-485 Ground	Digital Ground

Table 6 - COM Connector Pin-out

B.4 RS-485 Connector Pin-out (Optional – 8002-1-3)

10 Pin Bendix	Internal Wire Color	PCB connector J6 pin	Description
A	Brown	1	No Connection
B	Red	2	No Connection
C	Orange	3	No Connection
D	Yellow	4	Digital Ground
E	Green	5	RS-485 RX
F	Blue	6	RS-485 /RX
G	Violet	7	RS-485 TX
H	Grey	8	RS-485 /TX
J	White	9	RS-485 +12V
K	Black	10	RS-485 Ground

Table 7 - RS-485 Connector Pin-out

APPENDIX C. SAMPLE DATA FILES

C.1 Sample Raw Data File

Note: the datalogger ID feature (see **ID** command) is not being used.

2009,94,1401,30,3.22,24.02,10010.198,25.0,1
2009,94,1401,35,3.22,24.10,10010.213,25.0,2
2009,94,1401,40,3.22,24.13,10009.919,25.0,3
2009,94,1401,45,3.22,24.22,10010.012,25.0,4
2009,94,1401,50,3.22,24.25,10010.125,25.0,5
2009,94,1401,55,3.22,24.25,10010.165,25.0,6
2009,94,1402,0,3.22,24.13,10010.205,25.0,7
2009,94,1402,5,3.22,24.05,10010.031,25.0,8
2009,94,1402,10,3.22,23.99,10010.158,25.0,9
2009,94,1402,15,3.22,23.96,10010.052,25.0,10
2009,94,1402,20,3.22,23.90,10010.140,25.0,11
2009,94,1402,25,3.22,23.87,10010.313,25.0,12
2009,94,1402,30,3.22,23.87,10009.919,25.0,13
2009,94,1402,35,3.22,23.84,10010.146,25.0,14
2009,94,1402,40,3.22,23.84,10010.454,25.0,15
2009,94,1402,45,3.22,23.84,10010.227,25.0,16
2009,94,1402,50,3.22,23.82,10010.280,25.0,17

The comma delineated columns above represent the following:

Column 1 represents the year when the array was stored.
Column 2 represents the Julian day (or day and month, see Appendix L.5 to set date format).
Column 3 represents the time (see Appendix L.42 to display or set the time format).
Column 4 represents the seconds.
Column 5 represents the main battery voltage (alkaline batteries, nominal 3.0 VDC).
Column 6 represents the internal temperature in degrees Celsius.
Column 7 represents the datalogger measurement (as specified by the Gnn command).
Column 8 represents the external temperature in degrees Celsius.
Column 9 represents the array number.

C.2 Sample Formatted Data File

Year	Day	Time	Secs	Battery	D_Temp	Digits	S_Temp	Array
2009	94	1401	30	3.22	24.02	10010.198	25.0	1
2009	94	1401	35	3.22	24.10	10010.213	25.0	2
2009	94	1401	40	3.22	24.13	10009.919	25.0	3
2009	94	1401	45	3.22	24.22	10010.012	25.0	4
2009	94	1401	50	3.22	24.25	10010.125	25.0	5
2009	94	1401	55	3.22	24.25	10010.165	25.0	6
2009	94	1402	0	3.22	24.13	10010.205	25.0	7
2009	94	1402	5	3.22	24.05	10010.031	25.0	8
2009	94	1402	10	3.22	23.99	10010.158	25.0	9
2009	94	1402	15	3.22	23.96	10010.052	25.0	10
2009	94	1402	20	3.22	23.90	10010.140	25.0	11
2009	94	1402	25	3.22	23.87	10010.313	25.0	12
2009	94	1402	30	3.22	23.87	10009.919	25.0	13
2009	94	1402	35	3.22	23.84	10010.146	25.0	14
2009	94	1402	40	3.22	23.84	10010.454	25.0	15
2009	94	1402	45	3.22	23.84	10010.227	25.0	16
2009	94	1402	50	3.22	23.82	10010.280	25.0	17

APPENDIX D. THERMISTOR TEMPERATURE DERIVATION

D.1 Standard Thermistor

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3
Resistance to Temperature Equation:

$$T=\frac{1}{A+B(LnR)+C(LnR)^3}-273.15\ °C$$

Equation 1 - Resistance to Temperature

Where;
T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance.
$A = 1.4051 \times 10^{-3}$
$B = 2.369 \times 10^{-4}$
$C = 1.019 \times 10^{-7}$
Note: Coefficients calculated over the −50 to +150° C. span.

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
201.1K	-50	16.60K	-10	2417	+30	525.4	+70	153.2	+110
187.3K	-49	15.72K	-9	2317	31	507.8	71	149.0	111
174.5K	-48	14.90K	-8	2221	32	490.9	72	145.0	112
162.7K	-47	14.12K	-7	2130	33	474.7	73	141.1	113
151.7K	-46	13.39K	-6	2042	34	459.0	74	137.2	114
141.6K	-45	12.70K	-5	1959	35	444.0	75	133.6	115
132.2K	-44	12.05K	-4	1880	36	429.5	76	130.0	116
123.5K	-43	11.44K	-3	1805	37	415.6	77	126.5	117
115.4K	-42	10.86K	-2	1733	38	402.2	78	123.2	118
107.9K	-41	10.31K	-1	1664	39	389.3	79	119.9	119
101.0K	-40	9796	0	1598	40	376.9	80	116.8	120
94.48K	-39	9310	+1	1535	41	364.9	81	113.8	121
88.46K	-38	8851	2	1475	42	353.4	82	110.8	122
82.87K	-37	8417	3	1418	43	342.2	83	107.9	123
77.66K	-36	8006	4	1363	44	331.5	84	105.2	124
72.81K	-35	7618	5	1310	45	321.2	85	102.5	125
68.30K	-34	7252	6	1260	46	311.3	86	99.9	126
64.09K	-33	6905	7	1212	47	301.7	87	97.3	127
60.17K	-32	6576	8	1167	48	292.4	88	94.9	128
56.51K	-31	6265	9	1123	49	283.5	89	92.5	129
53.10K	-30	5971	10	1081	50	274.9	90	90.2	130
49.91K	-29	5692	11	1040	51	266.6	91	87.9	131
46.94K	-28	5427	12	1002	52	258.6	92	85.7	132
44.16K	-27	5177	13	965.0	53	250.9	93	83.6	133
41.56K	-26	4939	14	929.6	54	243.4	94	81.6	134
39.13K	-25	4714	15	895.8	55	236.2	95	79.6	135
36.86K	-24	4500	16	863.3	56	229.3	96	77.6	136
34.73K	-23	4297	17	832.2	57	222.6	97	75.8	137
32.74K	-22	4105	18	802.3	58	216.1	98	73.9	138
30.87K	-21	3922	19	773.7	59	209.8	99	72.2	139
29.13K	-20	3748	20	746.3	60	203.8	100	70.4	140
27.49K	-19	3583	21	719.9	61	197.9	101	68.8	141
25.95K	-18	3426	22	694.7	62	192.2	102	67.1	142
24.51K	-17	3277	23	670.4	63	186.8	103	65.5	143
23.16K	-16	3135	24	647.1	64	181.5	104	64.0	144
21.89K	-15	**3000**	**25**	624.7	65	176.4	105	62.5	145
20.70K	-14	2872	26	603.3	66	171.4	106	61.1	146
19.58K	-13	2750	27	582.6	67	166.7	107	59.6	147
18.52K	-12	2633	28	562.8	68	162.0	108	58.3	148
17.53K	-11	2523	29	543.7	69	157.6	109	56.8	149
								55.6	150

Table 8 - Thermistor Resistance versus Temperature

D.2 High Temperature Thermistor

Resistance to Temperature Equation for *US Sensor 103JL1A*:

$$T=\frac{1}{A+B(LnR)+C(LnR)^3+D(LnR)^5}-273.15\ ^\circ C$$

Equation 2 - High Temperature Resistance to Temperature

Where;
T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance.
$A = 1.127670 \times 10^{-3}$
$B = 2.344442 \times 10^{-4}$
$C = 8.476921 \times 10^{-8}$
$D = 1.175122 \times 10^{-11}$

Note: Coefficients optimized for a curve "J" Thermistor over the temperature range of 0°C to +250°C.

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
32,650	0	7,402	32	2,157	64	763.5	96	316.6	128	148.4	160	76.5	192	42.8	224
31,029	1	7,098	33	2,083	65	741.2	97	308.7	129	145.1	161	75.0	193	42.1	225
29,498	2	6,808	34	2,011	66	719.6	98	301.0	130	142.0	162	73.6	194	41.4	226
28,052	3	6,531	35	1,942	67	698.7	99	293.5	131	138.9	163	72.2	195	40.7	227
26,685	4	6,267	36	1,876	68	678.6	100	286.3	132	135.9	164	70.8	196	40.0	228
25,392	5	6,015	37	1,813	69	659.1	101	279.2	133	133.0	165	69.5	197	39.3	229
24,170	6	5,775	38	1,752	70	640.3	102	272.4	134	130.1	166	68.2	198	38.7	230
23,013	7	5,545	39	1,693	71	622.2	103	265.8	135	127.3	167	66.9	199	38.0	231
21,918	8	5,326	40	1,637	72	604.6	104	259.3	136	124.6	168	65.7	200	37.4	232
20,882	9	5,117	41	1,582	73	587.6	105	253.1	137	122.0	169	64.4	201	36.8	233
19,901	10	4,917	42	1,530	74	571.2	106	247.0	138	119.4	170	63.3	202	36.2	234
18,971	11	4,725	43	1,480	75	555.3	107	241.1	139	116.9	171	62.1	203	35.6	235
18,090	12	4,543	44	1,432	76	539.9	108	235.3	140	114.5	172	61.0	204	35.1	236
17,255	13	4,368	45	1,385	77	525.0	109	229.7	141	112.1	173	59.9	205	34.5	237
16,463	14	4,201	46	1,340	78	510.6	110	224.3	142	109.8	174	58.8	206	33.9	238
15,712	15	4,041	47	1,297	79	496.7	111	219.0	143	107.5	175	57.7	207	33.4	239
14,999	16	3,888	48	1,255	80	483.2	112	213.9	144	105.3	176	56.7	208	32.9	240
14,323	17	3,742	49	1,215	81	470.1	113	208.9	145	103.2	177	55.7	209	32.3	241
13,681	18	3,602	50	1,177	82	457.5	114	204.1	146	101.1	178	54.7	210	31.8	242
13,072	19	3,468	51	1,140	83	445.3	115	199.4	147	99.0	179	53.7	211	31.3	243
12,493	20	3,340	52	1,104	84	433.4	116	194.8	148	97.0	180	52.7	212	30.8	244
11,942	21	3,217	53	1,070	85	421.9	117	190.3	149	95.1	181	51.8	213	30.4	245
11,419	22	3,099	54	1,037	86	410.8	118	186.1	150	93.2	182	50.9	214	29.9	246
10,922	23	2,986	55	1,005	87	400.0	119	181.9	151	91.3	183	50.0	215	29.4	247
10,450	24	2,878	56	973.8	88	389.6	120	177.7	152	89.5	184	49.1	216	29.0	248
10,000	**25**	2,774	57	944.1	89	379.4	121	173.7	153	87.7	185	48.3	217	28.5	249
9,572	26	2,675	58	915.5	90	369.6	122	169.8	154	86.0	186	47.4	218	28.1	250
9,165	27	2,579	59	887.8	91	360.1	123	166.0	155	84.3	187	46.6	219		
8,777	28	2,488	60	861.2	92	350.9	124	162.3	156	82.7	188	45.8	220		
8,408	29	2,400	61	835.4	93	341.9	125	158.6	157	81.1	189	45.0	221		
8,057	30	2,316	62	810.6	94	333.2	126	155.1	158	79.5	190	44.3	222		
7,722	31	2,235	63	786.6	95	324.8	127	151.7	159	78.0	191	43.5	223		

Table 9 - Thermistor Resistance Versus Temperature for HT Models

APPENDIX E. NETWORKING

E.1 Description

The Model LC-2 Datalogger is capable of being networked by way of a single, optically isolated RS-485 communications cable. Utilizing one 8001-5 (RS-232) or 8002-5(USB) RS-485 interface adapter at the computer (data collection) end, up to 256 Model LC-2 Dataloggers* may be networked. Also, the maximum network length* can be up to 4000 feet (1.22 km). RS-485 is chosen as the transmission medium due to its inherent noise immunity and its capability to support a bus type of network architecture. The 8001-5 and 8002-5 RS-485 interface adapters are battery powered to allow for collection of data in the field. An AC adapter is also provided if mains power is available.

Each datalogger appears as a “node” on the RS-485 bus, with its own unique address. To communicate with a specific datalogger, the user transmits the address of the datalogger via the #nnn command, where nnn represents the network address of the datalogger. Valid addresses are 1 thru 256.

Connect one end of the supplied RS-485 network cable into the 10-pin “Network In” connector on the LC-2 enclosure and connect the other end to the 10-pin “Network Out” connector on the 8001-5 or 8002-5 RS-485 interface. Connect additional LC-2 dataloggers in daisy chain fashion, using RS-485 network cables to connect the “Network Out” of the first LC-2 to “Network In” of the second LC-2, “Network Out” of the second LC-2 to “Network In” of the third LC-2 and so on.

On the last networked LC-2 (the one physically furthest from the 8001-5 or 8002-5 RS-485 interface), set the TERMINATION JUMPER across pins one and two of PCB connector JP1. On all the remaining networked LC-2 dataloggers, ensure that this jumper is set across pins two and three.

To access this jumper, the battery pack will need to be removed. For this reason, LC-2 networks are typically configured at the factory before shipment.

Finally, it is helpful to set the datalogger ID# (see Appendix L.9) to agree with the network address. This will tend to eliminate any confusion when collecting data.

For further information, refer to Appendix L.9 as well as Appendix L.20 through 4.24.

* The total number of networked dataloggers is limited by the total network cable length. Contact a GEOKON Sales Engineer for further information.

E.2 Example of a Four Datalogger Networking Session

1) This session assumes that there are four dataloggers running at five second scan intervals.

2) Press <ENTER> to wake the dataloggers from sleep. At this point, each datalogger is "listening" for its network address to be transmitted down the RS-485 bus.

3) To communicate with Datalogger #1 and observe several readings, type #1<ENTER>. Datalogger #1 returns:

```
Network address: 1
*
1,2009,3,9,16,25,0,2.98,24.6,14.8114,20.5,1059
1,2009,3,9,16,25,5,2.98,24.7,14.8114,20.4,1060
1,2009,3,9,16,25,10,2.98,24.7,14.8114,20.5,1061
*E
```

Note that the datalogger ID, which is the first entry for each ASCII character string, corresponds to the network address. **This should be set by the user during initial datalogger setup via the ID command**.

Typing E<ENTER> puts the datalogger back to sleep and disconnects it from the RS-485 bus. The datalogger will continue to wake up periodically (scan rate setting) to take a data reading. **The E command must be used to disconnect from the current datalogger and allow connection to the next datalogger**.

4) To communicate with Datalogger #2 and observe several readings, type <ENTER> to wake the dataloggers and then type #2<ENTER>. Datalogger #2 returns:

```
Network address: 2
*
2,2009,3,9,16,23,25,2.95,24.7,14.8009,20.4,1040
2,2009,3,9,16,23,30,2.96,24.7,14.8009,20.4,1041
*E
```

5) Doing the same for Datalogger number three and four results in:

```
Network address: 3
*
3,2009,3,9,16,30,0,2.98,24.7,14.8116,20.5,1102
3,2009,3,9,16,30,5,2.98,24.7,14.8114,20.5,1103
*E

Network address: 4
*
4,2009,3,9,16,31,26,2.96,24.8,14.8110,20.4,1115
4,2009,3,9,16,31,31,2.96,24.8,14.8111,20.4,1116
*E
```

APPENDIX F. LITHIUM COIN CELL

F.1 Description

Under normal operating conditions, the 1.5V D cells provide all the power required to operate the LC-2 datalogger. To maintain the correct date and time settings for those periods when the D cells are removed, the LC-2 datalogger incorporates a 3V lithium coin cell (Panasonic CR2032) to supply operating current to the internal Real Time Clock.

Since the power requirements of the Real Time Clock circuit are minimal (3µA max.), the clock will continue to operate for up to 10 years under these conditions.

However, if the lithium cell voltage falls to 2.5V or less, it should be replaced using the following replacement procedure.

F.2 Replacement Procedure

Materials Required:

- 1/4" Slotted Screwdriver
- 1/4" Nut Driver
- CR2032 Lithium Coin Cell (GEOKON P/N BAT-115)
- Disposable Grounding Wrist Strap (3M P/N 2209 or equivalent)

Procedure:

1) Put on the disposable grounding wrist strap and connect to a good earth ground.

2) Using the 1/4" slotted screwdriver, loosen the four captive screws and remove the datalogger cover.

3) Remove the two D cells.

4) For Models 8002-1-1, 8002-2-1, 8002-3-1: Disconnect the transducer wires at the terminal block mounted on the battery board by pressing down on the orange tab at the back of the block and then removing the conductor.

5) Disconnect the 10-pin DIP connector (ribbon cable) from position J1 on the battery board.

6) Using the 1/4" slotted screwdriver, remove the four 3/8" 6x32 battery board mounting screws.

7) Lift the battery board and disconnect the two-wire Molex connector (red and black wires) from the main PCB, which is located below the battery board. Set the battery board aside.

8) Using the 1/4” nut driver, remove the four standoffs securing the printed circuit board to the case.

9) Lift the main PCB up to expose the bottom of the board.

10) Using the 1/8” slotted screwdriver, gently pry the lithium coin cell battery from the battery holder.

11) Insert the replacement lithium coin cell into the battery holder (+ side facing out).

12) Reinstall the main PCB back into the enclosure.

13) Thread the four standoffs onto the set screws, using the nut driver to gently tighten the standoffs.

14) Reconnect the two cables between the battery board and the main PCB. If unsure of where the cables should be connected to, refer to Table 10 below.

Position on Battery Board	To Main PCB
J4	J3 (J4 for 12V external batteries)
J1	J6 for RS-232 models
	J7 for USB models

Table 10 – Ribbon Cable Connections from Battery Board (upper) to Main PCB (lower)

15) Position the battery board over the standoffs and reinstall using the four 3/8” 6x32 mounting screws.

16) For loggers with a cable gland (models 8002-1-1, 8002-2-1, 8002-3-1), wire the instrument cable into the terminal block as follows:

RED	VW+
BLACK	VW-
WHITE	TH+
GREEN	TH-
SHIELD	S

17) Reinstall the D cells.

18) Reinstall the datalogger cover.

Lithium coin cell replacement complete.

APPENDIX G. BATTERY REPLACEMENT INSTRUCTIONS FOR UNITS MANUFACTURED BEFORE SEPTEMBER 2018

1) Remove the four captive lock regular head screws on the top of the case and lift the cover off. Underneath the cover is the 'D' cell battery holder.

2) Remove the two batteries from the holder being careful not to bend the sides outward.

3) Insert the new batteries straight down into the battery holder. Ensure that the polarity of the batteries matches the diagram on the battery holder.

4) Check for secure connection between the battery terminals and holder. If a gap exists, remove batteries and bend the holder sides inward. See Figure 4 below.

Proper Battery Installation **Faulty Battery Installation**

Figure 4 - Battery Installation Detail

5) Re-install the cover. Check datalogger for proper operation.

APPENDIX H. WATERPROOF LC-2

H.1 Initial Deployment

1) Remove the brass Swagelok nut from the Swagelok bulkhead using a 9/16” wrench. A second 9/16” wrench should be used on the bulkhead to prevent it from rotating while loosening or tightening the Swagelok nut. (Note: The white plastic dowel can be placed inside the logger for future use if the cable is removed and the logger needs to be stored. This will prevent water damage.)

2) Remove the screws from the top of the unit and carefully pull off the cover using the handle provided.

3) Make a mark on the cable 15 inches from the bare leads.

4) Slide the Swagelok nut and the two-part ferrule onto the cable as shown in Figure 5. It is important to note the position of each part to ensure a watertight seal. **<u>Failure to do so will result in water entry and datalogger damage.</u>**

Figure 5 - Swagelok and Ferule Orientation

Feed bare leads of instrument cable through the Swagelok bulkhead in the cover. Wire the cable’s conductors into the terminal block per Table 11.

Terminal block Position	Cable Wire Color	Description
VW+	RED	Vibrating Wire +
VW-	BLACK	Vibrating Wire -
TH+	WHITE	Thermistor +
TH-	GREEN	Thermistor -
S	BARE WIRE	Analog Ground (shields)

Table 11 - Transducer Cable Connections

5) Insert the two D cells straight down into the battery holder. Ensure that the polarity of the batteries matches the diagram on the battery holder.

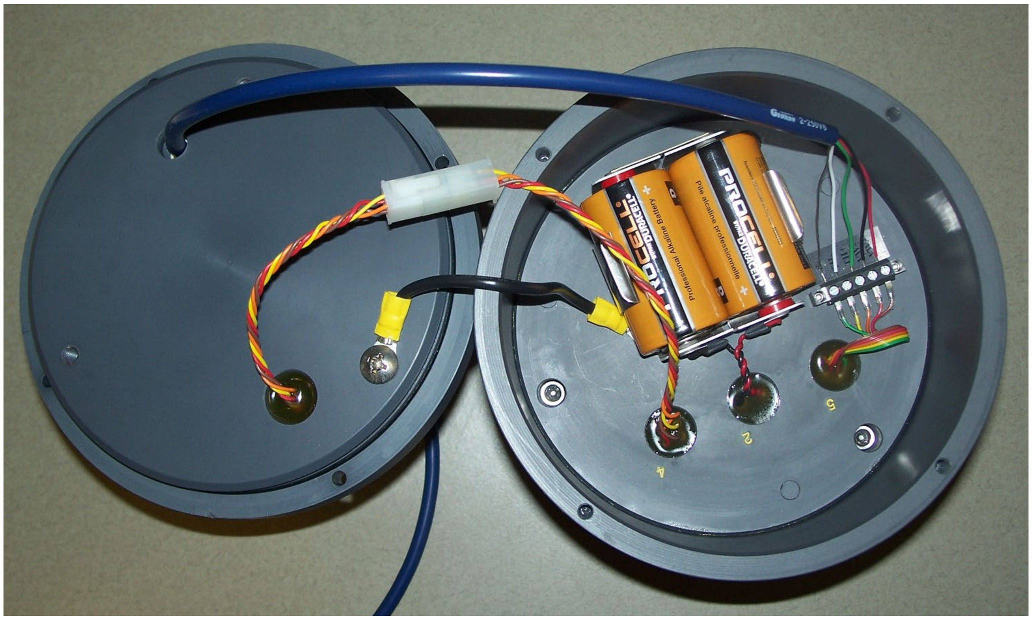

Figure 6 - Batteries and Cable Installed

6) After installing the batteries and wiring the cable into the terminal block (Figure 6), gently close the lid making sure no cables are pinched.

7) Line up the holes in the lid with the holes in the body. Install and tighten the screws in a zigzag pattern, ensuring that the cover seals tightly and evenly.

8) Screw the Swagelok nut loosely onto the bulkhead.

9) Gently feed the cable into the logger until the mark made previously is just above the top of the Swagelok nut. Tighten the Swagelok nut until it is finger tight.

10) Make a mark on the Swagelok nut as well as directly below the nut on the bulkhead (Figure 7).

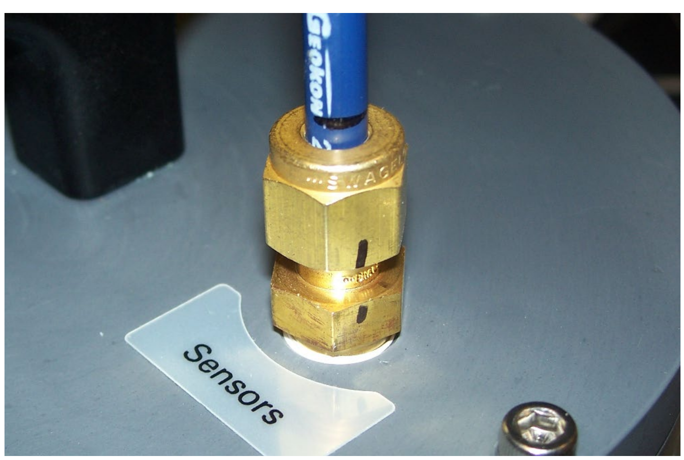

Figure 7 - Marks on the Swagelok Nut and Bulkhead

11) While holding the bulkhead with one wrench, rotate the Swagelok nut with the second wrench 1-1/4 turns using the marks as a reference point.

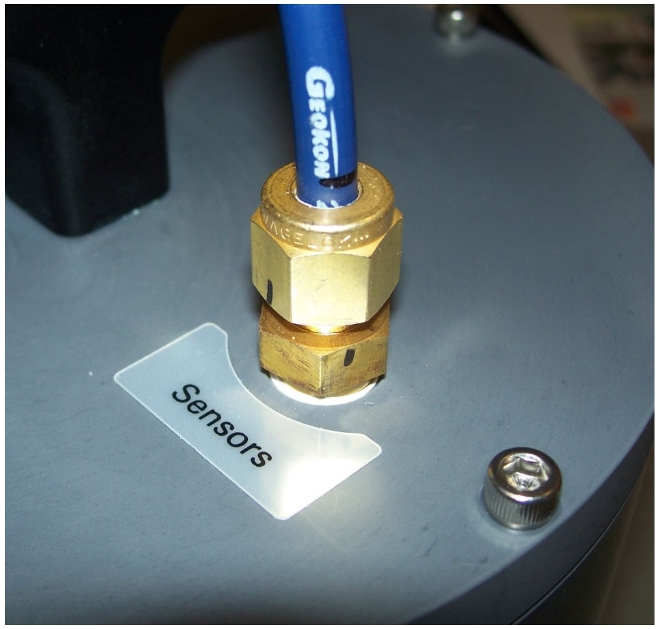

Figure 8 - Nut Position After Tightening

H.2 Changing Batteries

It is only necessary to remove the screws holding the lid in place. Do not loosen the Swagelok fitting.

H.3 Cable Removal/Reinstall

1) Loosen the Swagelok nut and remove screws holding the lid in place.

2) Disconnect the leads from the terminal block.

3) Gently remove cable from Swagelok bulkhead.

4) Nylon ferrules can be removed from cable by clipping them off. Be careful not to damage the cable sheath. (Only remove ferrules if not using same sensor, see below.)

5) If same sensor will be reinstalled, feed the cable back through the Swagelok bulkhead and attach the bare leads. Finger Tighten and this time only snug the fitting (DO NOT ROTATE 1-1/4 TURNS). The ferrules can be loosened and tightened multiple times on the same cable if they are not over tightened. Damaged ferrules should be replaced.

APPENDIX I. Mounting Bracket Dimensions

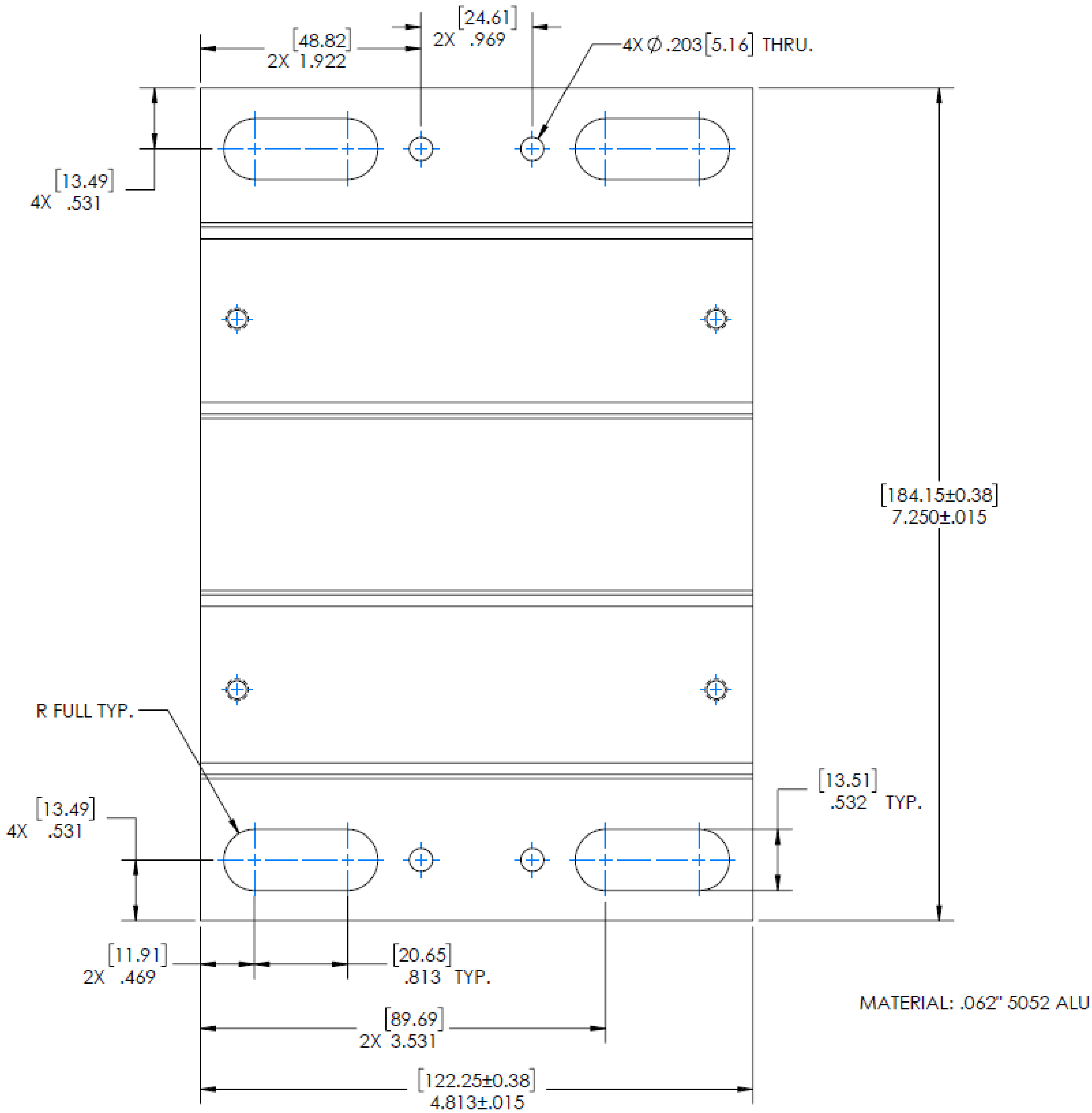

Figure 9 - Model 8002-7 Aluminum Mounting Bracket Dimensions

APPENDIX J. LOGVIEW SOFTWARE (LEGACY)

LogView is Graphical User Interface (GUI) software and is used to communicate with the datalogger, using a personal computer running a Microsoft Windows® operating system. Other general-purpose communication programs (e.g., Windows HyperTerminal™) can also be used to communicate with the Model LC-2 via text-based commands. The LogView and USB drivers install program can be downloaded at www.GEOKON.com/software.

Perform the following steps to install LogView software for each computer that will connect to an LC-2. These instructions are for computers running Windows XP. The installation procedure is very similar for computers running Windows 7, Windows 2000 and Windows 98. This installation procedure needs to be performed only once for each computer that will run LogView to communicate with a LC-2 datalogger.

NOTE: The USB drivers are only required for LC-2 models 8002-1-2, 8002-1A-2 and the 8002-5 RS-485 Interface

Make sure that the two 1.5V D cell alkaline batteries are installed in the datalogger (See Section 3.2, "Battery Installation") and that the LC-2 datalogger is **not connected** to the computer at this time.

J.1 LogView Installation

1) Using Windows Explorer, navigate to the extracted downloaded files. Double click on the file "start.bat" to start the install process.

2) Click "**Next >**" when the **Welcome** window appears.

3) When the **Choose Install Location** window appears, choose a folder for the LogView installation then click "**Next>**".

4) When the **Choose Start Menu Folder** window appears, choose an appropriate folder (default is GEOKON) then click "**Install**".

5) Click "**Next >**" when the **Java Installation Complete** window appears.

6) Click "**Finish**" when the **Completing the LogView Setup Wizard** window appears.

J.2 Launching LogView

Launching LogView can be accomplished two different ways. Double clicking on the desktop icon:

Or via the Start button: "Programs → GEOKON → LogView"

J.3 LogView Workspaces

When opening LogView for the first time, the user will be prompted to create a workspace name (see Figure 10). The workspace name can be any combination of letters and numbers and, ideally, will be descriptive in nature. See the LogView User's Guide for more information on workspaces.

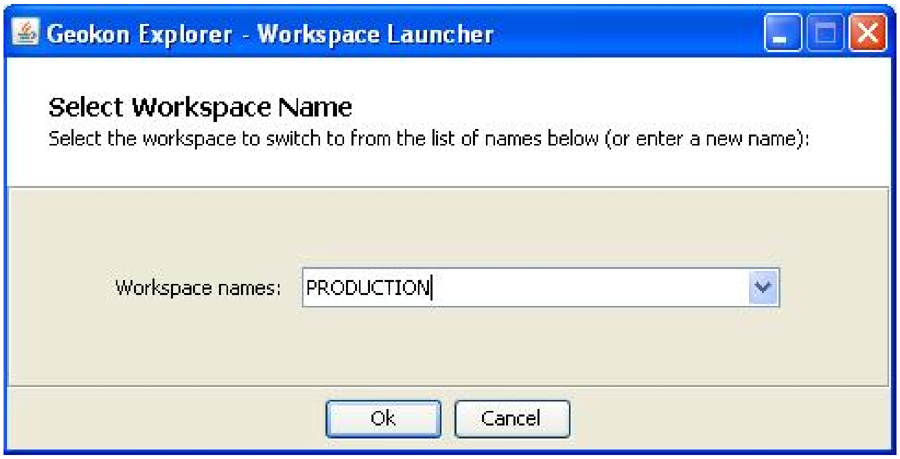

Figure 10 - Select Workspace Name

Once the workspace name has been selected, clicking on "**Ok**" causes LogView to prompt the user to choose or create a folder where all the workspace elements will be stored (see Figure 11). The folder location may be entered directly, e.g., `C:\Workspaces\East Coast` or the **Browse** button may be used to navigate to a folder location or to create a new folder (see below). This workspace location will be stored in the LogView configuration for subsequent application access. Once workspaces are created, future user access is always by name.

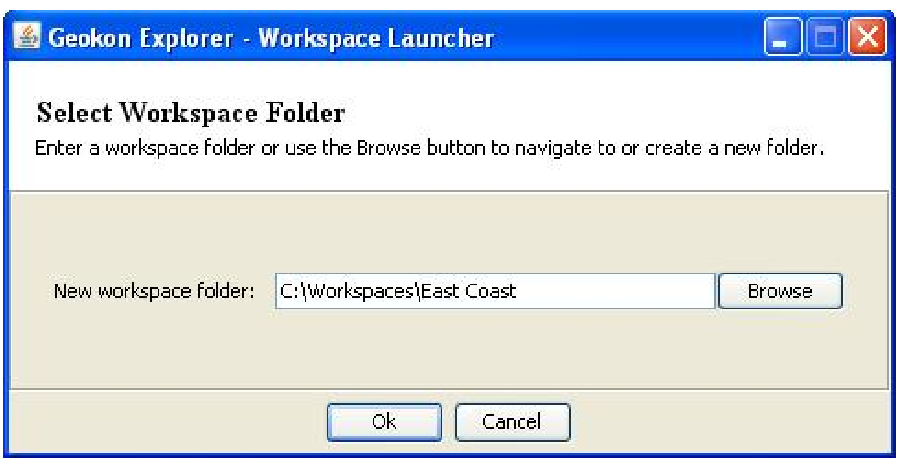

Figure 11 - Select Workspace Folder

If no other is specified, a default folder path is displayed based on the system default workspace path combined with the new workspace name. After the folder path has been specified, either the default or user selected (see Figure 11), clicking on "**Ok**" will display the main window of LogView (see Figure 12). On the left-hand side of the main window is the Project Explorer displaying the newly created workspace. The user can now add new project(s), datalogger(s), and sensor configurations to the workspace by right-clicking on the workspace and using the menu tools.

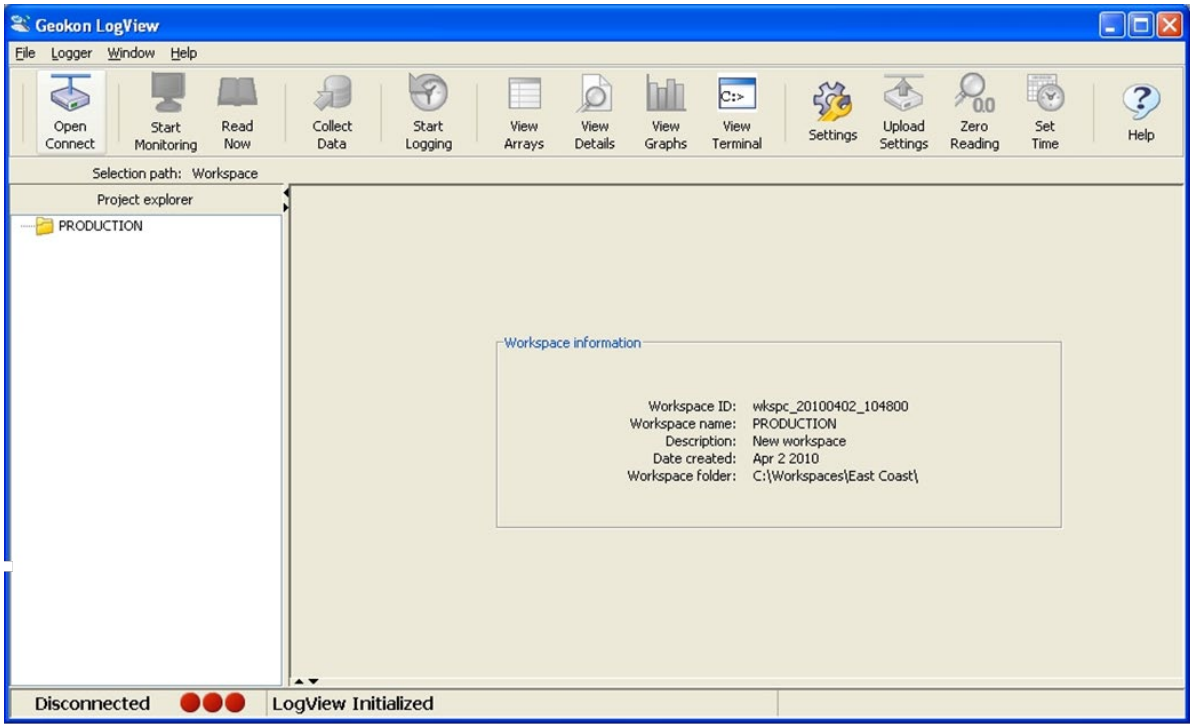

Figure 12 - LogView Main Window

J.4 Adding Projects to LogView Workspaces

Right-clicking on the "**PRODUCTION**" workspace brings up a context sensitive menu that allows the user to add projects to this workspace (using the "**New->Project**" menu selection). Select a name that makes sense for the real-world project this program will be used for. In this example, "TestLoggers" was chosen as the project name (Figure 13).

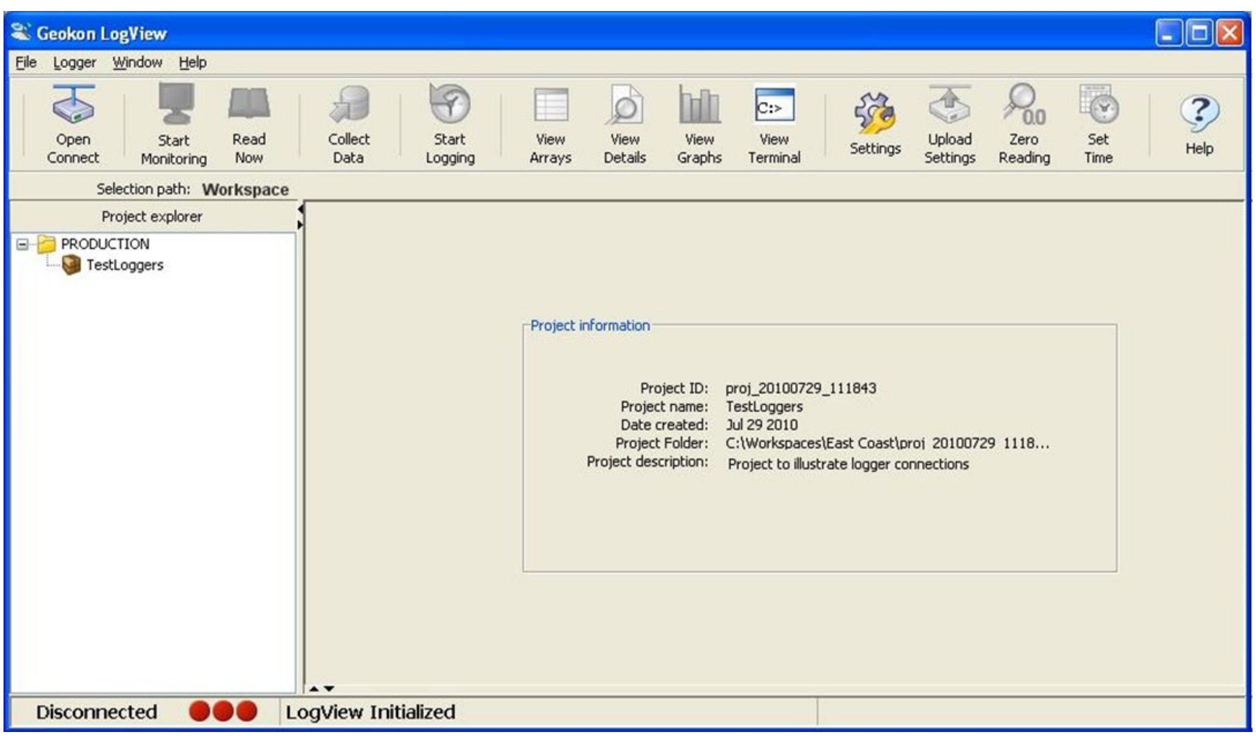

Figure 13 - LogView Main Window with New Project

J.5 Adding Dataloggers to LogView Projects

Right-clicking on the "**TestLoggers**" project brings up a context sensitive menu (see Figure 14) that allows users to add dataloggers to their projects. Selecting **New->Logger** from the context menu causes the "**Datalogger Settings**" dialog to be displayed. Like Workspaces and Projects, Dataloggers can be assigned a unique name. For this example, "MyLogger" was chosen for the Datalogger name. For a complete description of all datalogger settings please see the LogView Online Help section on Datalogger Settings. For connection purposes, the relevant tab in this dialog is "**Connection Options**" (see Figure 15).

Once connected to a PC, all LC-2 dataloggers require a COM port to be identified in the "**Connection Options**". Starting with firmware revision 5.2.X, LC-2 dataloggers can communicate at baud rates of 9600 and 115,200. Before this revision, the datalogger baud rate was 9600, for these dataloggers, the default setting should not be changed Figure 15).

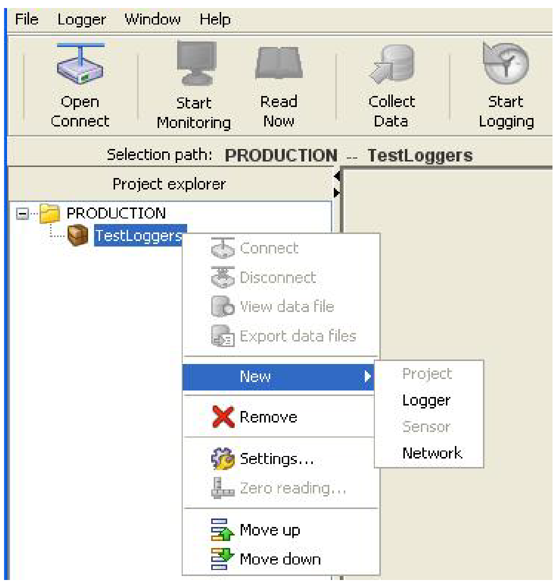

Figure 14 - LogView Context Menu

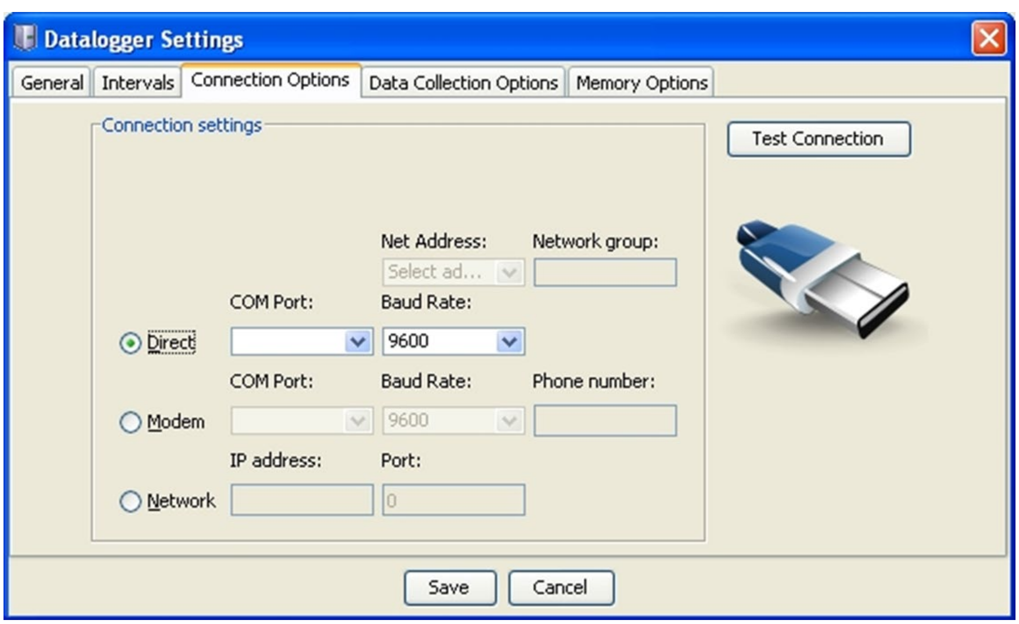

Figure 15 - Datalogger Settings, Connection Options

J.6 LC-2 Connection (8002-1-1, 8002-1A-1)

Connect the supplied LC-2 RS-232 Communications cable (COM-108) to the COM port of the LC-2 datalogger. The protective cap on the datalogger COM connector is removed by pushing in and turning. Plug the DB-9 end of the RS-232 Communications cable into the host computer's RS-232 port (either internal or external via a USB to Serial converter). Proceed to Appendix J.8, "Connecting to a Datalogger using LogView".

J.7 LC-2 Connection (8002-1-2, 8002-1A-2)

Connect the supplied LC-2 USB Communications cable (COM-109) to the USB port of the LC-2 datalogger. The protective cap on the datalogger USB connector is removed by pushing in and turning. Plug the USB-A end of the USB cable into an available USB-2.0 port on the host computer.

NOTE: On certain PCs with operating systems older than XP, Service Pack 3, the 8002-1-2 may require the installation of a driver to properly communicate with the PC. If the PC does not recognize the datalogger's internal USB to serial converter then the driver may need to be installed by executing the program, CDMv2_xxxx, from the LogView Install folder.

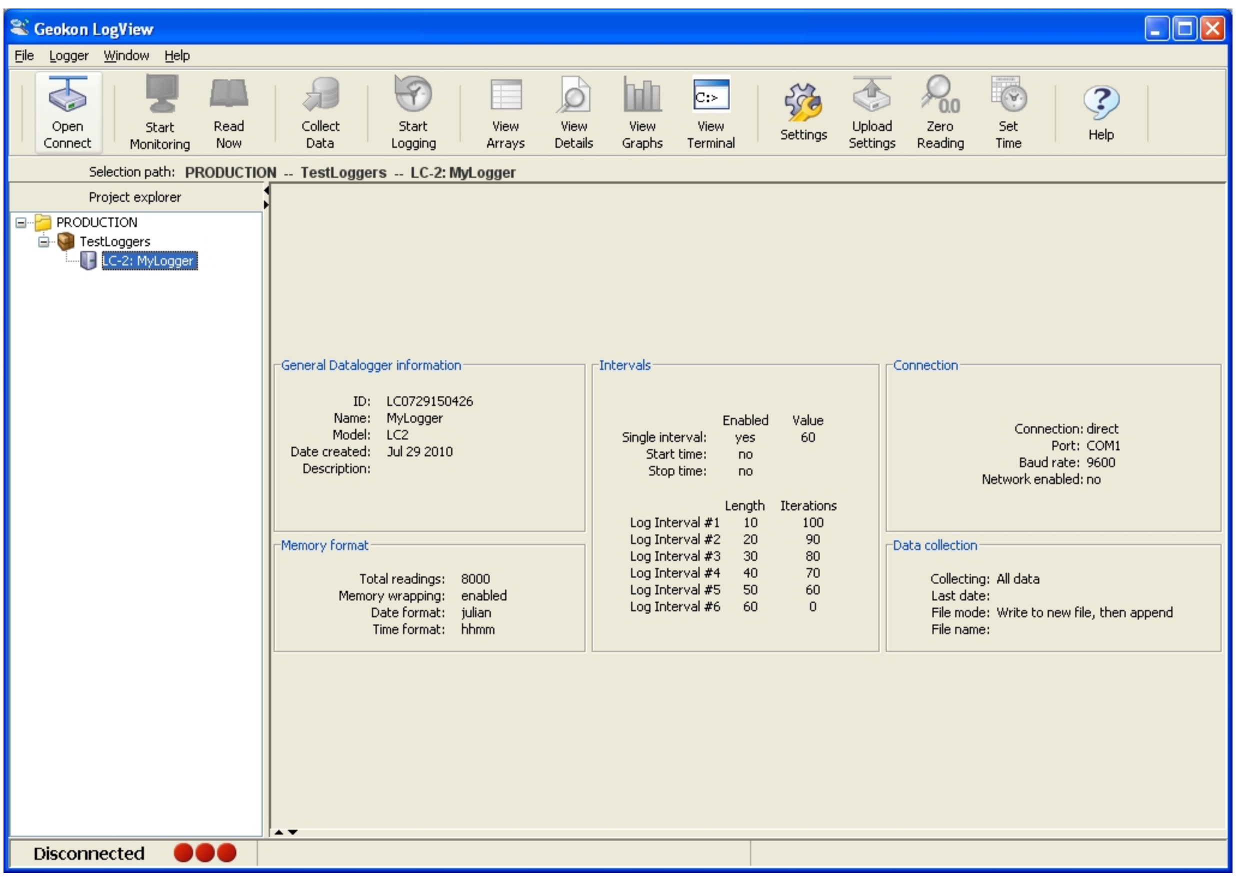

Figure 16 - Datalogger Highlighted, Not Connected

J.8 Connecting to a Datalogger using LogView

1) With a Datalogger profile configured and selected in the Project Explorer (see Figure 16 above), click on the "**Open Connect**" button on the LogView Toolbar.

2) When connecting to a new datalogger for the first time, the message shown in Figure 17 may be displayed after a few seconds. This is normal and is only an indication that the datalogger does not match the configuration created in the Project Explorer. Click on "Continue" to finish connecting to the datalogger.

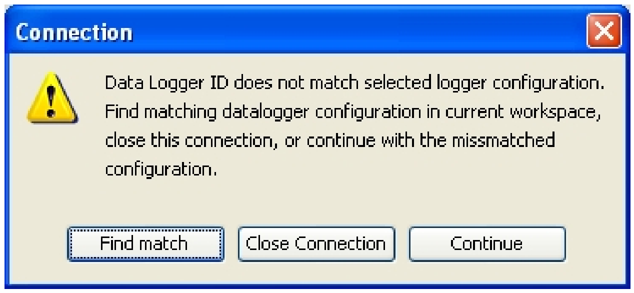

Figure 17 - Datalogger Connection Mismatch

3) Click on the "**Upload Settings**" button on the LogView Toolbar to synchronize the datalogger with the LogView configuration (see Figure 18).

4) LogView is now connected and configured correctly for the LC-2 datalogger. Sensors can now be added to the datalogger in a similar fashion as adding Dataloggers to Projects. Sensor settings are accessed via the context menu from the Project Explorer.

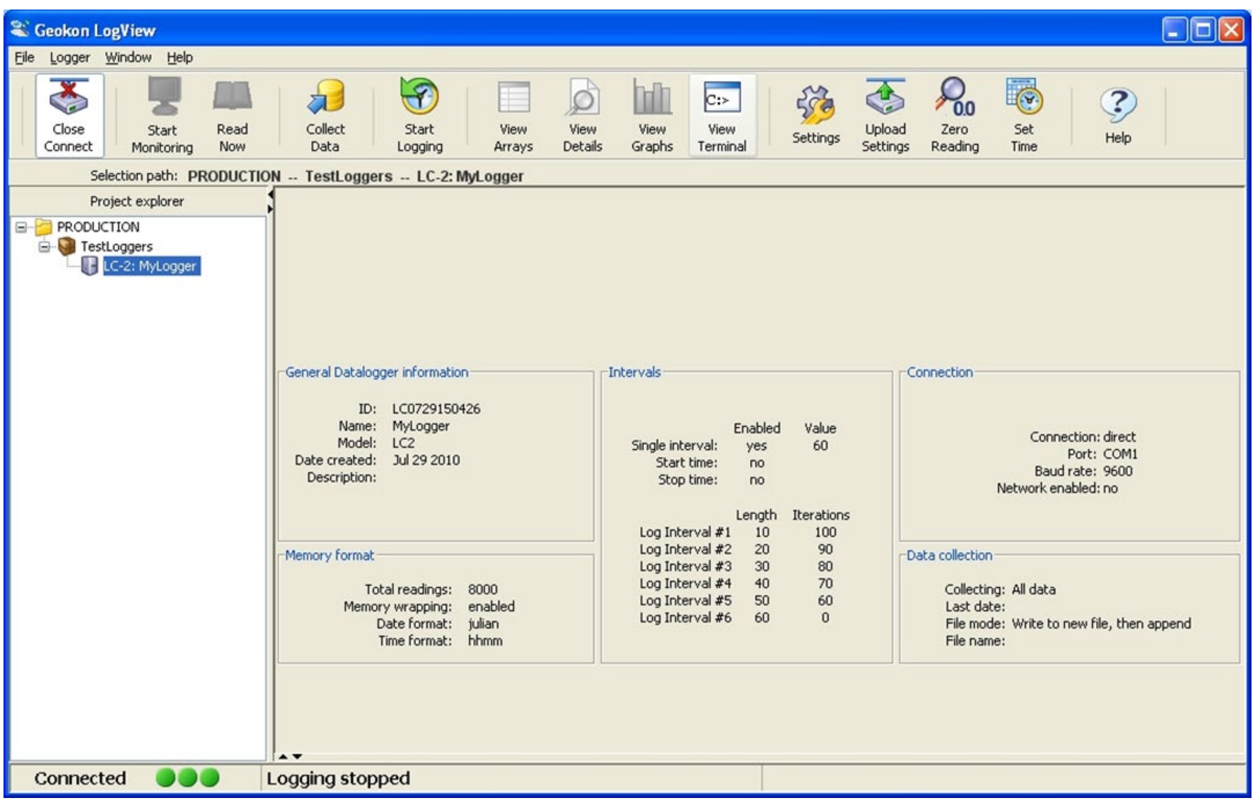

Figure 18 - Datalogger Connected

J.9 Determining COM Port Numbers

When connecting an 8002-1-1 or 8002-1A-1 datalogger to a PC with an internal serial port(s) the COM Port number that LogView requires is usually COM1 or COM2 but, occasionally may be COM3 if the PC has more than one internal serial port. The figure below (see Figure 19) illustrates that the PC has two serial ports, one internal, COM1 and the other via a USB to serial converter, COM13.

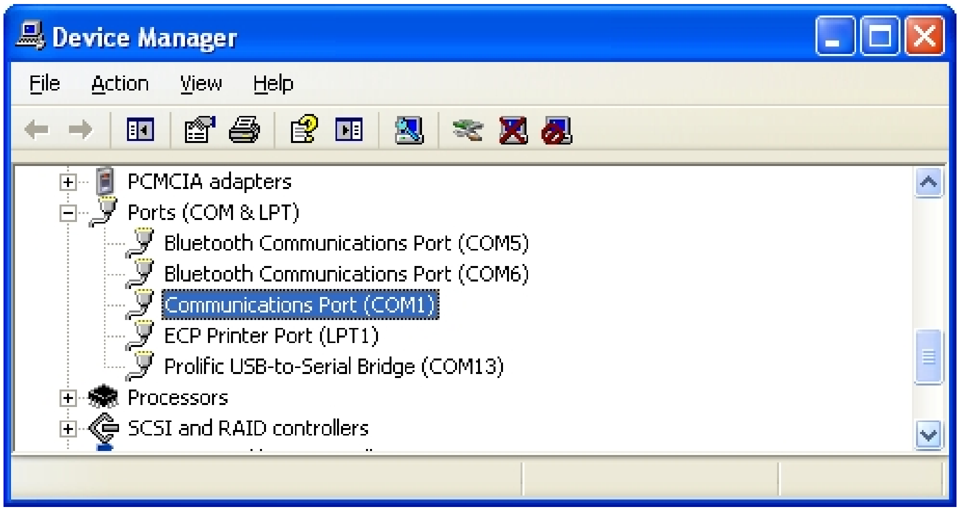

Figure 19 - Datalogger Connection Mismatch

When connecting an 8002-1-2 or 8002-1A-2 datalogger to a PC then the COM Port number that LogView requires can be any number and depends on how many other devices are attached to the PC such as, internal serial ports and wireless devices. Figure 20 below illustrates that the PC has three serial ports, one internal, COM1 and the other two via USB to serial converters, COM13 and COM3. One way to determine which COM port an 8002-1-2 datalogger is attached to is to disconnect the cable and see which COM device disappears from the Device Manager Ports list.

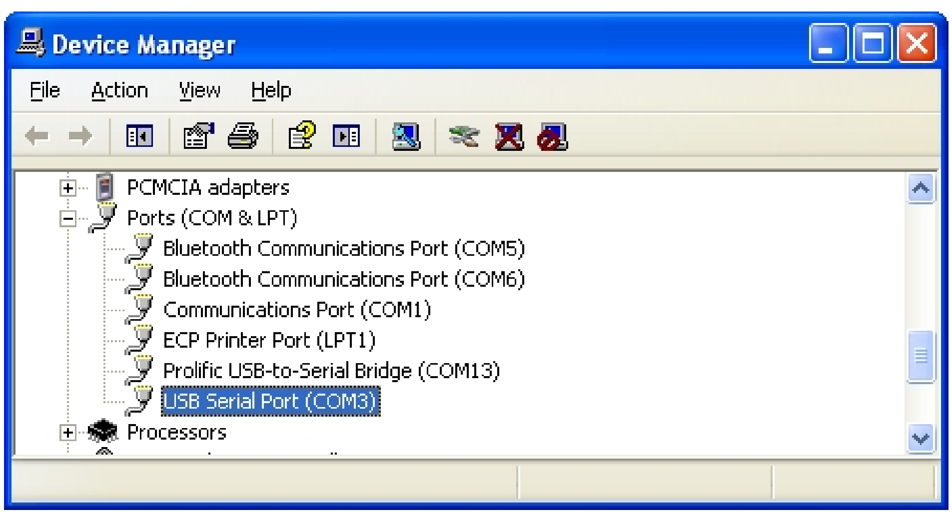

Figure 20 - Device Manager Ports List

In this case, COM3 is the 8002-1-2 datalogger and not a universally available serial port.

J.10 Data File Transfer to a Windows PC

Data can be downloaded to the PC either via LogView software (refer to the LogView Online Help) or Windows HyperTerminal, which, prior to Windows Vista, was supplied with most personal computers. The steps to download the data using LogView are as follows:

J.11 Downloading Data Using LogView

The steps below assume that a successful connection has been previously established between LogView and the datalogger. (See Appendix J.8, "Connecting to a Datalogger with LogView")

Click on the Collect Data button from the Main Toolbar. See Figure 21 below:

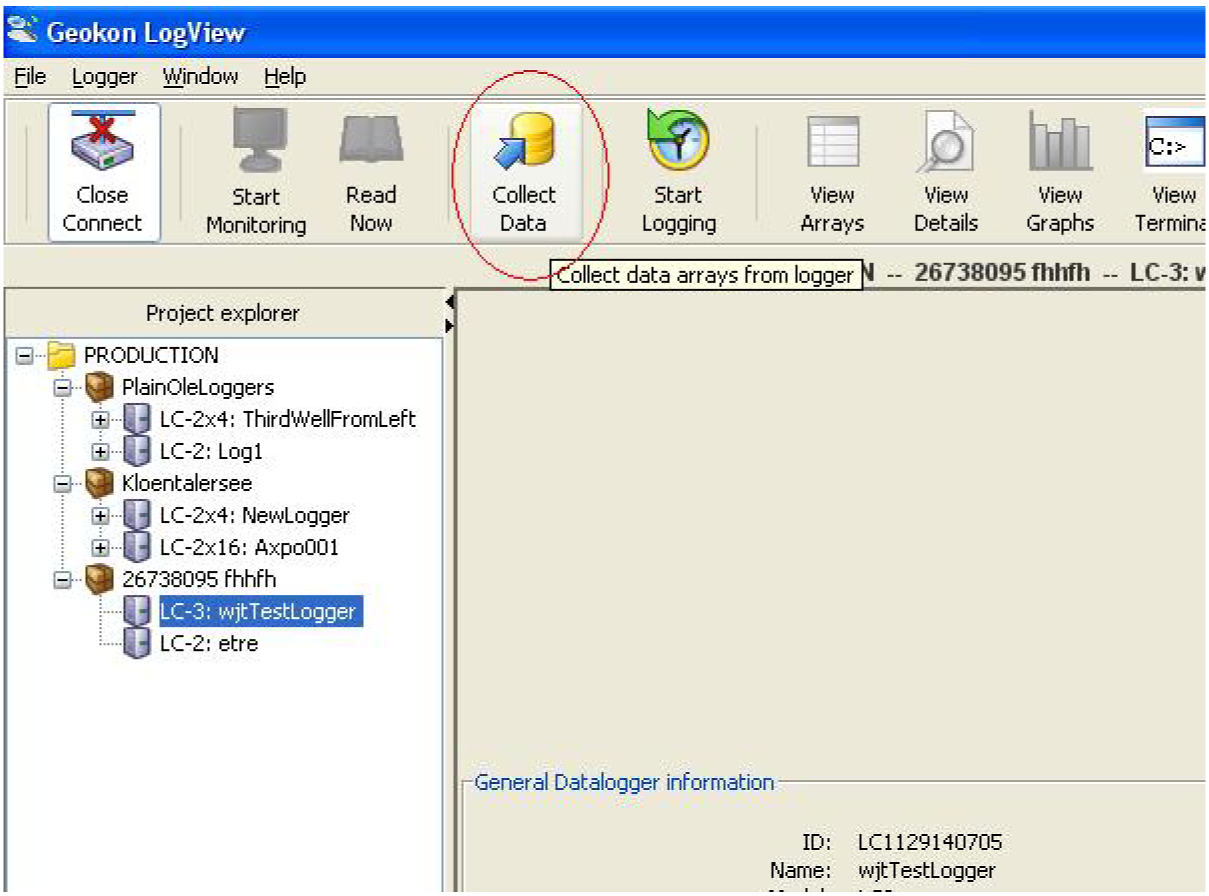

Figure 21 - LogView Collect Data Button

If the datalogger configuration is set for "Collect all data" in "Datalogger Settings->Data Collection Options" (see the LogView online help menu covering datalogger settings) then LogView will issue commands to the datalogger to initiate a download of all arrays logged on the datalogger. If the memory has wrapped then 16000 arrays (8000 if datalogger configuration set to **RT8**, see Appendix L.33) will be downloaded starting at the current User Pointer (See Appendix L.6 and L.26).

If the datalogger configuration is set for “Collect new data since last download” in “Datalogger Settings->Data Collection Options” then LogView will issue commands to the datalogger to initiate a download of all arrays since the last time data was downloaded.

Once the data collection has been initiated, the following progress bar (see Figure 22) will be displayed until the collection has completed:

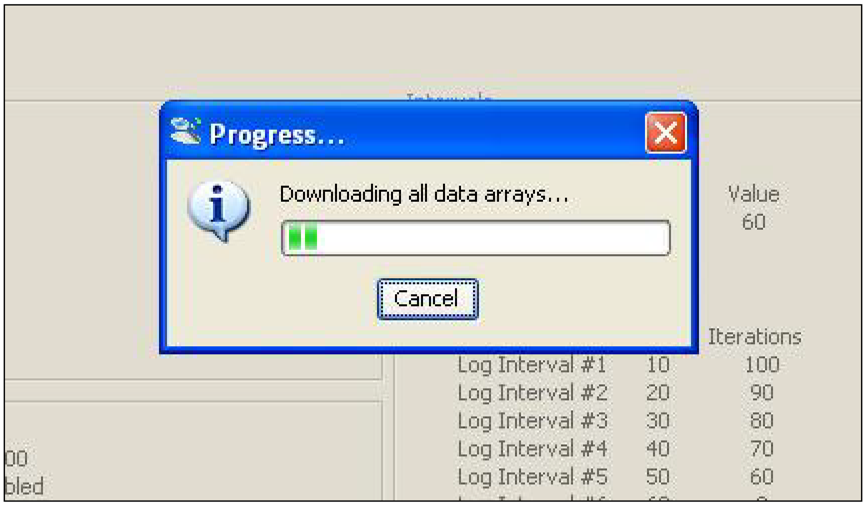

Figure 22 - Data Collection Progress Bar

After a data collection has finished, LogView will display the message shown in Figure 23:

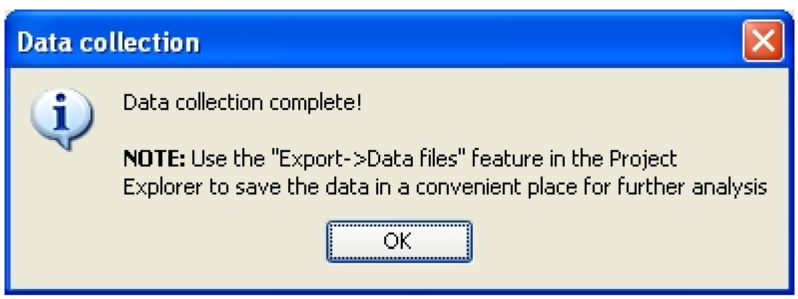

Figure 23 - Data Collection Complete Message

APPENDIX K. EXAMPLE SETUP USING A TERMINAL EMULATOR

For USB connected LC-2 dataloggers (8002-1-2, 8002-1A-2), it is important that the LC-2 first be connected to the computers USB port before running HyperTerminal™ (or other terminal emulator program) so that the LC-2 can be recognized by the computer as a virtual COM port.

Proceed with the following steps to connect with the datalogger using a terminal emulator program such as Microsoft Windows HyperTerminal™:

1) Launch HyperTerminal (Start → All Programs → Accessories → Communications → HyperTerminal). If running under Vista or newer, contact GEOKON for GEOKON's Terminal Window Software.

2) Enter a name for the New Connection and click OK (see Figure 24):

Figure 24 - HyperTerminal Connection Description

3) In the Connect Using window, select the appropriate COM port:

Figure 25 - COM Port Selection

4) In the COM Properties window, configure the COM port:

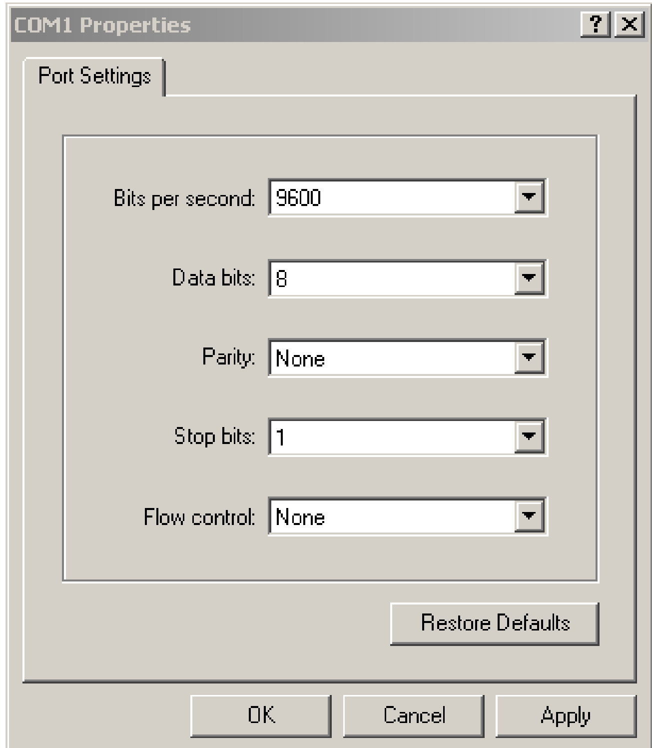

Figure 26 - COM Port Settings

<u>For 8002-4-1 (RS-232):</u> Configure the COM port (typically COM1 or COM2) as 9600 Bits per second, 8 Data bits, no Parity, 1 Stop bit, no Flow control.

<u>For 8002-4-2 (USB):</u> Configure the <u>new</u> COM port that is added when the LC-2 is connected as 9600 Bits per second, 8 Data bits, no Parity, 1 Stop bit, no Flow control.

5) Click Apply then OK.

6) Press <ENTER> to wake the datalogger from sleep. The datalogger returns the power up prompt:

```
Hello. Press "?" for Help.
*
```

Note: If no characters are received in 15 seconds the datalogger (non-networked) will return to its low power sleep mode. Press <ENTER> to wake it again.

Note: When network commands are enabled and RS-485 is being used, the address must be sent before the respective datalogger will respond. See Appendix L.20 through L.24 for additional information.

7) Type ? then press <ENTER> to display the Help list. See Appendix L for detailed information on all the commands listed. **All commands must be entered in capital letters!**

```
*?
Command                    Description
---------------------------------------------------------------------
C                          View current Clock
CSmm/dd/yy/hh:mm:ss        Clock Set
DEFAULT                    Load factory DEFAULT settings
DF                         Date Format (0=Julian, 1=month,day)
Dnnnnn                     Display nnnnn arrays from pointer
E                          End communications and go to sleep
Gnn/szzzz/sffff/soooo      Gauge information, where;
                                nn = gauge type
                                szzzz = zero reading with sign
                                sffff = gauge factor with sign
                                soooo = offset with sign
IDdddddddddddddddd         View current ID, set to dddddddddddddd
LC                         Select Linear Conversion
Ln/lllll/iii               View Log intervals/change n interval,
                           lllll=length,iii=iterations of interval
LD,LE                      Log intervals Disable, Enable
M,MD,ME                    Monitor status, Disable, Enable
MS                         Memory Status
N                          Display Next time to read
NAddd                      Network Address (1-256)
NS,ND,NE                   Network Status, Disable, Enable
PC                         Select Polynomial Conversion
Pnnnnn                     Position array pointer to nnnnn
R                          Reset memory
RESET                      Reset processor
RT                         Readings total (8=8000 readings,
                           16=16000 readings)
SR                         Synchronize readings (0=not synch'd,
                           1=synch'd)
S,SS                  Datalogger status, System status
SCnnnnn               View Scan interval/enter nnnnn interval
SPhh:mm               Stop logging, hh:mm = stop time
SThh:mm               Start logging, hh:mm = start time
SV                    Software Version
TEST                  System Test
TF                    Time Format (0=hhmm, 1=hh,mm)
T                     Thermistor type (0=standard,
                      1=high temp BR55A822J, 2=high temp 103JL1A)
TR,TR0                Display Trap count, zero Trap count
WF                    Wrap Format (0 = don't wrap memory,
                      1 = wrap memory)
X                     Single Reading - NOT stored
*
```

8) Type R then press <ENTER> to reset the memory pointers. "`Are you sure(Y/N)?`" will be displayed. Type Y then press <ENTER> to confirm. The datalogger should respond with "`Memory Cleared`".

***R**
Are you sure(Y/N)?Y
Memory cleared.
*****

9) Type C <ENTER> to display the current real time clock setting. See Appendix L.3, "Set the Internal Clock" if adjustments need to be made.

***C**
Date: 04/03/07 Time: 15:51:50
*****

10) Next, the configuration for the type of gauge being read must be specified. See Appendix L.8, "Gauge Settings".

Assume a GEOKON Model 4500S-50 Vibrating Wire Pressure Transducer with a gauge factor of 0.01234 psi/digit (found on the calibration report). Multiply this value by 2.31 to convert psi to feet of water, resulting in a factor of 0.02851. As with all vibrating wire gauge measurements, a zero reading needs to be determined for proper operation. Enter the gauge type and clear the zero reading, gauge factor, and offset positions in the datalogger's memory using the G command.

```
*G1/0/1/0
GT: 1  ZR: 0.00000  GF: 1.00000   GO: 0.00000
*
```

11) Make sure logarithmic intervals are disabled by typing **`LD`** and <ENTER>.

```
*LD
Log intervals disabled.
*
```

12) Enter a scan interval of 10 seconds by typing **`SC10`** and <ENTER>.

```
*SC10
Scan interval: 10 second(s).
*
```

13) Enable real-time display of the readings by typing **`ME`** <ENTER>.

***ME**
Monitor mode enabled.
*****

14) Start logging with the **ST** command.

```
*ST
Logging started.
*
```

Every 10 seconds an array of readings will display. For example:

2007,348,1217,32,3.11,23.50,-9149.485,21.6,1

***2007,348,1217,40,3.11,23.59,-9149.782,21.6,2**

***2007,348,1217,50,3.11,23.67,-9149.659,21.6,3**
2007,348,1218,0,3.11,23.41,-9149.812,21.6,4
2007,348,1218,10,3.11,23.19,-9149.694,21.6,5

Each line displayed represents an array of data, one set of readings taken at that interval. The seventh value in each line represents the gauge reading of the transducer.

See Appendix C, "Sample Data Files" for more information on the array format.

15) The transducer must be positioned to determine a zero reading. Follow the instructions in the Piezometer Instruction Manual for saturating the filter and lowering into the well. Let the transducer come to thermal equilibrium by leaving it immersed in the water for 15-20 minutes. If absolute depth of water is desired, position the transducer just above the water level. Note the displayed reading in the array. If change (delta) in water level is desired, note the reading displayed with the transducer left at its immersed location.

For this example, assume that the transducer will monitor absolute depth, has been pulled out of the water, and the reading displayed is `-9896.820`. Ignoring the sign and digits to the right of the decimal point yields an offset of 9896 to be entered in the datalogger's memory. Press **SP** <ENTER> to stop logging. Enter the zero reading and gauge factor by typing `G/9896/0.02851` <ENTER>. Lower the transducer back into the well to its installed location (below the maximum expected drawdown).

```
*G/9896/0.02851
GT: 1   ZR: 9896.00   GF: 0.02851   GO: 0.00000
*
```

16) Set the scan interval with the **SC** command. Scan interval is in seconds (3-86400).

```
*SC3600
Scan interval: 3600 second(s).
*
```

17) Press **ST**<ENTER> to start logging.

***ST**
Logging started.
2009,93,1621,55,3.22,25.30,-0.582,25.0,1

The datalogger will continue to log values based on the entered scan interval until one of the following conditions is met:

- The battery goes dead.
- The stop command is issued (see Appendix L.38, “Stop Logging”).

18) Press **E** <ENTER> to end communications with the LC-2 and enter low power sleep mode.

K.1 Downloading Data Using HyperTerminal (or Equivalent)

Data can be downloaded to the PC using Windows HyperTerminal (or other terminal emulator program), which, prior to Windows Vista, was supplied with most personal computers.

The steps to download the data using HyperTerminal are as follows:

Launch HyperTerminal: `Start → Programs → Accessories → Communications → Hyper-Terminal`

1) Enter a name for the New Connection – Select OK.

Figure 27 - HyperTerminal Connection Description

2) Change the “Connect using” setting to the appropriate COM port (in this case COM3).

Figure 28 - COM Port Selection

3) In the COM Properties Dialog, enter the “Port Settings”. Select Apply. Select OK.

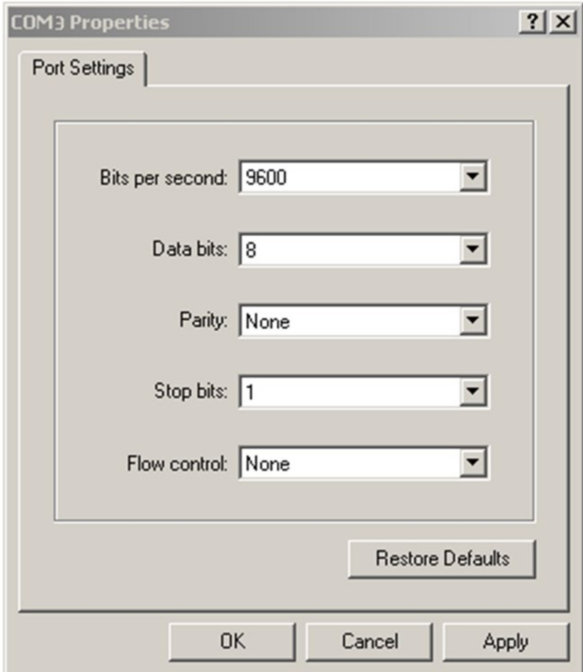

Figure 29 - COM Port Settings

4) With the cursor in the display screen, press the Enter key a few times to verify that communication has been established. The datalogger should return the power up prompt:

```
Hello. Press "?" for Help.
*
```

5) Upon confirmation of communication, select Transfer | Capture Text (see Figure 30):

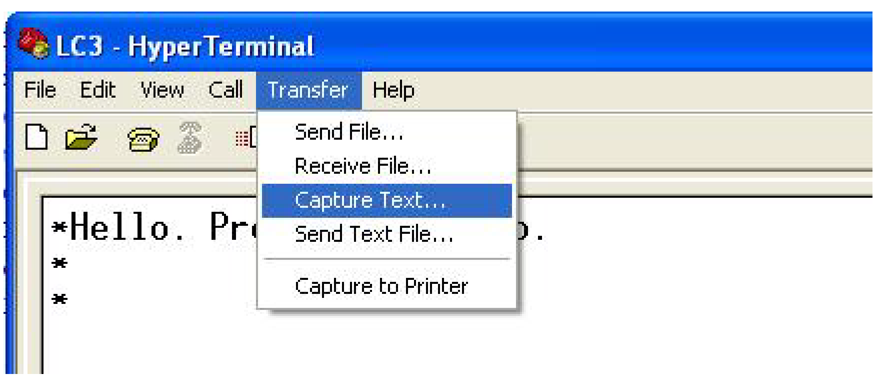

Figure 30 - HyperTerminal Transfer Menu

6) Enter the path and name of the file to be created, either directly, or with the Browse button, then click on the Start button (see Figure 31).

Hint: It may be helpful to specify .CSV as the file extension to allow direct formatted entry into a spreadsheet program.

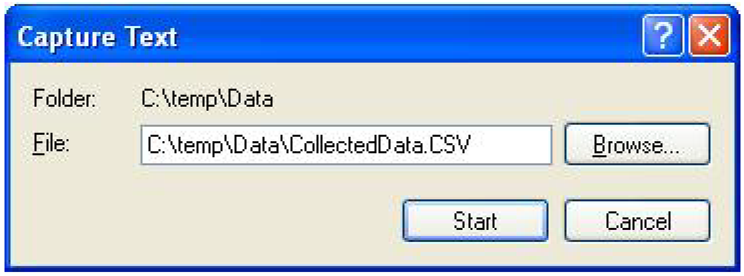

Figure 31 - Specify Data Capture File

7) With the cursor in the display screen, push the <Enter> key a few times to wake up the datalogger

Type "S" to get the Status of the datalogger.
Type "P1" to position the data array Pointer at location 1.
Type "D11" to Display the readings stored in memory (see Figure 32).
Select Transfer | Capture Text | Stop.

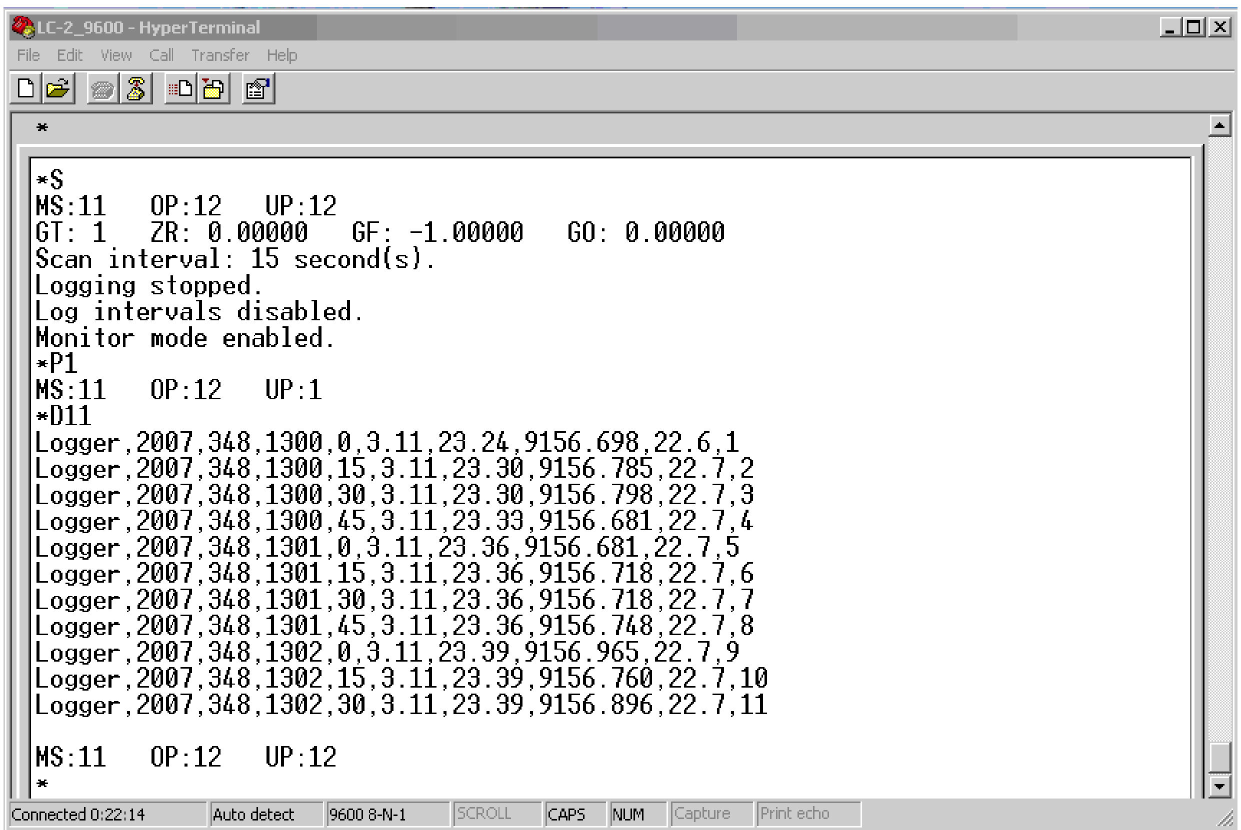

Figure 32 - HyperTerminal/Datalogger Communication

8) The data are now stored in the specified file.

APPENDIX L. TEXT COMMANDS

The commands listed here are to be used when sending commands directly to the LC2 in Agent software or if communications between the LC-2 and the host computer are established via a terminal emulator (e.g., Windows HyperTerminal). To send commands and receive information from the Model LC-2 the communications mode must be established between the host computer and the datalogger.

Pressing **?** <ENTER> while in the communications mode displays the following list of commands:

```
Command                  Description
---------------------------------------------------------------------
C                        View current Clock
CSmm/dd/yy/hh:mm:ss      Clock Set
DEFAULT                  Load factory DEFAULT settings
DF                       Date Format (0=Julian, 1=month,day)
Dnnnnn                   Display nnnnn arrays from pointer
E                        End communications and go to sleep
Gnn/szzzz/sffff/soooo    Gauge information, where;
                              nn = gauge type
                              szzzz = zero reading with sign
                              sffff = gauge factor with sign
                              soooo = offset with sign
IDdddddddddddddddd       View current ID, set to dddddddddddddd
LC                       Select Linear Conversion
Ln/lllll/iii             View Log intervals/change n interval,
                         lllll=length,iii=iterations of interval
LD,LE                    Log intervals Disable, Enable
M,MD,ME                  Monitor status, Disable, Enable
MS                       Memory Status
N                        Display Next time to read
NAddd                    Network Address (1-256)
NS,ND,NE                 Network Status, Disable, Enable
PC                       Select Polynomial Conversion
Pnnnnn                   Position array pointer to nnnnn
R                        Reset memory
RESET                    Reset processor
RT                       Readings total (8=8000 readings,
                         16=16000 readings)
SR                       Synchronize readings (0=not synch'd,
                         1=synch'd)
S,SS                     Datalogger status, System status
SCnnnnn                  View Scan interval/enter nnnnn interval
SPhh:mm                  Stop logging, hh:mm = stop time
SThh:mm                  Start logging, hh:mm = start time
SV                       Software Version
TEST                     System Test
TF                       Time Format (0=hhmm, 1=hh,mm)
```

```
T                    Thermistor type (0=standard,
                     1=high temp BR55A822J, 2=high temp 103JL1A)
TR,TR0               Display Trap count, zero Trap count
WF                   Wrap Format (0 = don't wrap memory,
                     1 = wrap memory)
X                    Single Reading - NOT stored
```

All commands are executed by typing with the correct syntax and pressing <ENTER>. If the command has not been entered correctly, the datalogger will usually not respond. For example:

```
*L7/100/255
*
```

The datalogger will respond to correctly entered commands by displaying the modified values. The purpose and syntax of each of these commands are discussed in the following sections.

L.1 "BRnnn" - Set or Display the Current Baud Rate

This command is not displayed in the help text (?<ENTER>). Displays or sets the current baud rate. Valid numbers for "nnn" are 9 (9600 baud) or 115 (115,200 baud). The example below changes the baud rate to 9600 with no confirmation.

```
*BR9
```

L.2 "C" - Display Current Clock Settings

Displays the current datalogger real-time clock settings. Appendix L.3 explains how to adjust the clock settings.

```
*C
Date: 02/21/07  Time: 10:43:08
*
```

L.3 "CSmm/dd/yy/hh:mm:ss" - Set the Internal Clock

Sets the datalogger's internal real-time clock; mm represents the month, dd the day of the month, yy the year, hh the hours, mm the minutes, and ss the seconds. Leading zeros are not needed except on the minutes and seconds entries. Illegal combinations will be ignored (e.g., CS02/30/97 or CS///12:60). Fields can be left blank to avoid changing (e.g., CS//97 to only change the year).

```
*CS///10:45:00
Date: 02/21/07   Time: 10:45:00
*
```

Note: If logging is currently started and the clock is changed, a restart of the scan interval or log interval table will occur. If the scan interval is fast (e.g., three seconds), logging may need to be stopped and restarted, depending on whether the internal "next time to read" register becomes unsynchronized with the current time.

L.4 "DEFAULT" - Load Factory Default Settings

All stored readings as well as the ID, networking and real-time clock settings are not affected by this command. User will be asked to verify before executing. Press **Y** to continue, any other key to abort.

```
*DEFAULT
This will load the factory default settings!
Are you sure(Y/N)?Y
Restored to factory default settings.
*
```

LC-2 setup after DEFAULT has been issued:

```
*S
MS:0   OP:1   UP:1
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000
Scan interval: 3 second(s).
Logging stopped.
Log intervals disabled.
Monitor mode enabled.
          *SS
Signature of RAM1: 58294
Signature of RAM2: 47463
Signature of RAM3: 51545
Signature of RAM4: 15546
Signature of ROM: 4497
Trap count: 0
Network address: 1
Network recognition disabled.
Time format is hhmm.
Date format is Julian.
Standard Temp thermistor selected

*
*WF
Logging will not stop when memory is full
*
*SR
Readings are synchronized to the top of the hour.
*
*RT
```

```
8000 readings maximum
*
*L

              Log Intervals List
------------------------------------------------
Interval #1  Length: 10       Iterations: 100

Interval #2  Length: 20       Iterations: 90

Interval #3  Length: 30       Iterations: 80

Interval #4  Length: 40       Iterations: 70

Interval #5  Length: 50       Iterations: 60

Interval #6  Length: 60       Iterations: 0

*
```

L.5 “DF” - Display or Set Date Format

This setting determines how the date information will be displayed in the array when the monitor mode is active, or arrays are displayed from memory. Entering DF displays the current date format. Entering DF0 sets the date format to Julian. Entering DF1 sets the date format to month, day. The default date format display is Julian (decimal) day.

```
*DF
Date format is Julian.
*X
2009,52,1343,20,3.00,24.7,-5372.293,24.3
*DF1
Date format is month,day.
*X
2009,2,21,1343,25,3.00,24.7,-5372.293,24.3
*DF0
Date format is Julian.
*X
2009,52,1343,30,3.00,24.7,-5372.293,24.3
```

L.6 “Dnnnn” - Display Arrays Forward from User Position

Use the D command to display arrays forward from the User Position for verification or collection. The updated memory pointers are displayed by this command.

```
*D
MS:8000   OP:1567   UP:1006
*
```

MS represents the Memory Status of the datalogger. This number indicates how many arrays have been written to memory. If, as in the above example, it is at 8000 and WF (wrap format) = 1, then memory has been filled and it is now overwriting the oldest arrays. If it is at 8000 and WF = 0, then the memory has been filled and logging has stopped. Figure 33 illustrates the ring memory scheme.

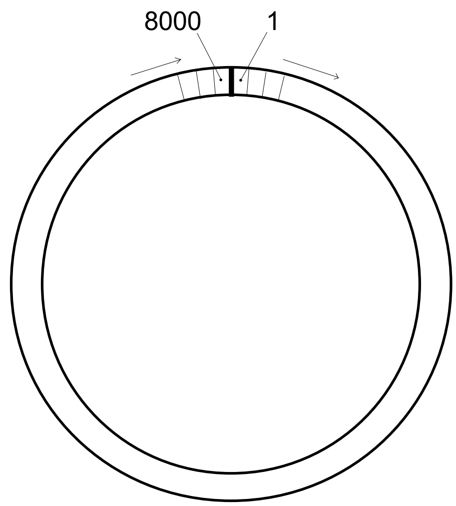

Figure 33 - Order of Array Usage

OP represents the Output Position that the next array will be written to.

UP represents the User Position. This value is updated by D and P commands. The user may display arrays from this position or reposition to another array. The last column in the data array is the User Position.

Display nnnn arrays from the current User Position. Press any key (other than a letter or digit) to abort the display

```
*P3600
MS:8000   OP:3683   UP:3600
*D5
2009,94,0838,28,3.22,22.23,9978.889,25.0,3600
2009,94,0838,33,3.22,22.23,9978.917,25.0,3601
2009,94,0838,38,3.22,22.23,9979.131,25.0,3602
2009,94,0838,43,3.22,22.23,9979.185,25.0,3603
2009,94,0838,48,3.22,22.23,9979.192,25.0,3604

MS:8000   OP:3683   UP:3605
*
```

The format is comma delineated ASCII, identical to that displayed when the Monitor mode is active. See Appendix C for a sample data file. See Appendix K.1 in regards using the D command to collect data. When the array display is finished the memory pointers are displayed.

L.7 "E" - Low Power Sleep Mode

Returns the datalogger to its low power sleep mode (readings continue to be logged and displayed in this mode). **This command should always be used when finished communicating with the datalogger to ensure the lowest power consumption.** However, the datalogger (non-networked) will enter sleep mode regardless if no command is received in a period of approximately 15 seconds, or immediately after the second reading (whichever comes first).

To return from the low power operating mode press <ENTER>. The datalogger responds with:

```
Hello. Press "?" for Help.
*
```

L.8 "Gnn/szzzz/smmmm/soooo or Gnn/saaaa/sbbbb/scccc" - Gauge Settings

When using linear conversion (LC) of the instrument reading, the G command is used to select the gauge type and enter the gauge zero reading, gauge factor, and gauge offset. When using polynomial conversion (PC), the G command is used to select the gauge type and enter the three polynomial coefficients, A, B and C. Entering only G will return the current gauge information. For example, with linear conversion selected:

```
*G
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000
*
```

With polynomial conversion selected:

```
*G
GT: 1   PA: 0.00000   PB: 1.00000   PC: 0.00000
*
```

Note the change in response depending on the conversion method selected.

Slashes (/) are entered to delineate the values and to substitute for a value that will not be changed. For example:

```
*G
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000
*G///1234.5
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 1234.500
*
```

Linear Conversion

The command is described further as follows: **nn** represents the gauge type, or the configuration of the datalogger's input channel (see Table 12 and Table 13 in this section), **szzzz** represents the zero reading for the transducer being read, **smmmm** represents the multiplier (calibration or gauge factor) that will be applied to the reading to convert to engineering units and **soooo** is the offset that will be applied to the gauge reading. The zero reading, gauge factor and offset can be entered with a sign and decimal point. The maximum number of digits, including sign and decimal point is 15. The entered value will display to a maximum of five places to the right of the decimal point.

For all vibrating wire instruments (Gauge Types 0-5), manufactured after November 2, 2011 and for all dataloggers (8002-1-X) with a firmware revision of 5.2.X and up, the basic formula for calculation of displayed and stored values is as follows:

$$\text{Display} = ((\text{CurrentReading} - \text{ZeroReading}) \times \text{Multiplier}) + \text{Offset}$$

Equation 3 - Displayed Gauge Reading using Linear Conversion

> **NOTE:** It is possible that a new datalogger might be used with an older sensor or vice versa and because of equation differences, the output might be negative. As of LogView version V2.1.1.X, an additional sensor configuration parameter is now required, allowing LogView to compensate for old versus new sensor/datalogger combinations. This new parameter: **Output Calculation**, determines whether the sensor was calibrated using the formula: **G x (R_0 – R_1)** or **G x (R_1 – R_0).** As with the gauge factor, this information is available from the calibration certificate supplied with each sensor. Please see the LogView User's Guide or the online help section, "Sensor Settings" available while running LogView.

NOTE: In Equation 3 (above), the "**CurrentReading**" is frequently referred to as $\mathbf{R_1}$ while the "**ZeroReading**" is referred to as $\mathbf{R_0}$

Polynomial Conversion

The command is described further as follows: **nn** represents the gauge type, or the configuration of the datalogger's input channel (see Table 12 and Table 13 in this section), **saaaa** represents polynomial coefficient A, **sbbbb** represents polynomial coefficient B and **scccc** polynomial coefficient C. The polynomial coefficients can be entered with a sign and decimal point. The maximum number of digits, including sign and decimal point is 15. The entered value will display to a maximum of five places to the right of the decimal point.

For the vibrating wire instruments (Gauge Types 1-5), the basic formula for calculation of displayed and stored values is as follows:

$$\text{Display} = (\text{CurrentReading}^2 \times \text{A}) + (\text{CurrentReading} \times \text{B}) + \text{C}$$

Equation 4 - Displayed Gauge Reading using Polynomial Conversion

NOTE: When using the Polynomial conversion method, the default reading units for a vibrating wire instrument is the frequency squared multiplied by 10^{-6}. For example, an instrument reading 3000Hz will output a value of "9.000" when A is entered as "0", B is "1" and C is "0". However, typical calibration units for vibrating wire instruments are frequency squared multiplied by 10^{-3}. To adjust for this discrepancy between LC-2 expected units and calibration units **multiply the A coefficient by 1,000,000 and the B coefficient by 1000. The A and B coefficients can be found on the supplied calibration certificate.** The **C** coefficient should be calculated based on an actual field reading. The above multiplication is **only** necessary if the datalogger is being set up via text commands (see Appendix K for an example setup using text commands) **AND** the gauge conversion is set for polynomial. When using LogView to setup the datalogger configuration, the multiplication is performed by LogView. Refer to the appropriate sensor manual for more information on how to calculate the **C** coefficient.

GEOKON Model	Gauge Type	Description
4000	3	Strain Gauge
4100	1	Strain Gauge
4200	3	Strain Gauge
4204	6	Strain Gauge
4202/421X	1	Strain Gauge
4300BX	1	BX Borehole Stressmeter
4300EX	5	EX Borehole Stressmeter
4300NX	1	NX Borehole Stressmeter
4400	1	Embedment Jointmeter
4420	1	Crackmeter
4450	1	Displacement Transducer
4500	1	Piezometer
4600/4651/4675	1	Settlement Systems
4700	1	Temperature Transducer
4800	1	Pressure Cell
4850	1	Low Pressure Piezometer
4900	1	Load Cell
4910/4911/4912	1	Load Bolts

Table 12 - Vibrating Wire Gauge Types

Type	Measurement Type	Description	Output Units	Linear Range	Polynomial Range
0	Vibrating Wire	Test frequency sweep, 400-4500 Hz	Digits	160 to 20250	0.160 to 20.250
1	Vibrating Wire	Middle frequency sweep, 1400-3500 Hz	Digits	1960 to 12250	1.960 to 12.250
2	Vibrating Wire	High frequency sweep, 2800-4500 Hz	Digits	7840 to 20250	7.840 to 20.250
3	Vibrating Wire	Very low frequency sweep, 400-1200 Hz	Digits	160 to 1440	0.160 to 1.440
4	Vibrating Wire	Low frequency sweep, 1200-2800 Hz	Digits	1440 to 7840	1.440 to 7.840
5	Vibrating Wire	Very high frequency sweep, 2500-4500 Hz	Digits	6250 to 20250	6.250 to 20.250
6	Vibrating Wire	Low frequency sweep, 800-1600 Hz	Digits	640 to 2560	0.640 to 2.560
7-84	Not assigned				
85	External thermistor	Reads the thermistor encapsulated in the Vibrating Wire instrument.	°C	-50 to +80	-50 to +80
86	Internal thermistor	Reads the thermistor installed in the LC-2 Printed Circuit Board (PCB)	°C	-50 to +80	-50 to +80
87	Main battery: 12V	Reads the main 12V battery voltage	VDC	0 to 15	0 to 15
88-94	Not assigned				
95	3V lithium battery	Reads the 3V lithium RTC battery	VDC	0 to 3.5	0 to 3.5
97	Main battery: 3V	Reads the main 3V battery voltage	VDC	0 to 7.5	0 to 3.5

Table 13 - Gauge Type Descriptions

The "Digits" calculation for the Vibrating Wire transducer output when using linear conversion is based on this equation:

$$\text{Digits} = \text{frequency}^2 \times 10^{-3}$$

Equation 5 - Digits Calculation using Linear Conversion

The "Digits" calculation for the Vibrating Wire transducer output when using polynomial conversion is based on this equation:

$$\text{Digits} = \text{frequency}^2 \times 10^{-6}$$

Equation 6 - Digits Calculation using Polynomial Conversion

Frequency, in the above equations, represents the resonant frequency of vibration of the wire in the transducer (in Hertz) as determined by the datalogger.

To convert calibration factors (pressure transducers are usually psi per digit) to other engineering units consult the following table:

From → To ↓	psi	"H_2O	'H_2O	mm H_20	m H_20	"HG	mm HG	atm	mbar	bar	kPa	MPa
psi	1	.036127	.43275	.0014223	1.4223	.49116	.019337	14.696	.014503	14.5039	.14503	145.03
"H_2O	27.730	1	12	.039372	39.372	13.596	.53525	406.78	.40147	401.47	4.0147	4016.1
'H_2O	2.3108	.08333	1	.003281	3.281	1.133	.044604	33.8983	.033456	33.4558	.3346	334.6
mm H_20	704.32	25.399	304.788	1	1000	345.32	13.595	10332	10.197	10197	101.97	101970
m H_20	.70432	.025399	.304788	.001	1	.34532	.013595	10.332	.010197	10.197	.10197	101.97
"HG	2.036	.073552	.882624	.0028959	2.8959	1	.03937	29.920	.029529	29.529	.2953	295.3
mm HG	51.706	1.8683	22.4196	.073558	73.558	25.4	1	760	.75008	750.08	7.5008	7500.8
atm	.06805	.0024583	.0294996	.0000968	.0968	.03342	.0013158	1	.0009869	.98692	.009869	9.869
mbar	68.947	2.4908	29.8896	.098068	98.068	33.863	1.3332	1013.2	1	1000	10	10000
bar	.068947	.0024908	.0298896	.0000981	.098068	.033863	.001333	1.0132	.001	1	.01	10
kPa	6.8947	.24908	2.98896	.0098068	9.8068	3.3863	.13332	101.320	.1	100	1	1000
MPa	.006895	.000249	.002988	.00000981	.009807	.003386	.000133	.101320	.0001	.1	.001	1

Table 14 - Engineering Units Multiplication Factors

L.9 "IDdddddddddddddddd" - Display or Set Datalogger ID

The ID is a 16-character string that can be used to identify a datalogger and the data that is transmitted by it. If an ID is entered, it will be transmitted as the first element in each array of data. For example:

```
*ID
Datalogger ID:
*IDDatalogger#1
Datalogger ID:Datalogger#1
*ST
Logging started.
Datalogger#1,2009,94,0939,20,3.22,23.19,9986.034,25.0,1

*Datalogger#1,2009,94,0939,25,3.22,23.36,9985.864,25.0,2
```

```
Datalogger#1,2009,94,0939,30,3.22,23.44,9985.479,25.0,3
Datalogger#1,2009,94,0939,35,3.22,23.53,9985.686,25.0,4
```

To clear the ID, enter a <SPACE> character as the ID. When the ID is cleared the arrays from the logger will display beginning with the year. To display the current ID, enter **ID** <ENTER>.

L.10 "LC" - Linear Conversion

Selects the linear conversion method for the instrument reading. See Appendix L.8, "Gauge Settings" for more information.

```
*LC
Linear conversion selected.
*
```

L.11 "L" - Display Log Intervals

Displays all six log intervals.

```
*L
              Log Intervals List
-------------------------------------------------
Interval #1  Length: 10    Iterations: 100

Interval #2  Length: 20    Iterations: 90

Interval #3  Length: 30    Iterations: 80

Interval #4  Length: 40    Iterations: 70

Interval #5  Length: 50    Iterations: 60

Interval #6  Length: 60    Iterations: 0
```

This command has no affect on the current interval (scan or log). If logging is started and log intervals are enabled the iterations value will be followed by the number of readings left at that interval. For example:

```
*L
              Log Intervals List
------------------------------------------------

Interval #1  Length: 10       Iterations: 100/58

Interval #2  Length: 20       Iterations: 90/90

Interval #3  Length: 30       Iterations: 80/80
```

```
Interval #4  Length: 40      Iterations: 70/70

Interval #5  Length: 50      Iterations: 60/60

Interval #6  Length: 60      Iterations: 0/0

*
```

The above list indicates that there are 42 iterations of interval #1 left before interval #2 begins execution. See Appendix L.12 to modify intervals.

L.12 "Ln/lllll/iii" - Define Length and Iteration of Interval

Define the length and iteration of any interval in the list; n refers to the number of the interval (1-6), lllll is the length (3-86400), and iii is the iterations (0-255), or the number of readings that will be taken at that interval. If zero is entered for the iteration value that interval will execute indefinitely. Illegal entries will be ignored, e.g., **L7/10/100** or **L1/1000/500**. If the entry is correct, the modified interval will display:

```
*L1/100/0
Interval #1  Length: 100   Iterations: 0
*
```

If log intervals are enabled and logging was started, any change to the interval list will result in a restart of the table!

Table 15 lists possible logarithmic interval lengths and iterations. Any combination of lengths and iterations is permissible.

Interval	Length	Iterations	Elapsed Time
1	3 seconds	3	0.1 minute
2	6 seconds	9	1 minute
3	10 seconds	54	10 minutes
4	30 seconds	180	100 minutes
5	240 seconds	225	1000 minutes
6	3600 seconds	endless	

Table 15 - Logarithmic Intervals List

L.13 "LD" - Disable Log Intervals

If logging is started (**ST** command) it will continue based on the scan interval entry (**SC** command).

```
*LD
Log intervals disabled.
*Datalogger#1,2009,94,1002,46,3.22,24.39,9986.389,25.0,1
*
```

L.14 “LE” - Enable Log Intervals

If logging is started (**ST** command) it will continue based on the interval lengths and iterations of the log list (**SC** command).

```
*LE
Log intervals enabled.
*Datalogger#1,2009,94,1004,35,3.22,23.36,9986.394,25.0,1
*
```

L.15 “M” - Display Current Monitor Mode Setting

The monitor mode will display arrays as they are stored in memory in the course of logging. This is useful where a test is being conducted and immediate display of logged values would be helpful. Use the **MD** (Appendix L.16) and **ME** (Appendix L.17) commands to disable or enable the use of the Monitor mode.

```
*M
Monitor mode enabled.
*
```

L.16 “MD” - Disable Monitor Mode

Arrays will not be sent to the host computer as they are logged.

```
*MD
Monitor mode disabled.
*
```

L.17 “ME” - Enable Monitor Mode

Arrays will be sent to the host computer as they are logged.

```
*ME
Monitor mode enabled.
*
```

L.18 “MS” – Display Current Memory Status

Maximum number of readings (8000 or 16000) will be displayed, along with the wrap format and status of reading synchronization.

```
*MS
8000 readings maximum
Logging will not stop when memory is full
Readings are synchronized to the top of the hour.
*
```

L.19 “N” - Display Next Measurement Cycle

Displays the next time the datalogger will initiate a measurement cycle. If the start time (**ST** command) has been set this command will display when logging will begin.

```
*ST10:48
Logging will start at:  10:48:00
*N
Next time to read:  10:48:00
*
```

L.20 “NA” - Display Network Address

Displays the current network address.

```
*NA
Network address: 1
*
```

When network recognition is enabled, this number (preceded by the # character) must be entered for the respective datalogger to respond. The following example illustrates communication with two different dataloggers on the RS-485 network.

```
<ENTER>
<ENTER>
#1<ENTER>
Network address: 1
*NA
Network address: 1
*E

<ENTER>
<ENTER>
#2<ENTER>
Network address: 2
*NA
Network address: 2
*E
```

L.21 “NAddd” - Set Network Address

Sets the current network address to any address between 1 and 256.

```
*NA10
Network address: 10
*
```

When network recognition is enabled, this number (preceded by the # character) must be entered for the respective datalogger to respond. The datalogger then responds by transmitting its network address. The following example illustrates communication with two different dataloggers on the RS-485 network.

```
<ENTER>
<ENTER>
#1<ENTER>
Network address: 1
*E

<ENTER>
<ENTER>
#20<ENTER>
Network address: 20
*E
```

NOTE: The network address may not be changed while networked. Direct connect to the datalogger via USB to change the network address. If connected directly to the datalogger via USB and networking is enabled, the datalogger will respond with the * prompt only.

L.22 "ND" - Network Disable

Disables networking of two or more LC-2 dataloggers.

```
*ND
Network recognition disabled.
```

NOTE: Networking may not be disabled while networked. Direct connect to the datalogger via USB to disable networking.

L.23 "NE" - Network Enable

Enables networking of two or more LC-2 dataloggers.

```
*NE
Network recognition enabled.
```

NOTE: If the LC-2 is connected via the USB port, connection to a network enabled datalogger can be made directly without the need to enter the correct datalogger address. This can be helpful if the network address is unknown and the datalogger is network enabled.

L.24 “NS” - Display Network Status

Displays the current network status.

```
*NS
Network recognition disabled.
*
```

Or;

```
*NS
Network recognition enabled.
*
```

L.25 “PC” - Polynomial Conversion

Selects the polynomial conversion method for the instrument reading. See Appendix L.8, “Gauge Settings” for more information.

```
*PC
Polynomial conversion selected.
*
```

L.26 “Pnnnn” - Set User Position Memory Pointer

Type P and a number between 1 and 8000 (or 1 and 16000 if 16000 readings is enabled) to position the pointer. Arrays can then be displayed (**D** command) from the new position. The updated pointers will display after entering a valid position.

```
*P1
MS:3200   OP:1567   UP:1
*
```

L.27 “R” - Reset Memory Pointers

Reset memory pointers to default settings. Gauge and interval settings, as well as the real-time clock settings, are not affected by this command. User will be asked to verify before executing. Press **Y** to continue, any other key to abort.

```
*R
Are you sure(Y/N)?Y
Memory cleared.
*
```

Note: This command does not erase memory. If the need arises to recover data that was previously taken, take one (or more) readings and then position the memory pointers via the **P** and **D** commands to recover previously taken readings.

L.28 "RESET" - Reboot the LC-2 Microprocessor

All stored readings and settings, as well as the ID and real-time clock settings are not affected by this command.

```
*RESET
Resetting...
RESET COMPLETE
*
```

L.29 "RT" - Display Total Number of Readings

Displays the total number of readings that the datalogger will take (8000 or 16000) before either overwriting data memory or stopping logging (depending on the Wrap Format status).

```
*RT
8000 readings maximum
*
```

L.30 "SR" - Synchronize Readings

Displays status of reading synchronization

```
*SR
Readings are synchronized to the top of the hour.
*
```

L.31 "SR0" - Readings will not Synchronize with the Hour

Readings will not be synchronized to the top of the hour. All subsequent readings will occur at the time of the first reading plus the scan interval.

```
*SR0
Readings are not synchronized to the top of the hour.
*SC5
Scan interval: 5 second(s).
*ST
Logging started.
2009,195,0921,28,3.07,24.05,-9025.851,23.4,1

*2009,195,0921,33,3.07,24.10,-9025.595,23.4,2

*2009,195,0921,38,3.07,24.16,-9025.825,23.4,3
2009,195,0921,43,3.07,24.16,-9025.317,23.4,4
2009,195,0921,48,3.07,24.16,-9025.618,23.4,5
2009,195,0921,53,3.07,24.13,-9025.377,23.4,6
```

L.32 “SR1” - Readings will Synchronize with the Hour

(Default) Readings will be synchronized to the top of the hour. All subsequent readings will occur at the specified scan interval while evenly divisible into the top of the hour.

```
*SR1
Readings are synchronized to the top of the hour.
*SC5
Scan interval: 5 second(s).
*ST
Logging started.
2009,195,0923,17,3.07,23.93,-9025.767,23.4,1

*2009,195,0923,20,3.07,23.96,-9025.185,23.4,2

*2009,195,0923,25,3.07,24.05,-9025.486,23.4,3
2009,195,0923,30,3.07,24.08,-9025.754,23.4,4
2009,195,0923,35,3.07,24.08,-9025.632,23.4,5
2009,195,0923,40,3.07,24.08,-9025.486,23.4,6
```

L.33 “RT8” - Set Maximum Number of Readings to 8000

Sets the total number of readings to 8000.

```
*RT8
8000 readings maximum
*
```

L.34 “RT16” - Set Maximum Number of Readings to 16000

Sets the total number of readings to 16000.

```
*RT16
16000 readings maximum
*
```

L.35 “S” - Display Status

Displays the datalogger status.

```
*S
MS:3200   OP:1567  UP:1
GT: 1   GZ:  8934.0000  GF: 0.01234  GO: 0.00000
Scan interval: 60 second(s).
Logging started.
Logging will stop at:  10:50:00
Log intervals enabled.
Monitor mode disabled.   *
```

Line	Description	Manual Sections
1	Status of memory pointers	L.6, L.26
2	Gauge information	L.8
3	Scan interval setting	L.36
4	Start/Stop status	L.38, L.39
5	Stop time (optional)	L.38
6	Log interval status	L.13, L.14
7	Monitor mode status	L.15

Table 16 - S Command Information

L.36 "SCnnnnn" - Set Scan Interval

Enter the scan interval, in seconds. Range of entry is 3 to 86400. Only whole numbers are accepted. Typing **SC** with no value returns the current setting only

```
*SC
Scan interval: 60 second(s).
*SC300
Scan interval: 300 second(s).

*
```

L.37 "SS" - Display System Status

Displays the system status of the datalogger.

```
*SS
Signature of RAM1: 32819
Signature of RAM2: 15979
Signature of RAM3: 63255
Signature of RAM4: 2197
Signature of ROM: 15283
Trap count: 0
Network address: 1
Network recognition disabled.
Time format is hhmm.
Date format is Julian.
Standard Temp thermistor selected
*
```

Line	Description
1	Signature of RAM bank one. (checksum)
2	Signature of RAM bank two. (checksum)
3	Signature of RAM bank three. (checksum)
4	Signature of RAM bank four. (checksum)
5	Signature of ROM (checksum)
6	Communication errors counter.
7	Current network address.
8	Current network status.
9	Current time format configuration.
10	Current date format configuration.
11	External Thermistor Selection

Table 17 - SS Command Information

L.38 "SPhh:mm" - Stop Logging

Stop the datalogger logging values; hh is the hour (24-hour format) of the day to stop and mm the minutes. The time entry is optional.

```
*SC60
Scan interval: 60 second(s).
*ST
Logging started.
2009,92,1512,46,3.24,25.66,12046.43,22.33,1

*SP12:00
Logging will start at: 15:13:46
Logging will stop at: 12:00:00
*
```

Note that when SPhh:mm is issued, the datalogger responds with the time of the next reading along with the time at which logging will stop.

L.39 "SThh:mm" - Start Logging

Start the datalogger logging values; hh is the hour of the day (24-hour format) to start and mm the minutes. The time entry is optional. Entry is ignored if logging is already started (unless a time is entered).

```
*ST
Logging already started!
*ST11:00
Logging will start at: 11:00:00
Logging will stop at: 12:00:00
*
```

L.40 “SV” - Display Software Version

Returns the software version of the datalogger’s operating system software. Consult the factory to check on latest versions available.

```
*SV
Software version: 4.17.0
*
```

L.41 “TEST” - Perform Internal Self-Tests

Initiates a set of internal self-tests that are performed at the factory during final testing.

```
*TEST


LC-2 TEST MENU:

SELECTION         TEST

 0         INTERNAL EEPROM
 1         EXTERNAL EEPROM BANK 1
 2         EXTERNAL EEPROM BANK 2
 3         EXTERNAL EEPROM BANK 3
 4         EXTERNAL EEPROM BANK 4
 5         EXTERNAL EEPROM BANK 5
 6         EXTERNAL EEPROM BANK 6
 7         ALL EEPROM
 8         +5X_X
 9         RTC 32KHz
 A         EXTERNAL INPUT (GAUGE TYPE 1)
 B         EXTERNAL INPUT (GAUGE TYPE 2)
 C         EXTERNAL INPUT (GAUGE TYPE 3)
 D         EXTERNAL INPUT (GAUGE TYPE 4)
 E         EXTERNAL INPUT (GAUGE TYPE 5)
```

ENTER SELECTION:

Selection	Description
0	Test the Configuration memory bank
1	Test Readings 1-3200 memory bank
2	Test Readings 3201-6400 memory bank
3	Test Readings 6401-9600 memory bank
4	Test Readings 9601-12800 memory bank
5	Test Readings 12801-16000 memory bank
6	Test Readings 16001-19200 memory bank
7	Test all memory banks
8	Turn on system power supplies
9	Test the 32.768 RTC timebase
A	External test input configuration: gauge type 1
B	External test input configuration: gauge type 2
C	External test input configuration: gauge type 3
D	External test input configuration: gauge type 4
E	External test input configuration: gauge type 5
X	Exit and return to normal operations

Table 18 - TEST Menu Information

L.42 “TF” - Display or Set Time Format

Displays the current time format display option setting. This setting determines how the time information will be displayed in the array when the Monitor mode is active (see Appendix L.15, “Display Current Monitor Mode Settings”) or arrays are being displayed from memory. Entering TF alone returns the current time format. Entering TF0 sets the time format to hhmm. Entering TF1 sets the time format to hh,mm. The default time format display is hhmm.

```
*TF0
Time format is hhmm.
*D
2009,52,1343,30,3.00,24.7,-5372.293,24.3,57
*TF1
Time format is hh,mm.
*D
2009,52,13,43,30,3.00,24.7,-5372.293,24.3,57
*
```

L.43 “T” - Display Current Thermistor Setting

This setting determines the type of external thermistor that is incorporated into the VW gauge. Entering T alone returns the current thermistor setting. Entering T0 sets the external thermistor type to standard 3KΩ@25ºC NTC (default). Entering T1 sets the external thermistor type to high temperature BR55KA822J 8.22KΩ@25ºC NTC. Entering T2 sets the external thermistor type to high temperature 103JL1A 10KΩ@25ºC.

```
*T
103JL1A thermistor selected.
*T0
Standard Temp thermistor selected.
*T1
BR55KA822J thermistor selected.
*T2
103JL1A thermistor selected.
*
```

L.44 “TR” - Display Current Trap Count

The trap counter is a register that keeps track of the number of times that the internal processor has detected a communications error. This is a useful register to check if communication problems are suspected.

L.45 “TR0” - Reset Trap Count

Reset the trap count register to zero.

L.46 “WF” - Display Current Wrap Format

Memory “wrapping” means that once the memory has filled, the datalogger will continue taking readings and overwrite the stored values in a circular fashion (see Appendix L.6, “Display Arrays Forward from User Position).

When the wrap format is set to zero, logging will stop once the memory becomes full. This is useful if critical data is stored and it must not be inadvertently overwritten and lost.

When the wrap format is set to one, logging will continue when the memory becomes full and the original stored values will be overwritten. With this setting, logging will continue indefinitely until told to stop with the SP command, or the programmed stop time has been reached.

```
*WF
Logging will not stop when memory is full
*WF0
Logging will stop when memory is full
*WF1
Logging will not stop when memory is full*
```

L.47 “X” - Take Immediate Reading

Takes and displays one reading but does not store this reading in memory. This is useful if interested in obtaining a reading at the moment, without interrupting or affecting the current logging schedule. The User Position is not displayed with the array data.

```
*D

There are no arrays to display.
*X
2009,92,1603,12,3.00,24.7,-5372.293,24.3


*D

There are no arrays to display.
*
```