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Instruction Manual

Model LC-2x4

4 Channel VW Datalogger

*Waterproof dataloggers (Models 8002-WP-4-USB and 8002-WP-4-RS232) are not CE Approved.

(Doc Rev BB, 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.

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1. INTRODUCTION

The four-channel LC-2 datalogger is a low cost, battery powered, easy to use measurement instrument, designed to read up to four vibrating wire sensors equipped with thermistors. The 320K standard memory provides storage for 10666 data arrays. 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 readings, the transducer temperature and the Array number.

Internal math is calculated using 32-bit floating point notation (IEEE). Math operations on the instrument readings, such as application of zero readings, gauge factors (or calibration factors) and offsets when using a linear conversion technique or polynomial coefficients when using the polynomial conversion, provide outputs directly in engineering units. The dataloggers internal configuration is defined through communication with a computer using the supplied RS-232 or USB (or optional RS-485) interface cable. The datalogger is configured and monitored using Agent, a GEOKON proprietary Graphic User Interface (GUI) software application. Agent can be downloaded from the GEOKON website. Please refer to the Agent software manual for further information on using the Agent program. (See Appendix K. for the legacy software application, Logview.) The datalogger can also be configured and monitored via text-based commands with any standard terminal emulator software, such as Microsoft Windows HyperTerminal™ (see Appendices L and M).

The communication method for each model of the LC-2x4 is described below

8002-4-1, 8002-WP-4-RS232: Communication with the LC-2x4 is implemented via the host computer's RS-232 COM port. See Section 2.5.1 for further information.

8002-4-2, 8002-WP-4-USB: Communication with the LC-2x4 is implemented via the host computer's USB 2.0 port. When connected to a computer via the USB port, the LC-2x4 appears to the computer as a "virtual" COM port. The LC-2x4 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. See Section 2.5.2 for further information.

8002-4-3: Communication with the LC-2x4 is implemented via RS-485. This allows for long communication cables (up to 4000') between the host computer and the LC-2x4. The ability to network two or more LC-2x4 dataloggers together is also available with this communication option. See Section 2.5.3 and Appendix G for further information.

All data, both readings and configuration, are stored in non-volatile 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 approximately 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 D for sample data files.

2. GETTING STARTED

The following equipment will arrive with the Model LC-2x4 datalogger:
(If any accessories are missing or damaged, please contact the factory.)

- Set of two alkaline D cell batteries.
- Set of four desiccant packs packaged with the batteries.
- Accessories:

Shipped with the 8002-4-1, 8002-WP-4-RS232:
Part #8002-10-RS232 comprising: a USB to RS-232 serial adapter cable, a RS-232 Communication Cable (DB-9F to 10-pin Bendix Male), a #3 Phillips head screwdriver, and a 3/32" flat head screw driver.

Shipped with the 8002-4-2, 8002-WP-4-USB:
Part #8002-10-USB comprising: USB Communication Cable (USB-A to 10-pin Bendix Male) a #3 Phillips head screwdriver, and a 3/32" flat head screw driver.

Shipped with the 8002-4-3:
USB Communication Cable (USB-A to 10-pin Bendix Male), RS-485 Interface for PC, RS-485 patch cord

The following are optional accessories:
- Model 8002-8 aluminum mounting bracket kit (See section 2.3 for installation instructions.)
- Vibrating Wire Sensor with built-in thermistor.

2.1 Transducer Installation

2.1.1 Cable Gland Connections (Models 8002-4-1, 8002-4-2, 8002-4-3)

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 nuts on the cable fittings and remove the white plastic dowels.

3) Thread the transducer cables through the cable fittings.

4) Connect the cable wires to the datalogger's 5-pin internal terminal blocks, located on the Multiplexer circuit board. **(NOTE: The multiplexer board is mounted on the right side of the enclosure. Do not connect any transducer cables to the terminal block located on the battery board.)** 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 Table 1 for transducer wiring information. (See also Appendix B.)

Terminal Block Position	Channel Number	Description	Cable Wire Color
VW1+	1	Vibrating Wire +	RED
VW1-	1	Vibrating Wire -	BLACK
TH1+	1	Thermistor +	WHITE
TH1-	1	Thermistor -	GREEN
SHLD1	1	Analog Ground (shield)	BARE WIRE
VW2+	2	Vibrating Wire +	RED
VW2-	2	Vibrating Wire -	BLACK
TH2+	2	Thermistor +	WHITE
TH2-	2	Thermistor -	GREEN
SHLD2	2	Analog Ground (shield)	BARE WIRE
VW3+	3	Vibrating Wire +	RED
VW3-	3	Vibrating Wire -	BLACK
TH3+	3	Thermistor +	WHITE
TH3-	3	Thermistor -	GREEN
SHLD3	3	Analog Ground (shield)	BARE WIRE
VW4+	4	Vibrating Wire +	RED
VW4-	4	Vibrating Wire -	BLACK
TH4+	4	Thermistor +	WHITE
TH4-	4	Thermistor -	GREEN
SHLD4	4	Analog Ground (shield)	BARE WIRE

Table 1 - Transducer Cable Connections

5) Tighten the nuts on the cable fittings so that they securely grip the cables. **This must be done to ensure that water does not enter the enclosure. (Beware of overtightening, which may damage the plastic threads.)**

2.1.2 10-pin Bulkhead Connections (Models 8002-4A-1, 8002-4A-2, 8002-4A-3)

Transducers are attached to the datalogger with 10-pin Bulkhead connectors. 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.

2.1.3 6-pin Waterproof Connections (Models 8002-WP-4-RS232, 8002-WP-4-USB)

Transducers are attached to the datalogger as follows:

1) Loosen the locking sleeve by rotating it counterclockwise. Then remove the "dummy" connector from the datalogger by pulling on it. (You will experience some resistance when removing the connector due to the internal O-ring seal.)

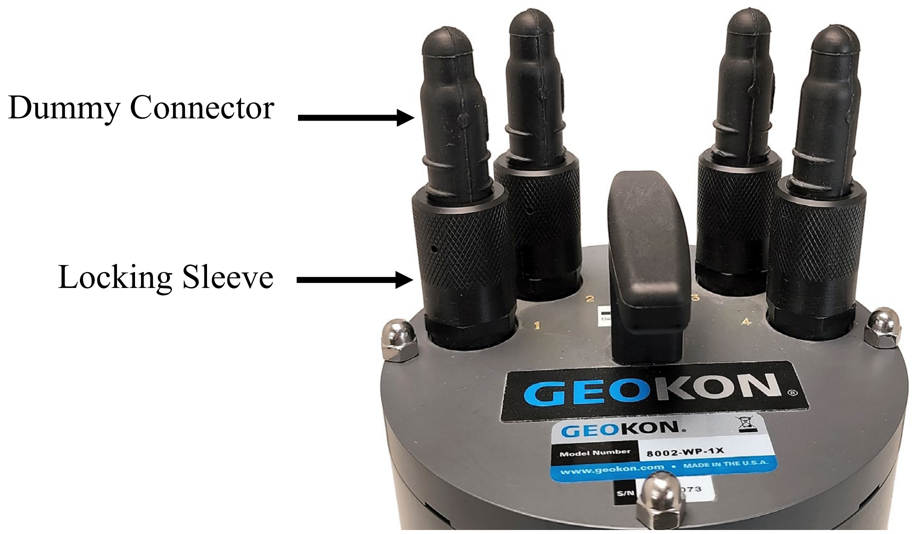


Figure 1 – Dummy Connector and Lock Sleeve

2) Align the large pin on the datalogger connector (male) with the large hole on the transducer connector (female). (Use the 3H logo on the female connector as a guide.)

Figure 2 – Connector Alignment

3) Push the connectors together until they are completely mated.
4) Tighten the locking sleeve onto the connector by turning it clockwise.
5) Repeat the above process for the rest of the transducers.

2.2 Battery Installation

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

1) Open the device by unscrewing the four captive screws on the front of the enclosure. For waterproof models, remove the 4 acorn nuts from the top of the enclosure, then pull on the handle to remove the cover.

   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 3 - Battery Detail

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

If the optional 8002-8 aluminum mounting bracket has been purchased, follow the instructions in Section 2.3, otherwise continue to Section 2.4.

2.3 Optional Model 8002-8 Aluminum Mounting Bracket
(See Appendix C. for mounting bracket dimensions.)

If the optional 8002-8 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 4 shows the completed installation

Figure 4 - Aluminum Mounting Bracket Installed

2.4 Final Steps

After the batteries have been installed:

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

2) Ensure that the rubber gasket or o-ring is clean and properly seated in the groove on the enclosure. Tighten the screws (acorn nuts for waterproof models) a little at a time, working in a diagonal pattern. Make sure the cover seals tightly and evenly.

2.4.1 Earth Ground Installation

The LC-2x4 provides lightning protection in the form of gas tube surge arrestors. In order for these components to divert the energy from a lightning strike safely to ground, a good solid electrical connection to earth ground needs to be made. A grounding rod should be driven (or other suitable attachment to earth utilized) to ground the system and provide a path to earth in the event of a lightning strike. A 6' to 8' copper stake with appropriate large gauge wire (12 AWG or larger) connected to the LC-2x4 enclosure is suggested. The stake should be driven as close to the datalogger as possible, and to a depth of at least one meter (three feet). A copper grounding lug is supplied on the exterior of the LC-2x4 enclosure to provide connection to this wire from the grounding rod.

2.5 PC Connections

2.5.1 RS-232 Connection (8002-4-1, 8002-WP-4-RS232)

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 RS-232 Communications cable (S-8001-6) to the COM port of the LC-2x4 datalogger. 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).

2.5.2 USB Connection (8002-4-2, 8002-WP-4-USB)

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.

2.5.3 RS-485 Connection (8002-4-3)

Make the COM port connection per Section 2.5.1 (RS-232) or 2.5.2 (USB), and then refer to Appendix G to establish communications.

2.6 Software Installation and Setup

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

3. MAINTENANCE

While the Model LC-2x4 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.

3.1 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; therefore, 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 using.

3.2 Batteries

When the unit is not in use, especially for extended periods of time, the D cells 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 can be used with the Model LC-2x4.

Battery Chemistry (Two D cells)	Battery Pack Voltage	Battery Capacity	Ten Second Scan Rate	One Minute Scan Rate	One Hour Scan Rate	One Day Scan Rate
Lithium	7.2V	17 AHr	14.2 days	82.9 days	4.9 years	7.3 years
Alkaline	3V	13 AHr	6.4 days	36.9 days	1.8 years	2.5 years
Carbon-Zinc	3V	5 Ahr	2.4 days	14.2 days	254.3 days	350.6 days

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. If the datalogger is continuously connected to an active computer's 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 3V battery) or 10.5 VDC (external 12V 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 was logging when it halted due to low battery voltage, it will resume logging as soon as new batteries are installed or as soon as it is connected to a USB port.

[1]The datalogger electronics will stop the datalogger from logging and disable RS-485 communications if the battery goes below 1.6 VDC (internal 3V battery) or 5.5V (external 12V battery).

4. 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.
✓ The USB Drivers may not be properly installed. See Section 2.5.2.
✓ If RS-232 or RS-485 communications are being used, the internal batteries of the datalogger may be low, dead, or inserted incorrectly. Check the batteries and replace if necessary. (Units manufactured before September 2018 were supplied with an aluminum battery holder, which may need adjusting; refer to Appendix J.)
✓ If RS-485 communications is being used, the **<ENTER>, <ENTER>, #,datalogger address**, **<ENTER>** key sequence is not being sent. Refer to Appendix G for further information.

Symptom: Vibrating wire gauge measurement reads -999999.0

✓ Using an ohmmeter, check connections to the vibrating wire gauge leads. Resistance should be between 90 and 180 ohms (pins A and B on the 10-pin connector, see Appendix B). Remember to correct for cable resistance, which is approximately 50 Ω per km (14.7Ω per 1000 ft.) Multiply this factor by two to account for both directions. If resistance reads less than 100Ω, the cable is probably shorted. If resistance reads infinite or in the megohms range, the cable is probably cut.
✓ Check the datalogger with another known good transducer. If it still reads –999999.0, the datalogger may be malfunctioning.
✓ Check that the proper gauge type is selected (see Table 11 and Table 12).
✓ Check that the transducer shield wire is not shorted to either the red or black wire.

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

✓ A mathematical over-range 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 cables away from the power lines or electrical equipment.
✓ Check if the proper gauge type is selected (see Table 11 and Table 12).

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. Appendices E and F detail the resistance versus temperature relationship for standard and high temperature thermistors.

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	10666
Data memory type:	ring (oldest over-write)
Array elements:	ID (optional) Year Julian day (or month,day) Time (hhmm or hh,mm) Seconds Battery voltage Datalogger temperature Channel 1 Transducer reading Channel 2 Transducer reading Channel 3 Transducer reading Channel 4 Transducer reading Channel 1 Transducer temperature Channel 2 Transducer temperature Channel 3 Transducer temperature Channel 4 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-2x4 models)

Speed:	9600 bps & 115,200 (version 3.1.X and later)
Parameters:	8 Data bits
	1 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	0)
	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		

A.10 Multiplexer Relay

NAIS TXS2SA-4.5V

Contact resistance: 0.1 ohm (max)
Switching current: 1A (max)

APPENDIX B. CONNECTOR PINOUTS

B.1 Transducer Cable Connections

Terminal Block Position	Channel Number	Description	Cable Wire Color
VW1+	1	Vibrating Wire +	RED
VW1-	1	Vibrating Wire -	BLACK
TH1+	1	Thermistor +	WHITE
TH1-	1	Thermistor -	GREEN
SHLD1	1	Analog Ground (shield)	BARE WIRE
VW2+	2	Vibrating Wire +	RED
VW2-	2	Vibrating Wire -	BLACK
TH2+	2	Thermistor +	WHITE
TH2-	2	Thermistor -	GREEN
SHLD2	2	Analog Ground (shield)	BARE WIRE
VW3+	3	Vibrating Wire +	RED
VW3-	3	Vibrating Wire -	BLACK
TH3+	3	Thermistor +	WHITE
TH3-	3	Thermistor -	GREEN
SHLD3	3	Analog Ground (shield)	BARE WIRE
VW4+	4	Vibrating Wire +	RED
VW4-	4	Vibrating Wire -	BLACK
TH4+	4	Thermistor +	WHITE
TH4-	4	Thermistor -	GREEN
SHLD4	4	Analog Ground (shield)	BARE WIRE

Table 3 - Transducer Cable Connections

B.2 RS-232 Connector Pinout (8002-4-1)

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

10-pin Bendix	Internal Wire Color	PCB connector J5 pin	Description
A	Brown	1	Ground
B	Red	2	Tx
C	Orange	3	Rx
D	Yellow	4	RTS
E	Green	5	CTS
F	Blue	6	N/C
G	Violet	7	DTR
H	Grey	8	+5V
J	White	9	N/C
K	Black	10	Ground

Table 4 - RS-232 Connector Pinout

B.3 USB Connector Pinout (8002-4-2)

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

10-pin Bendix	Internal Wire Color	PCB connector J5 pin	Description
A	Brown	1	USB VCC
B	Red	2	USB DM
C	Orange	3	USB DP
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 5 - USB Connector Pinout

B.4 RS-485 Connector Pinout (optional, 8002-4-3)

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 6 - RS-485 Connector Pinout

APPENDIX C. MOUNTING BRACKET DIMENSIONS

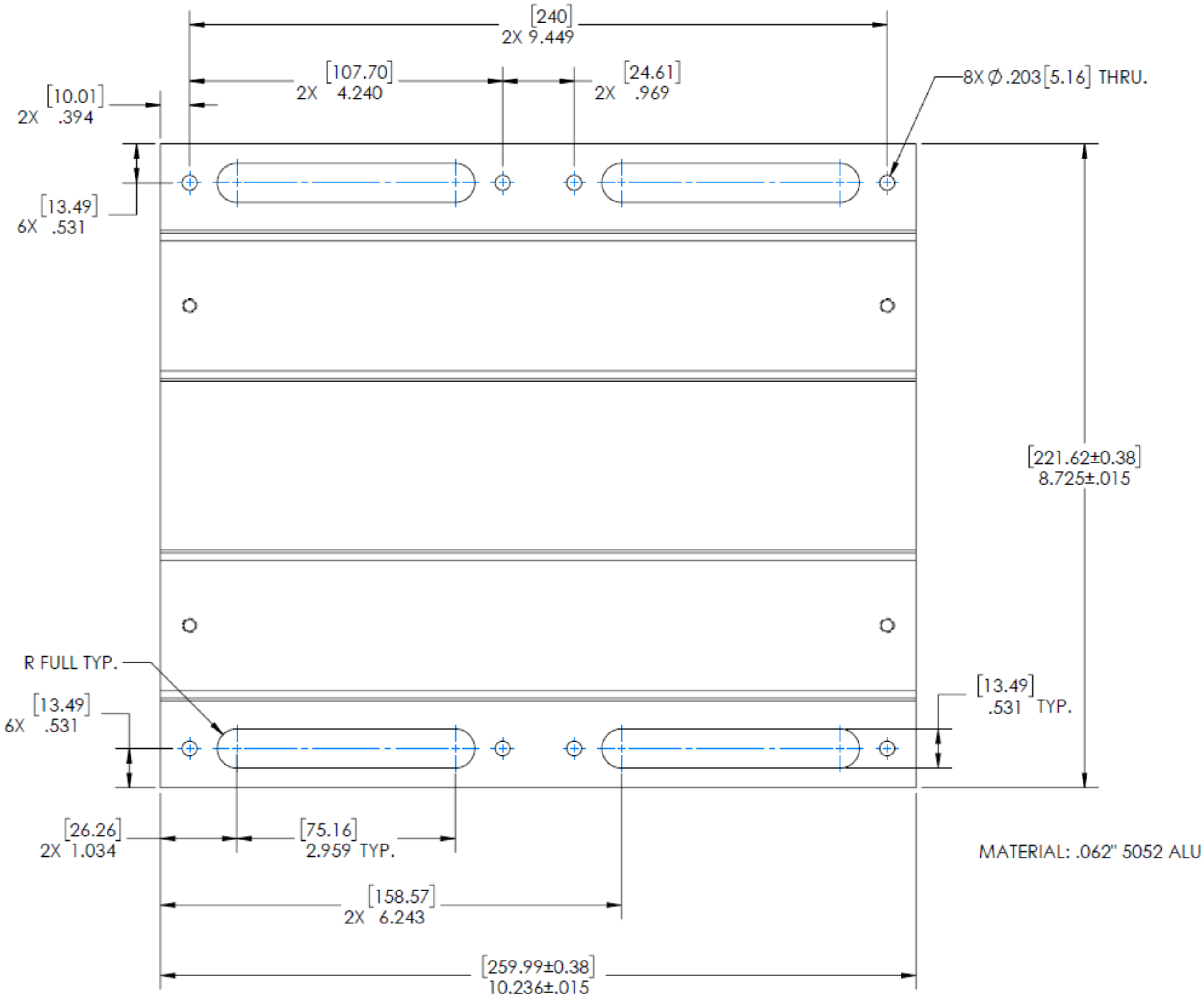


Figure 5 - Model 8002-8 Aluminum Mounting Bracket Dimensions

APPENDIX D. SAMPLE DATA FILE

D.1 Sample Raw Data File

Datalogger#1,2007,329,1421, 0 ,2.93,25.01,-9040.265,---,---,---,23.7,---,---,---,1
Datalogger#1,2007,329,1421,10,2.93,25.13,-9039.986,---,---,---,23.7,---,---,---,2
Datalogger#1,2007,329,1421,20,2.93,25.42,-9039.950,---,---,---,23.7,---,---,---,3
Datalogger#1,2007,329,1421,30,2.93,25.30,-9041.042,---,---,---,23.7,---,---,---,4
Datalogger#1,2007,329,1421,40,2.93,25.16,-9040.502,---,---,---,23.7,---,---,---,5
Datalogger#1,2007,329,1421,50,2.93,25.07,-9039.458,---,---,---,23.7,---,---,---,6
Datalogger#1,2007,329,1422, 0 ,2.93,25.04,-9040.303,---,---,---,23.7,---,---,---,7

The comma delineated columns above represent the following:

Column 1 represents the datalogger id
Column 2 represents the year when the array was stored.
Column 3 represents the julian day (or day, month format, see Appendix M.5).
Column 4 represents the time (or hh,mm format, see Appendix M.37).
Column 5 represents the seconds.
Column 6 represents the main battery voltage (alkaline batteries, nominal 3.0 VDC).
Column 7 represents the internal temperature in degrees Celsius.
Column 8 represents the Channel 1 vibrating wire reading.
Column 9 represents the Channel 2 vibrating wire reading.
(disabled)
Column 10 represents the Channel 3 vibrating wire reading.
(disabled)
Column 11 represents the Channel 4 vibrating wire reading.
(disabled)
Column 12 represents the Channel 1 external temperature in degrees Celsius.
Column 13 represents the Channel 2 external temperature in degrees Celsius. (disabled)
Column 14 represents the Channel 3 external temperature in degrees Celsius. (disabled)
Column 15 represents the Channel 4 external temperature in degrees Celsius. (disabled)
Column 16 represents the Array #

APPENDIX E. STANDARD THERMISTOR TEMPERATURE DERIVATION

Thermistor Type: YSI 44005, Dale #1C3001-B3, Alpha #13A3001-B3

Resistance to Temperature Equation:

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

Equation 1 - Convert Thermistor Resistance to Temperature

Where: T = Temperature in °C.
LnR = Natural Log of Thermistor Resistance
A = 1.4051×10^{-3} (coefficients calculated over the −50 to +150° C. span)
B = 2.369×10^{-4}
C = 1.019×10^{-7}

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 7 - Standard Thermistor Resistance versus Temperature

APPENDIX F. HIGH TEMP THERMISTOR TEMPERATURE DERIVATION

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

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

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 8 - Thermistor Resistance Versus Temperature for HT Models

APPENDIX G. NETWORKING

G.1 Description

The Model LC-2x4 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-2x4 Dataloggers* can be networked. Also, the maximum network length* can be up to 1.22 km (4000 ft.). 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 RS-485 interface adapter is battery powered to allow for collection of data in the field. An AC adapter is also provided if mains power is available. The 8002-5 draws its operating power from the host computer's USB 2.0 port.

Each datalogger appears as a "node" on the RS-485 bus, with its own unique address. In order 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.

In a RS-485 system, it is important to locate the "termination" device at the end of the bus. Make sure that circuit board jumper JP1 (located adjacent to J5 – the COM connector cable termination on datalogger the circuit board) is positioned between pins one and two on the datalogger that is located at the farthest point on the bus from the RS-485 Interface Adapter and data collection computer. Refer to Appendix G.2 for an example of a typical communications session.

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

For further information, refer to Appendix M.10, and M.21 through M.25.

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

G.2 Example of a Four-Datalogger Networking Session

1) This session assumes that there are four dataloggers running at five second scan intervals, and that each datalogger has only one channel enabled.

2) Press <ENTER> <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
*
1,2007,11,25,16,25,0,2.98,24.6,-9040.265,---,---,---,20.5,---,---,---,34
1,2007,11,25,16,25,5,2.98,24.7,-9039.886,---,---,---,20.4,---,---,---,35
1,2007,11,25,16,25,10,2.98,24.7,-9040.028,---,---,---,20.5,---,---,---,36
*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> <ENTER>to wake the dataloggers and then type #2<ENTER>. Datalogger #2 returns:

```
Network address: 2
*
2,2007,11,25,16,25,25,2.95,24.7,-360.112,---,---,---,20.4,---,---,---,27
2,2007,11,25,16,25,30,2.96,24.7,-360.155,---,---,---,20.4,---,---,---,28
*E
```

5) Doing the same for Datalogger #3 and #4 results in:

```
Network address: 3
*
3,2007,11,25,16,30,0,2.98,24.7,9091.346,---,---,---,20.5,---,---,---,25
3,2007,11,25,16,30,5,2.98,24.7,9091.400,---,---,---,20.5,---,---,---,26
*E

Network address: 4
*
4,2007,11,25,16,31,26,2.96,24.8,-8457.811,---,---,---,20.4,---,---,---,20
4,2007,11,25,16,31,31,2.96,24.8,-8456.978,---,---,---,20.4,---,---,---,21
*E
```

APPENDIX H. LITHIUM COIN CELL

H.1 Description

Under normal operating conditions, the 1.5-volt D cells provide all the power required to operate the LC-2x4 datalogger. To maintain the correct date and time settings for those periods when the D cells are removed, the LC-2x4 datalogger incorporates a 3-volt 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 2.5-volts or less, it should be replaced using the following replacement procedure.

H.2 Replacement Procedure

Materials Required:

- 6 mm (1/4") Slotted Screwdriver
- 6 mm (1/4") Nutdriver
- 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 6 mm (1/4") slotted screwdriver, loosen the four captive screws and remove the datalogger cover.

3) Remove the two D cells.

4) Using the 6 mm (1/4") slotted screwdriver, remove the four 9.5 mm long M3.5 x .6 (3/8" long, 6-32) battery board mounting screws.

5) 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.

6) Using the 6 mm (1/4") nut driver, remove the four standoffs securing the printed circuit board to the case.

7) Lift the printed circuit board up to expose the bottom of the circuit board.

8) Using the 3 mm (1/8") slotted screwdriver, gently pry the lithium coin cell battery from the battery holder.

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

10) Re-install the printed circuit board back into the enclosure.

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

12) Reconnect the two-wire Molex connector to the header labeled “3V” (“12V” if applicable).

13) Position the battery board over the standoffs and reinstall using the four, 9.5 mm long, M3.5 x .6 (3/8" long, 6-32) battery board mounting screws.

14) Reinstall the D cells.

15) Reinstall the datalogger cover.

Lithium coin cell replacement is now complete.

APPENDIX I. MODEL 8032-27 AND LOAD CELL WIRING

Connect the "common" VW- conductor from the load cell to the 8032-27 by lifting up on the orange tab located on the opposite side of the six black conductors, inserting the common conductor fully into the 8032-27 (Figure 6), and then pushing down on the orange tab until it snaps into place. Refer to Table 9 to identify which conductor carries the common VW- signal.

Figure 6 - Model 8032-27 Jumper Wire Assembly

10-pin Bendix PT06A-12-10P	**Function**	**3 Gauge VW Load Cell, Purple Cable**	**4 Gauge VW Load Cell, Purple Cable**	**6 Gauge VW Load Cell, Orange Cable**
H	Common	White's Black*	Green	Blue

Table 9 - Common Conductor Chart

* White's black and Green wires are switched on GEOKON three-gauge VW load cells prior to serial number 3313.

The following wiring chart details the connections between the load cell, the 8032-27, and the multiplexer board:

Multiplexer Board	Vibrating Wire with Thermistor
VW1+	VW Sensor #1
VW1-	8032-27
TH1+	Thermistor
TH1-	Thermistor
SHLD1	Shield Drain Wire
VW2+	VW Sensor #2
VW2-	8032-27
TH2+	-
TH2-	-
SHLD2	-
VW3+	VW Sensor #3
VW3-	8032-27
TH3+	-
TH3-	-
SHLD3	-
VW4+	VW Sensor #4
VW4-	8032-7
TH4+	-
TH4-	-
SHLD4	-

Table 10 - Multiplexer Board Wiring

APPENDIX J. 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 7 below.

Proper Battery Installation **Faulty Battery Installation**

Figure 7 - Battery Installation Detail

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

APPENDIX K. LOGVIEW SOFTWARE (LEGACY)

LogView is Graphical User Interface (GUI) software 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-2x4 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-2x4. These instructions are for computers running Windows XP. The installation procedure is very similar for computers running Windows7, Windows 2000 and Windows 98. This installation procedure needs to be performed only once for each computer that will run LogView to communicate with an LC-2x4 datalogger.

NOTE: The USB drivers are only required for LC-2x4 models 8002-4-2, 8002-WP-4-USB and the 8002-5 RS-485 Interface

Make sure that the two 1.5-volt D cell alkaline batteries are installed in the datalogger (See Section 2.2, "Battery Installation" for instructions) and that the LC-2x4 datalogger is not connected to the computer at this time.

K.1 LogView Installation

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

2) Click " >" 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.

K.2 Launching LogView

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

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

K.3 LogView Workspaces

When opening LogView for the first time, the user will be prompted to create a workspace name (see Figure 8). 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.

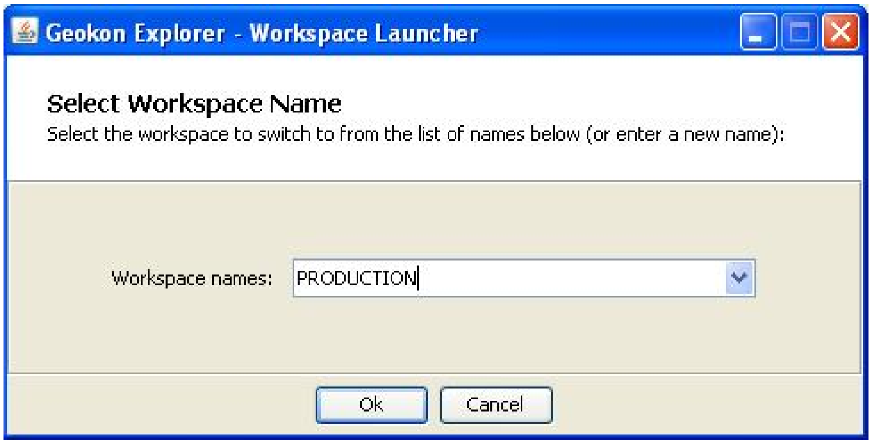


Figure 8 - Select Workspace Name

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 9). The folder location can be entered directly, e.g., `C:\Workspaces\East Coast` or the **Browse** button can be used to navigate to a folder location or to create a new folder (see Figure 9). 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.

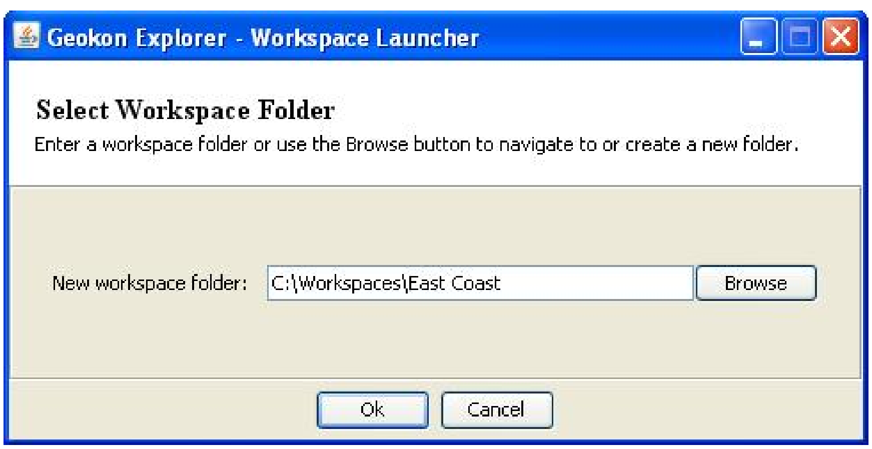


Figure 9 - Select Workspace Folder

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, clicking on "**Ok**" will display the main window of LogView (see Figure 10). 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.

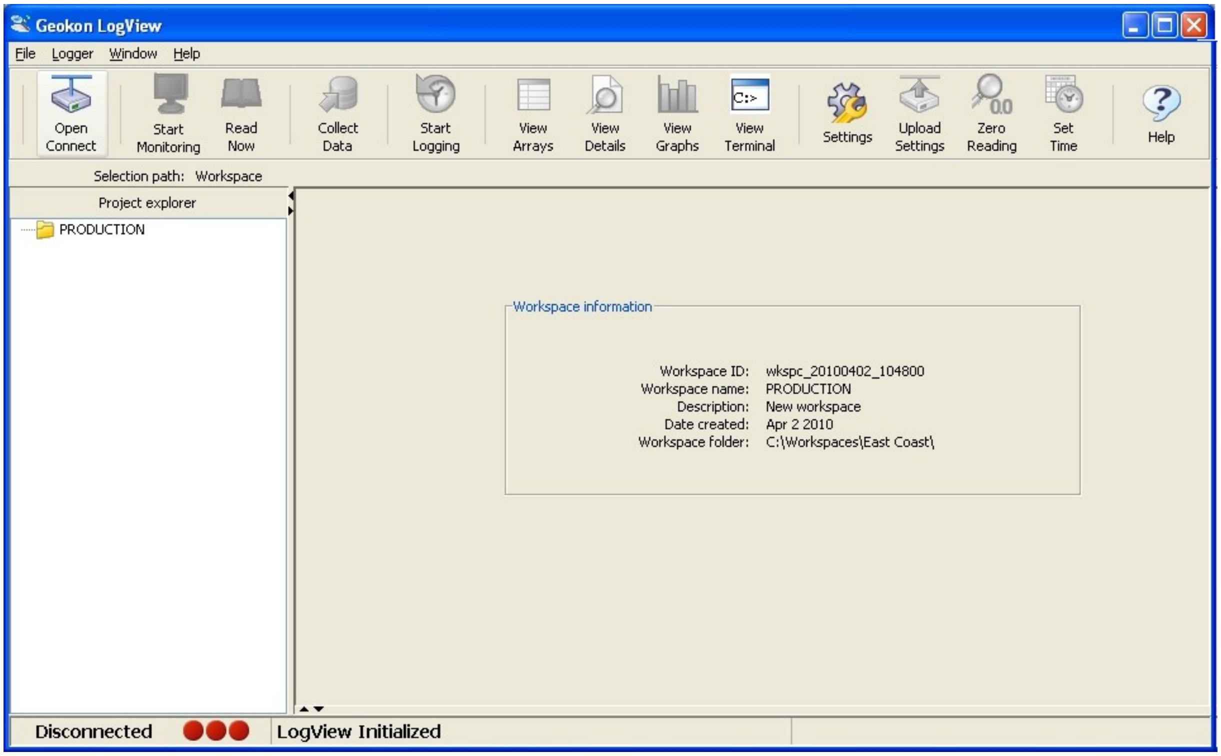


Figure 10 - LogView Main Window

K.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 (see Figure 11 below)

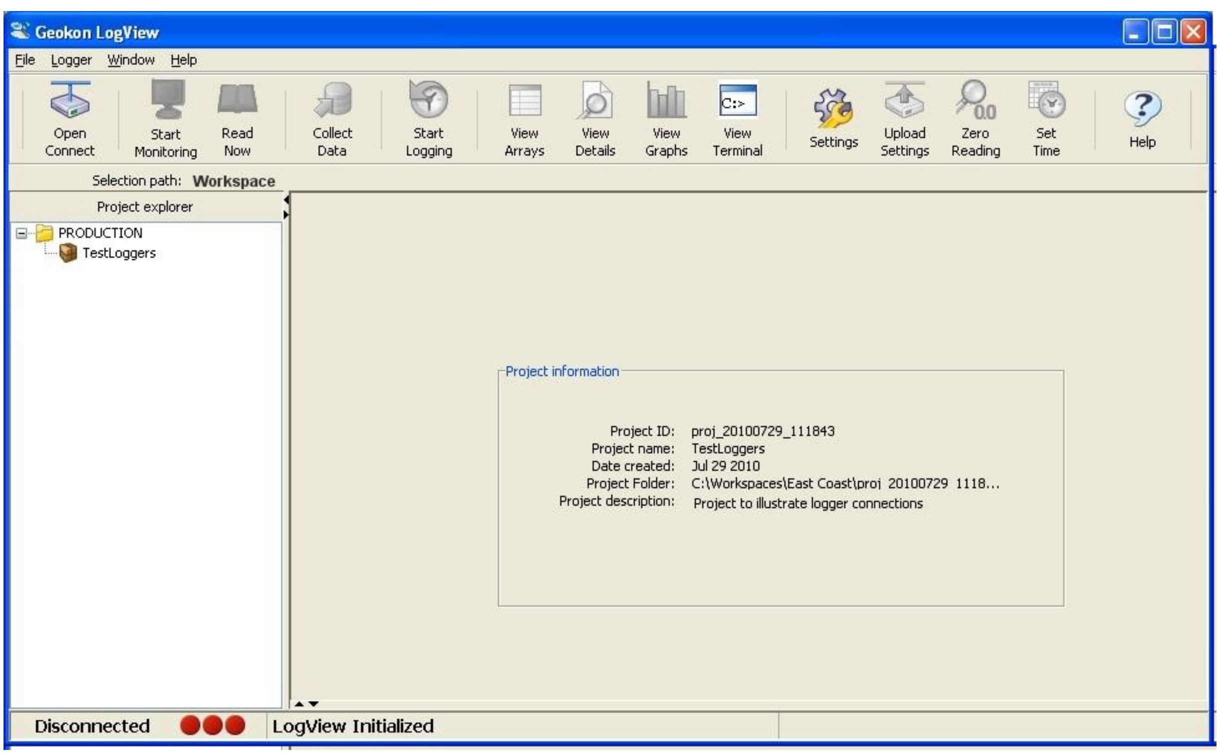


Figure 11 - LogView Main Window with new project

K.5 Adding Dataloggers to LogView Projects

Right-clicking on the "**TestLoggers**" project brings up a context sensitive menu (see Figure 12) 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 human-readable 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 13).

After physically connecting to a PC, all LC-2x4 dataloggers require a COM port to be identified in the "**Connection Options**". Starting with firmware revision 3.1.X, LC-2x4 dataloggers can communicate at baud rates of 9600 and 115,200. Before this revision the datalogger baud rate was 9600 only; for these dataloggers, the default setting should not be changed (See Figure 13)

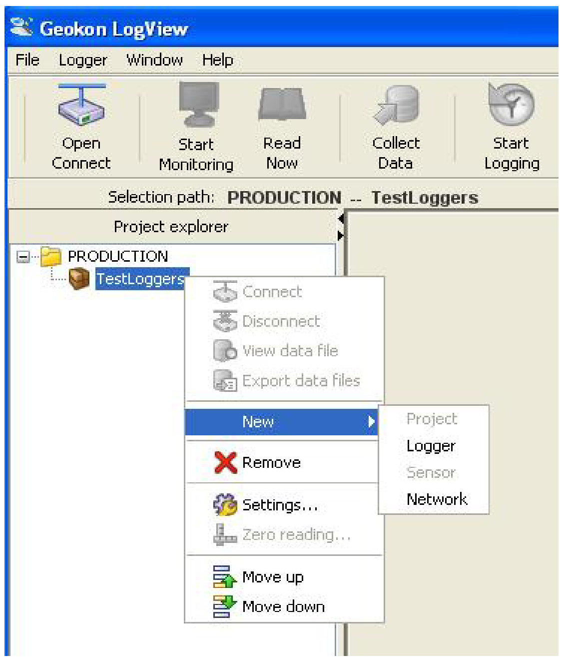


Figure 12 - LogView Context Menu

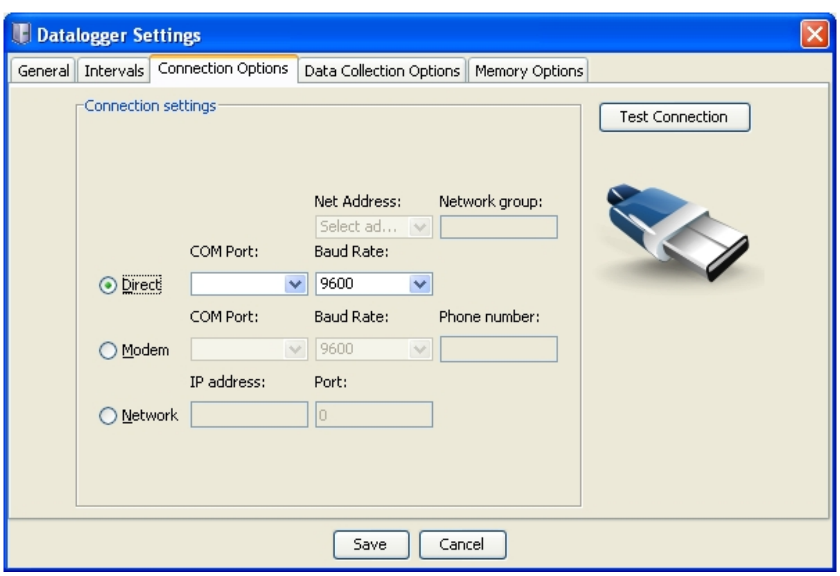


Figure 13 - Datalogger Settings, Connection Options

K.6 LC-2x4 Connection (8002-4-1, 8002-WP-4-RS232)

Connect the supplied LC-2x4 RS-232 Communications cable (S-8001-6) to the COM port of the LC-2x4 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 K.9, Connecting to a Datalogger with LogView.

K.7 LC-2x4 Connection (8002-4-2, 8002-WP-4-USB)

Connect the supplied LC-2x4 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 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 driver may need to be installed by executing the program, CDMv2_xxxx, from the LogView Install folder. Proceed to Appendix K.9, Connecting to a Datalogger with LogView.

K.8 LC-2x4 Connection 8002-4-3 (RS_485)

Make the COM port connection per Appendix K.6 (RS-232) or K.7 (USB), and then refer to Appendix G to establish communications.

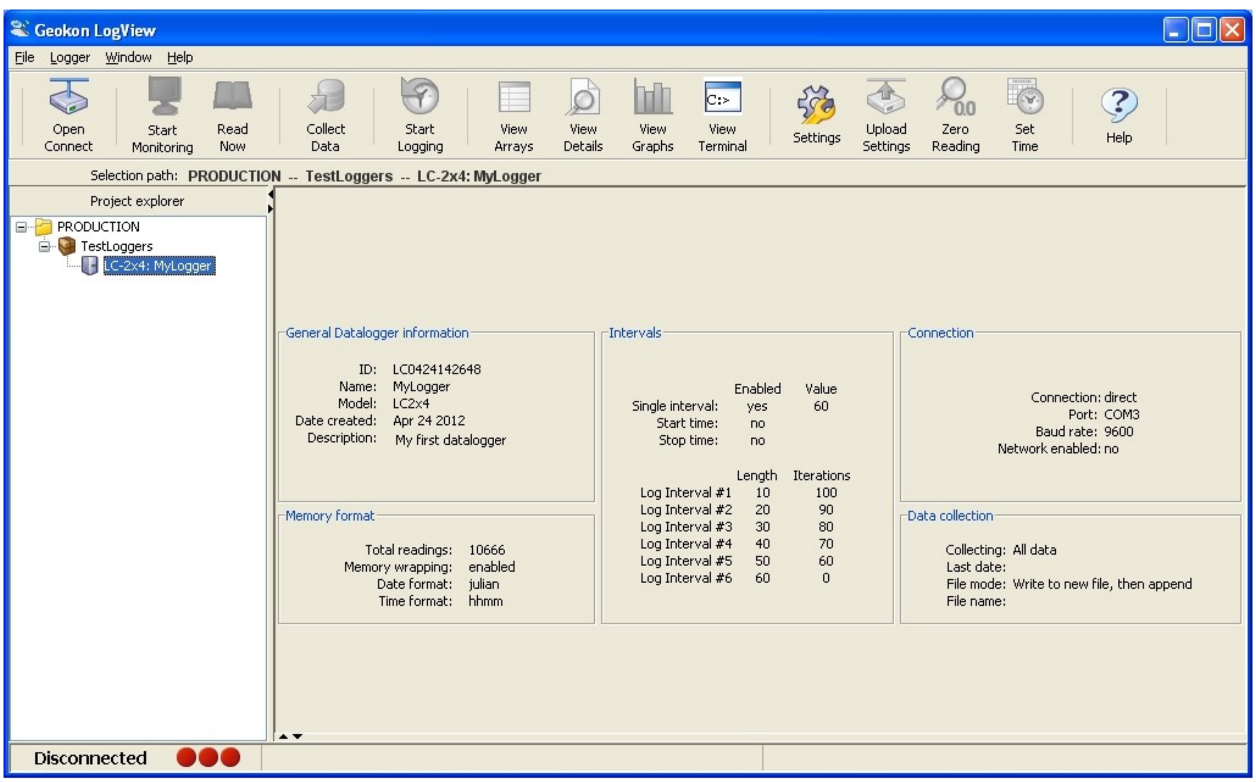


Figure 14 - Datalogger Highlighted, Not Connected

K.9 Connecting to a Datalogger with LogView

1) With a Datalogger profile configured and selected in the Project Explorer (see Figure 14), click on the "**Open Connect**" button on the LogView Toolbar.

2) When connecting to a new Datalogger for the first time, the message below (see Figure 15) 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.

3) Click on the "**Upload Settings**" button on the LogView Toolbar to synchronize the datalogger with the LogView configuration (see Figure 16).

4) LogView is now connected and configured correctly for the LC-2x4 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.

5) Always upload the new settings to the datalogger after changing its configuration in LogView.

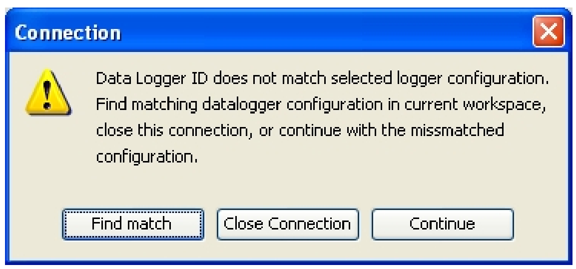


Figure 15 - Datalogger Connection Mismatch

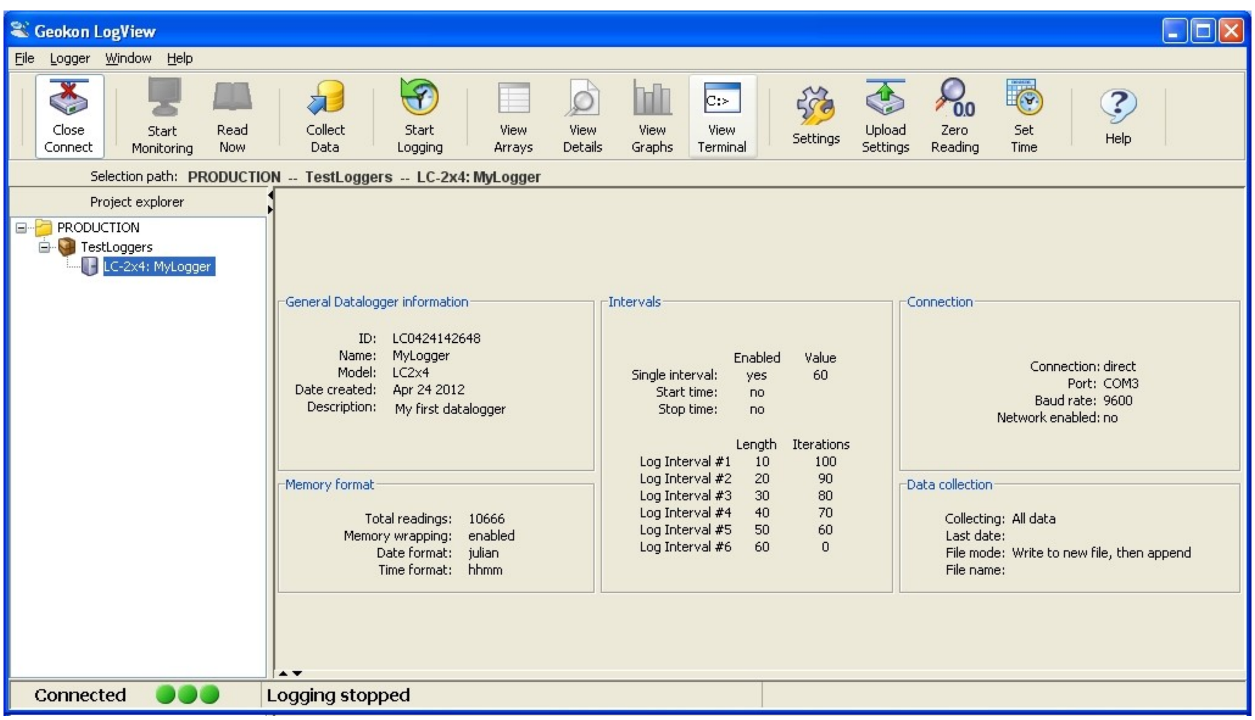


Figure 16 - Datalogger Connected

K.10 Determining COM Port Numbers

When connecting an 8002-4-1 or 8002-WP-4-RS232 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. Figure 17 below illustrates that the PC has two serial ports, one internal (COM1) and the other via a USB to serial converter (COM13).

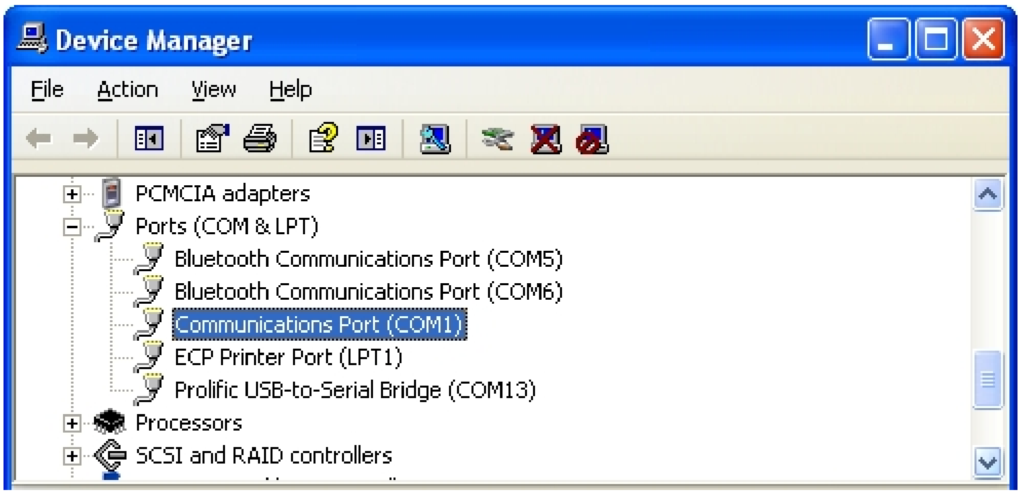


Figure 17 - PC Internal COM Port

When connecting an 8002-4-2 or 8002-WP-4-USB datalogger to a PC the COM Port number LogView requires can be any number and depends on how many other devices are attached to the PC like, internal serial ports and wireless devices. Figure 18 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 LC-2 datalogger is attached to is to disconnect the cable and see which COM device disappears from the Device Manager Ports list.

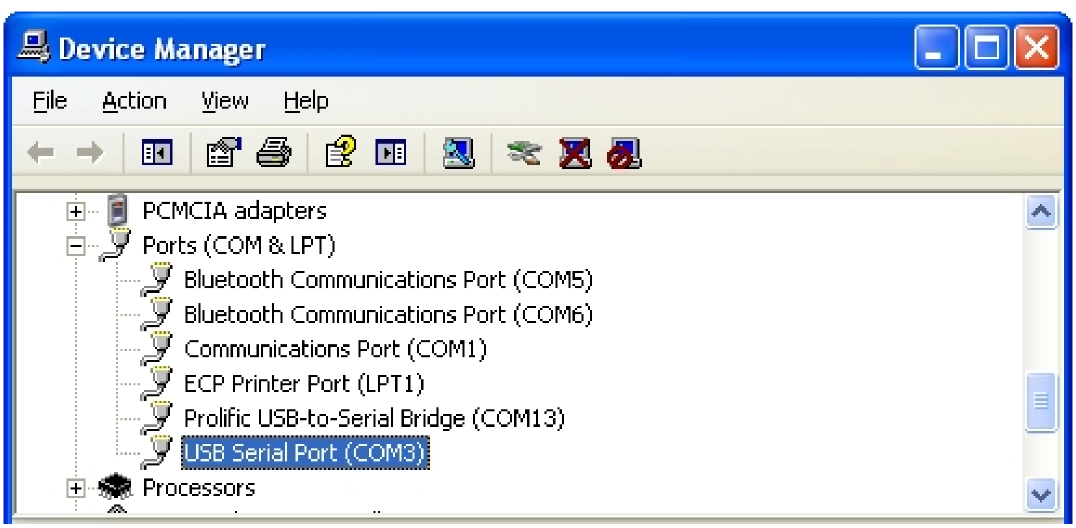


Figure 18 - Device Manager Ports List

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

K.11 Downloading Data using LogView

The steps below assume that a successful connection has been previously established between LogView and the datalogger.

Click on the Collect Data button from the Main Toolbar. See Figure 19 below:

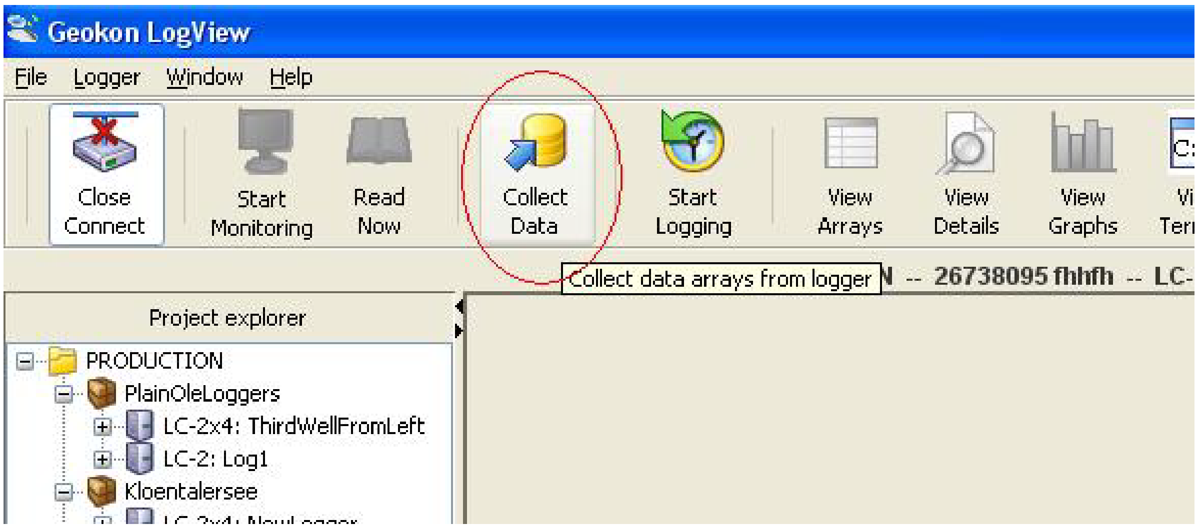


Figure 19 - LogView Collect Data Button

If the datalogger configuration is set for “Collect all data” in “Datalogger Settings→Data Collection Options” (see the LogView on-line 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 10666 arrays will be downloaded starting at the current User Pointer (See Appendix M.7 and M.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, a progress bar will be displayed until the collection has completed. After a data collection has finished LogView will display the message shown in Figure 20:

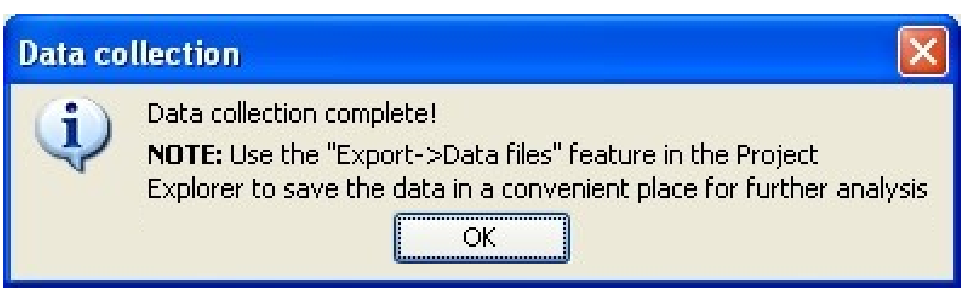


Figure 20 - Data Collection Complete Message

APPENDIX L. EXAMPLE SETUP USING A TERMINAL EMULATOR

For USB connected LC-2 dataloggers (8002-4-2, 8002-WP-4-USB), 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 21):

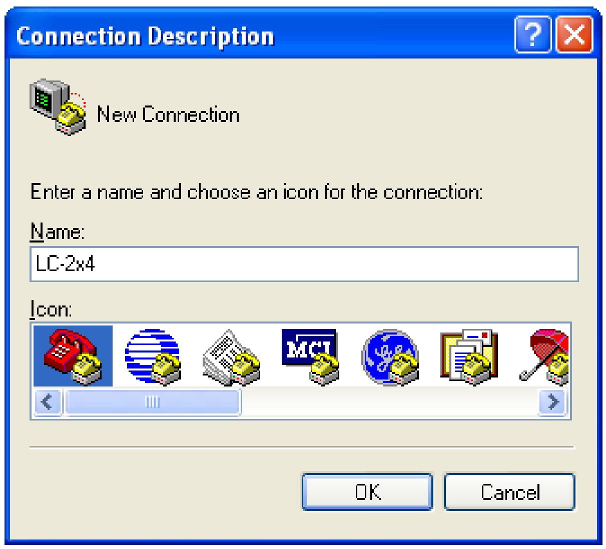


Figure 21 - HyperTerminal Connection Description

3) In the Connect Using window, select the appropriate COM port (see Figure 22):

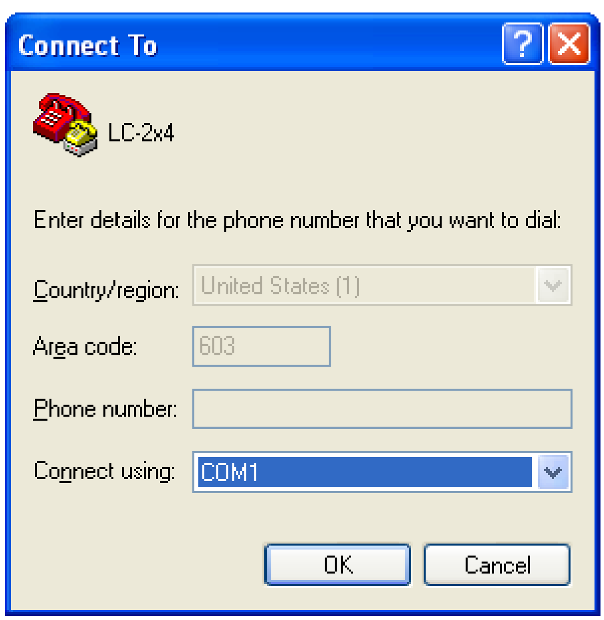


Figure 22 - COM Port Selection

4) In the COM Properties window, configure the COM port (see Figure 23):

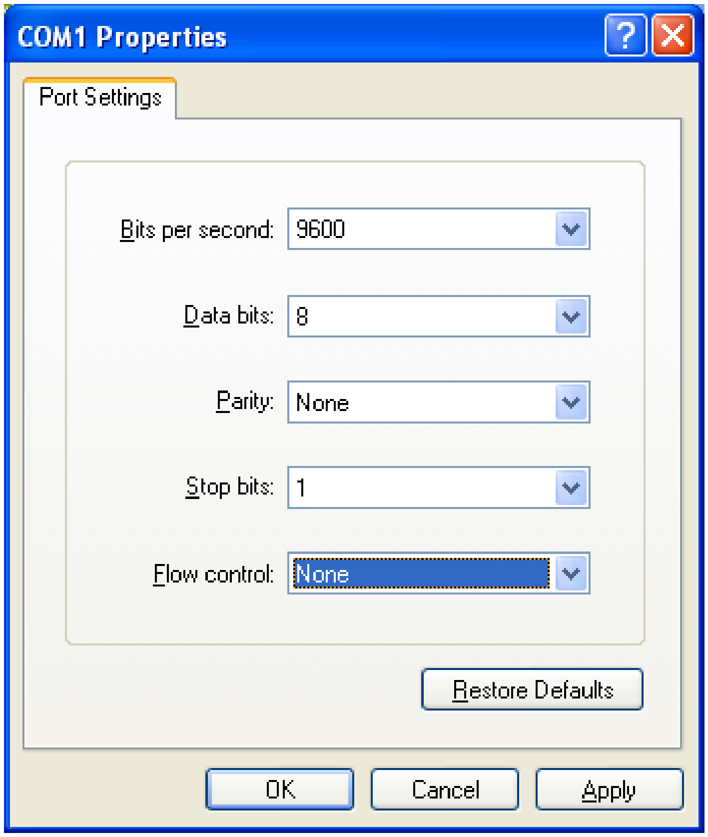


Figure 23 - COM Port Settings

<u>8002-4-1, 8002-WP-4-RS232:</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>8002-4-2, 8002-WP-4-USB:</u> Configure the <u>new</u> COM port that is added when the LC-2x4 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> <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> <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 M.21 thru M.25 for additional information.

1) Type ? <ENTER> to display the Help list. See Appendix M for detailed information on all the commands listed. **Note: 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 gauge settings
DF                   Date Format(0=julian,1=month,day)
DL                   Display DataLogger type
Dnnnnn               Display nnnnn arrays from pointer
E                    End communications and go to sleep

Gnn/c/tt/szzzzzz/sffffff/soooooo
(or Gnn/c/tt/saaaaaa/sbbbbbb/scccccc)
                     Gauge information, where;
                     nn = Channel #
                     c = Conversion Type(L/P)
                     tt = Gauge Type

                     For Linear (L) Conversion:
                     szzzzzz = zero reading with sign
                     sffffff = gauge factor with sign
                     soooooo = offset with sign

                     For Polynomial (P) Conversion:
                     saaaaaa = polynomial coefficient A with sign
                     sbbbbbb = polynomial coefficient B with sign
                     scccccc = polynomial coefficient C with sign

IDdddddddddddddddd   View current ID,set to dddddddddddddddd
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
MXS                  Display Multiplexer Setup
MX#                  Select Multiplexer Configuration(4,16)
N                    Display Next time to read
NAddd                Network Address (1-256)
NS,ND,NE             Network Status, Disable, Enable
Pnnnnn               Position array pointer to nnnnn
R                    Reset memory
RESET                RESET processor
S,SS                 Datalogger Status, System Status
SCnnnnn              View SCan interval/enter nnnnn interval
SPhh:mm              StoP logging, hh:mm = stop time
SR                   Synchronize Readings(0=not synch'd,1=synch'd)
SThh:mm              STart logging, hh:mm = start time
```

SV	**Software Version**
TEST	**System Test**
TF	**Time Format (0 = hhmm, 1 = hh,mm)**
Tnn/t	**Thermistor information, where;** **nn = Channel #** **t = Thermistor Type** **0=standard** **1 = high temp BR55A822J** **2 = high temp 103JL1A)**
TR,TR0	**display TRap count, zero TRap count**
VL	**display Lithium cell Voltage**
V3	**display 3V Battery Voltage**
V12	**display 12V Battery Voltage**
WFn	**Wrap Format(0=don't wrap memory,1=wrap memory)**
X	**Single Reading - NOT stored**

These commands are executed by typing with the correct syntax and pressing <ENTER>. If the command has not been entered correctly, the datalogger will respond with an asterisk only.

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 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 → HyperTerminal

1) Enter a name for the New Connection – Select OK (Figure 24).

Figure 24 – HyperTerminal Connection Description

2) Change the Connect using setting to the appropriate COM port (Figure 25) – Select OK.

Figure 25 - HyperTerminal Connection Selection

3) In the COM Properties Dialog, enter the "Port Settings". Select Apply. Select OK (Figure 26).

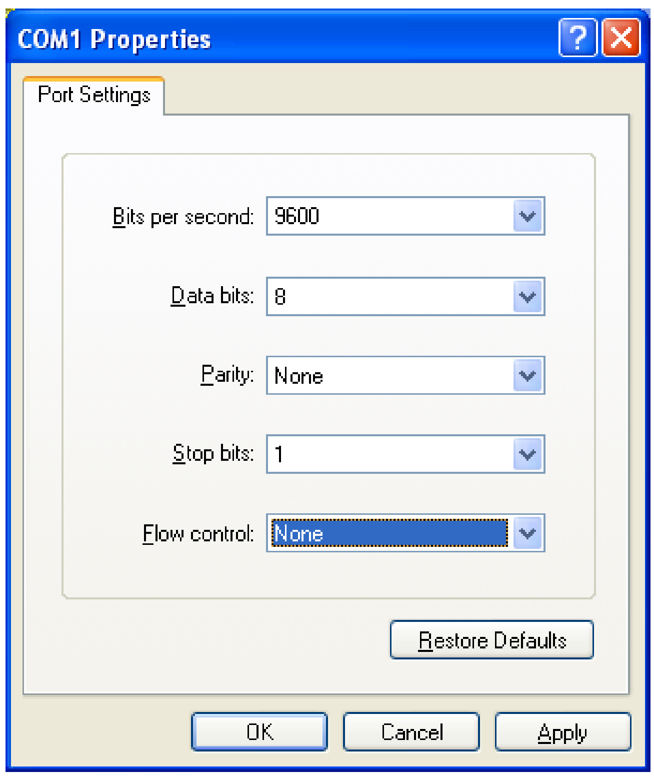


Figure 26 - HyperTerminal COM Port Settings

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

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

5) Upon confirmation of communications, select Transfer | Capture Text (see Figure 27):

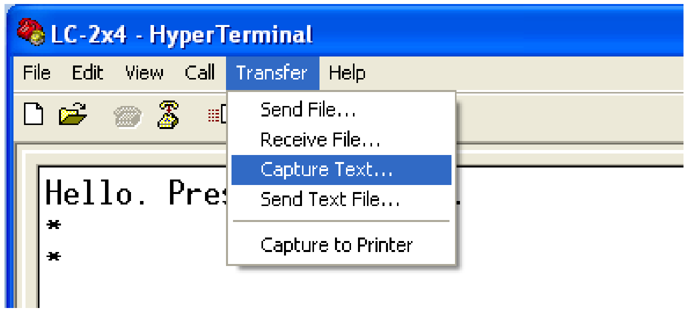


Figure 27 - HyperTerminal Transfer Menu

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 28).

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

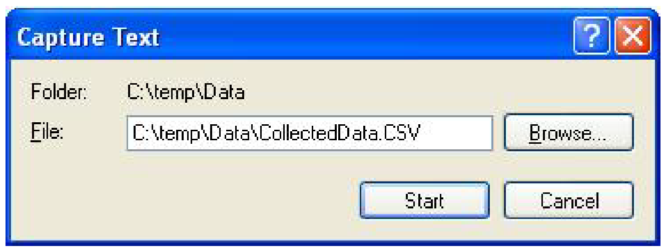
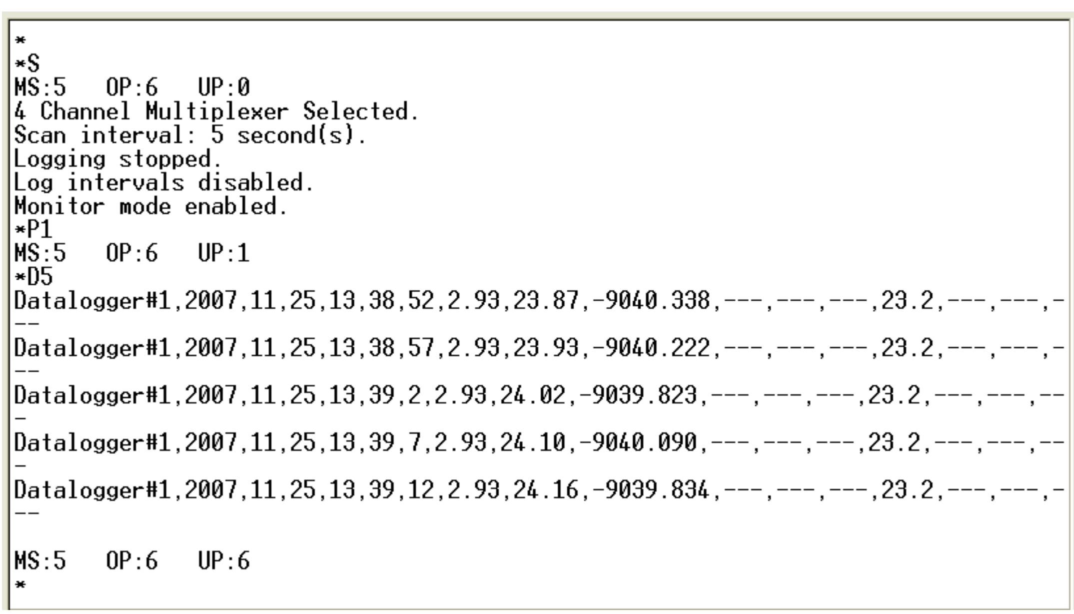


Figure 28 - Specify Data Capture File

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

Type "S" to get the Status of the datalogger.
Type "P1" to position the data array Pointer at location one.
Type "D5" to Display the readings stored in memory (see Figure 29).
Select Transfer | Capture Text | Stop.



```
*
*S
MS:5   OP:6   UP:0
4 Channel Multiplexer Selected.
Scan interval: 5 second(s).
Logging stopped.
Log intervals disabled.
Monitor mode enabled.
*P1
MS:5   OP:6   UP:1
*D5
Datalogger#1,2007,11,25,13,38,52,2.93,23.87,-9040.338,---,---,---,23.2,---,---,-
--
Datalogger#1,2007,11,25,13,38,57,2.93,23.93,-9040.222,---,---,---,23.2,---,---,-
--
Datalogger#1,2007,11,25,13,39,2,2.93,24.02,-9039.823,---,---,---,23.2,---,---,--
-
Datalogger#1,2007,11,25,13,39,7,2.93,24.10,-9040.090,---,---,---,23.2,---,---,--
-
Datalogger#1,2007,11,25,13,39,12,2.93,24.16,-9039.834,---,---,---,23.2,---,---,-
--

MS:5   OP:6   UP:6
*
```

Figure 29 - HyperTerminal/Datalogger Communication

The data are now stored in the specified file.

APPENDIX M. COMMAND LIST

M.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
```

M.2 "C" - Display Current Clock Settings

Displays the current datalogger real-time clock settings. The **CS** command section explains how to adjust the clock settings.

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

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

Set 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. Illegal combinations will be ignored (e.g., CS02/30/07 or CS///12:60). Fields that are left blank will not be changed (e.g., CS//07 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.

M.4 "DEFAULT" – Load Factory Default Settings

The DEFAULT command will reload the datalogger's channel and gauge settings to the factory default settings, along with the reading synchronization and memory wrap settings. This results in:

All channels Enabled
All Gauge Types set to 1
All Zero Readings set to 0.00000
All Gauge Factors set to 1.00000
All Gauge Offsets set to 0.00000
All channels use linear conversion
Scan interval = 10S
All readings synchronized to the top of the hour

Memory will wrap when full and continue logging
All Thermistors set to standard temperature

***DEFAULT**
This will load all channels with factory default gauge settings!
Are you sure(Y/N)?Y
All channels restored to factory default gauge settings.

M.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.

*DF1
Date format is month,day.

*DF0
Date format is julian.
```

M.6 "DL" – Display Current Mode

Displays the current datalogger mode setting.

```
*DL
LC-2x4
```

M.7 "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.

*P1
MS:3146   OP:3147   UP:1
***D5**
2007,11,23,17,52,43,3.10,25.51,9039.950,-999999.0,-999999.0,-999999.0,23.2,-99.0,
-99.0,-99.0,1
2007,11,23,17,53,43,3.10,24.77,9040.149,-999999.0,-999999.0,-999999.0,23.2,-99.0,
-99.0,-99.0,2
2007,11,23,17,54,43,2.97,24.42,9040.319,-999999.0,-999999.0,-999999.0,23.2,-99.0,
-99.0,-99.0,3
2007,11,23,17,55,43,2.98,24.22,9039.622,-999999.0,-999999.0,-999999.0,23.1,-99.0,
-99.0,-99.0,4

2007,11,23,17,56,43,2.98,23.96,9038.542,-999999.0,-999999.0,-999999.0,22.7,-99.0, -99.0,-99.0,5

MS:3146 OP:3147 UP:6*

MS represents the Memory Status of the datalogger. This number indicates how many arrays have been written to memory. In this example, **MS:3146** indicates that 3146 out of 10666 arrays have been written to memory. **OP:3147** indicates that the next memory location to be written to is location 3147. **UP:1** indicates that the memory location currently being pointed to (via the P command) is memory location one. Use the D command to display arrays forward from the User Position. In this case, **D5** displays the arrays stored at memory locations 1, 2, 3, 4, and 5, and leaves the memory pointer at memory location 6. Figure 30 illustrates the ring memory scheme.

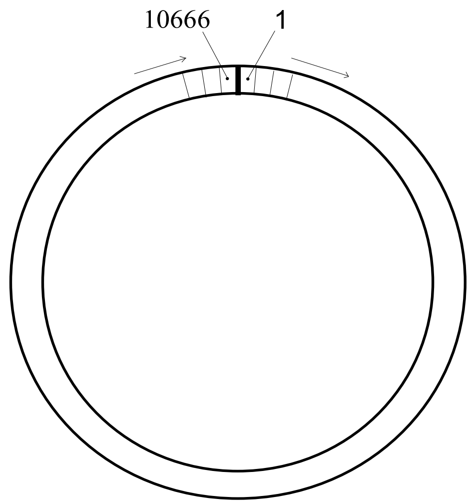


Figure 30 - Order of Array Usage

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 can display arrays from this position or re-position to another array.

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

M.8 "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.

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

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

Note: When network commands are enabled the address must be sent before the respective datalogger will respond. See Appendix M.21, M.23, and M.24 for additional information.

M.9 "Gnn/c/tt/szzzzzz/sffffff/soooooo" or "Gnn/c/tt/saaaaaa/sbbbbbb/scccccc" – Gauge Settings

The G command is used to set up each of the four datalogger channels. All of the transducer parameters, including the type of conversion (linear or polynomial) and whether a channel is enabled or disabled are set with this command.
Refer to Table 11 and Table 12 for a description of each gauge type.

The syntax for this command is:

Linear Conversion:
Gnn/c/t/szzzzzz/sffffff/soooooo
Where:
nn = Channel # (Valid entries are 1, 2, 3, and 4 for the LC-2x4)
c = Conversion Type(L/P) where L=Linear and P=Polynomial
t = Gauge Type:
0: Channel Disabled (will display "---")
1: VW Gauge Type 1
2: VW Gauge Type 2
3: VW Gauge Type 3
4: VW Gauge Type 4
5: VW Gauge Type 5
6: VW Gauge Type 6
szzzzzz = zero reading with sign
sffffff = gauge factor with sign
soooooo = offset with sign

Example: To setup Channel 1 as a model 4000 VW Strain Gauge with a Zero Reading of 490 digits, a Gauge Factor of –0.0015 and a Gauge Offset of zero, enter:

G1/L/3/490/-0.0015/0 <ENTER>

The LC-2x4 will return:

CH 1: ENABLED
GT: 3   ZR: 490.0000   GF: -0.00150   GO: 0.00000

***Note**: If selecting Gauge Type 0 to disable the channel, the LC-2x4 will only return "*". Use the **MXS** command (Appendix M.18) to view the disabled channels.

When using linear conversion (L) 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.

Linear Conversion is described further as follows:

szzzzzz represents the zero reading for the transducer being read, **sffffff** represents the multiplier (calibration or gauge factor) that will be applied to the reading to convert to engineering units and **soooooo** 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 1-6), manufactured after November 2, 2011 and for all dataloggers (8002-4-X) with a firmware revision of 3.1.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 **R_1** while the "**ZeroReading**" is referred to as **R_0**

Polynomial Conversion:
Gnn/c/tt/saaaaaa/sbbbbbb/sccccccc

Where:
nn = Channel # (Valid entries are 1, 2, 3, and 4 for the LC-2x4)
c = Conversion Type(L/P)
t = Gauge Type:
0: Channel Disabled (will display "---")
1: VW Gauge Type 1
2: VW Gauge Type 2
3: VW Gauge Type 3
4: VW Gauge Type 4
5: VW Gauge Type 5
6: VW Gauge Type 6
saaaaaa = polynomial coefficient A with sign
sbbbbbb = polynomial coefficient B with sign
sccccccc = polynomial coefficient C with sign

When using polynomial conversion (P), the G command is used to select the gauge type and enter the three polynomial coefficients, A, B and C.

Polynomial Conversion is described further as follows:

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 1-6), the basic formula for calculation of displayed and stored values is:

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

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 L) **AND** the gauge conversion is set for polynomial. When using LogView to set up 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 11 - Vibrating Wire Gauge Types

Type	Measurement Type	Description	Output Units	Linear Range	Polynomial Range
0		Channel Disabled			
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

Table 12 - 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 Table 13.

NOTE: In LogView Sensor Settings, when output units are set different than inputs units, a conversion factor (see Table 13) is automatically applied to the gauge factor of each sensor. See the LogView User’s Guide for more information on Sensor Settings.

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 13 - Engineering Units Multiplication Factors

M.10 "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:
*ID
Datalogger ID:
*IDDatalogger#1
Datalogger ID:Datalogger#1
*ST
Logging started.
Datalogger#1,2007,11,25,11,25,16,2.92,20.93,9.020,
-999999.0,-999999.0,-999999.0,22.0,-99.0,-99.0,-99.0,1
Datalogger#1,2007,11,25,11,25,21,2.92,20.95,9.061,
-999999.0,-999999.0,-999999.0,22.0,-99.0,-99.0,-99.0,2
Datalogger#1,2007,11,25,11,25,26,2.92,21.04,9.045,
-999999.0,-999999.0,-999999.0,22.0,-99.0,-99.0,-99.0,3
Datalogger#1,2007,11,25,11,25,31,2.92,21.09,9.014,
-999999.0,-999999.0,-999999.0,22.0,-99.0,-99.0,-99.0,4
```

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>.

M.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: 50

*
```

This command has no effect 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: 100/96
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: 50/50

*****

The above list indicates that there are 96 iterations of interval #1 left before interval #2 begins execution. See Appendix M.12 to modify intervals.

M.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 0 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 14 lists possible logarithmic interval lengths and iterations. Any combination of lengths and iterations is permissible.

Interval	Length	Iterations	Elapsed Time
1	10 seconds	6	1 minute
2	30 seconds	20	10 minutes
3	60 seconds	100	100 minutes
4	300 seconds	200	1000 minutes
5	2400 seconds	250	10000 minutes
6	3600 seconds	0	endless

Table 14 - Logarithmic Intervals List

M.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#1,2007,11,25,11,41,17,2.92,20.63,9.055,
-999999.0,-999999.0,-999999.0,22.5,-99.0,-99.0,-99.0,549
*
```

M.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#1,2007,11,25,11,42,56,2.92,21.51,9.042,
-999999.0,-999999.0,-999999.0,22.5,-99.0,-99.0,-99.0,622
```

M.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” and “ME” commands (next two sections) to disable or enable the use of the Monitor mode.

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

M.16 “MD” - Disable Monitor Mode

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

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

M.17 “ME” - Enable Monitor Mode

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

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

M.18 “MXS” – Display Multiplexer Status

Displays the Multiplexer Status.

***MXS**

LC-2MUX 4-Channel Multiplexer Setup:

CH 1: ENABLED
GT: 3 ZR: 0.00000 GF: 1.00000 GO: 0.00000 TH: 0

CH 2: ENABLED
GT: 1 ZR: 0.00000 GF: 1.00000 GO: 0.00000 TH: 0

CH 3: ENABLED
GT: 1 ZR: 0.00000 GF: 1.00000 GO: 0.00000 TH: 0

CH 4: ENABLED
GT: 1 ZR: 0.00000 GF: 1.00000 GO: 0.00000 TH: 0

*****

M.19 “MXn” – Set the Maximum Number of Channels

Set the maximum number of channels of the multiplexer. Can be set to 4 or 16. Set to 4 by the factory for all LC-2x4 dataloggers.

***MX4**
4 Channel Multiplexer Selected.
*****

M.20 “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.

```
*ST12:00
Logging will start at: 12:00:00
*N
Next time to read: 12:00:00
*
```

M.21 “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
```

M.22 “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 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>
#10<ENTER>
Network address: 10
*NA
Network address: 10
*E
```

NOTE: If connected directly to the datalogger via USB and networking is enabled, the datalogger will respond with the * prompt only.

NOTE: The network address cannot be changed while networked. Direct connect to the datalogger via USB to change the network address.

M.23 “ND” - Network Disable

Disables networking of two or more LC-2x4 dataloggers.

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

M.24 “NE” - Network Enable

Enables networking of two or more LC-2x4 dataloggers.

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

Note: If a networked LC-2x4 is connected via the RS-232 or USB port, connection to the 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.

M.25 “NS” - Display Network Status

Displays the current network status.

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

Or;

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

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

Type P and a number between 1 and 10666 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
*
```

M.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

M.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
*****

M.29 “S” – Display Status

Displays the datalogger Status.

```
*S
MS:1004   OP:1005   UP:1004
4 Channel Multiplexer Selected.
Scan interval: 15 second(s).
Logging stopped.
Log intervals disabled.
Monitor mode enabled.
*
```

Line	Description	Manual Sections
1	Status of memory pointers	M.7, M.26
2	Multiplexer Type	M.18
3	Scan interval setting	M.30
4	Start/Stop status	M.32, M.34
5	Stop time (optional)	M.32
6	Log interval status	M.13, M.14
7	Monitor mode status	M.15, M.16, M.17

Table 15 - S Command Information

M.30 "SCnnnnn" - Set Scan Interval

Enter the scan interval, in seconds. Range of entry is 3 to 86400 and is dependent on the number and type of transducers connected. 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).

*
```

M.31 "SS" - Display System Status

Displays the System Status of the datalogger.

```
*SS
Trap count: 0
Network address: 1
Network recognition disabled.
Time format is hh,mm.
Date format is month,day.
*
```

Line	Description
1	Trap Count (Communication errors counter)
2	Current network address
3	Current network status
4	Current time format configuration.
5	Current date format configuration.

Table 16 - SS Command Information

M.32 "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.
Datalogger#1,2007,11,25,14,10,05,2.94,23.99,9.071,---,---,
---,22.9,---,---,---,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.

M.33 "SR" - Synchronize Readings

Synchronize readings to the top of the hour. If enabled (default) via the SR1 command, then all readings after the first reading will synchronize to the top of the hour:

```
*SR1
Readings are synchronized to the top of the hour.
*ST
Logging started.
2008,318,1314,41,3.50,24.45,-8961.077,-999999.0,-999999.0,
-8444.892,23.1,-99.0,23.8,23.9,6645

*2008,318,1314,45,3.50,24.57,-8961.276,-999999.0,-999999.0,
-8445.080,23.2,-99.0,23.8,23.9,6646
2008,318,1315,0,3.50,24.86,-8960.023,-999999.0,-999999.0,
-8445.035,23.2,-99.0,23.8,23.9,6647

*SR0
Readings are not synchronized to the top of the hour.
*ST
Logging started.
2008,318,1316,31,3.50,24.39,-8960.209,-999999.0,-999999.0,
-8445.080,23.3,-99.0,23.8,23.9,6648

*2008,318,1316,46,3.50,24.80,-8960.090,-999999.0,-999999.0,
-8445.092,23.3,-99.0,23.8,23.9,6649

*2008,318,1317,1,3.50,24.80,-8961.173,-999999.0,-999999.0,
-8445.302,23.4,-99.0,23.8,23.9,6650
```

M.34 "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
*
```

M.35 "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: 3.7.0
*
```

M.36 "TEST" - Perform Internal Self-Tests

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

```
*TEST

LC-2MUX 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)
   X        EXIT TEST MENU

   ENTER SELECTION:
```

Selection	Description
0	Test the Configuration memory bank
1	Test Readings 1-1777 memory bank
2	Test Readings 1778-3554 memory bank
3	Test Readings 3555-5331 memory bank
4	Test Readings 5332-7108 memory bank
5	Test Readings 7109-8885 memory bank
6	Test Readings 8886-10666 memory bank
7	Test all memory banks
8	Turn on System power supplies
9	Test the 32.768 RTC timebase
A	External Input with Gauge Type 1 filter configuration
B	External Input with Gauge Type 2 filter configuration
C	External Input with Gauge Type 3 filter configuration
D	External Input with Gauge Type 4 filter configuration
E	External Input with Gauge Type 5 filter configuration
X	Exit and return to normal operations

Table 17 - TEST Menu Information

M.37 "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 M.15, "Display Current Monitor Mode Setting") 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.

```
*TF
Time format is hh,mm.
*TF0
Time format is hhmm.
*TF1
Time format is hh,mm.
*
```

M.38 "Tnn/t" – Set Thermistor Type

Enter the channel's (nn) thermistor type (t). This command allows a specific thermistor to be assigned to each individual channel (generally the external thermistor that is incorporated into the VW gauge). Entering T1/0 sets the external thermistor type of Channel 1 to the standard 3KΩ@25ºC NTC (default). For example, entering T2/1 sets the external thermistor type of Channel 2 to the high temperature BR55KA822J 8.22KΩ@25ºC NTC thermistor. Entering T3/2 sets the external thermistor type of Channel 3 to the high temperature 103JL1A 10KΩ@25ºC NTC thermistor.

```
T1/0:
CH 1: ENABLED
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000   TH: 0

T2/1:
CH 2: ENABLED
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000   TH: 1

T3/2:
CH 3: ENABLED
GT: 1   ZR: 0.00000   GF: 1.00000   GO: 0.00000   TH: 2
```

M.39 "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.

M.40 "TR0" - Reset Trap Count

Reset the TRap count register to zero.

M.41 "VL" – Display Coin Cell Voltage

The internal 3V lithium coin-cell is used to supply power to the real-time clock circuit. The 3V lithium coin cell life is rated at 10 years minimum.

***VL**
Lithium Cell Voltage = 2.92V
*****

M.42 “V3” – Display the D Cell Battery Voltage

Displays the three-volt D cell battery pack voltage. Replace the batteries when this voltage is less than 1.8-volts.

***V3**
3V Battery Voltage = 2.93V
*****

M.43 “V12” – Display the External Battery Voltage

Displays the external 12-volt battery voltage. Replace or recharge the battery when this voltage is less than six volts.

***V12**
12V Battery Voltage = 12.33V
*****

M.44 “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 M.7, “Display Arrays Forward from User Position”).

When the wrap format is set to 0, 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 1, 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, the programmed stop time has been reached, or the battery has fallen to 1.6-volts.

```
*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
*
```

M.45 “X” - Take Immediate Reading

Takes and displays one reading, but do not store this reading in memory. Useful if interested in obtaining a reading at the moment, without interrupting or affecting the current logging schedule.

```
*D

MS:3   OP:4   UP:3
*X
Datalogger#1,2007,11,25,13,11,39,2.93,23.59,9.060,---,---,---,22.8,---,---,---

*D

MS:3   OP:4   UP:3
*
```

Note: In this example, Channels 2, 3, and 4 are disabled.