Instruction Manual

Model LC-2

Single Channel Datalogger

C E

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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 arrays (8000 data arrays maximum when used with LogWare). 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, gage 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.

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 LogWare software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows Hyper Terminal™ along with the LC-2 Command List (see section 4).

LC-2 model 8002-1-1 provides hard-wired transducer connection by means of an internal terminal strip (see Figure 1, pg. 4). LC-2 model 8002-1-1A provides transducer connection by means of a 10-pin connector. Refer to section 3.1 Transducer Installation 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 LogWare software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows Hyper Terminal™ along with the LC-2 Command List (see section 4).

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 all of 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 strip (see Figure 1, pg. 4). LC-2 model 8002-1A-2 provides transducer connection by means of a 10-pin connector. Refer to section 3.1 Transducer Installation 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 LogWare software. The datalogger may also be configured and monitored using any standard terminal emulator software, such as Microsoft Windows Hyper Terminal™ along with the LC-2 Command List (see section 4).

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 (daisychained) together over one RS-485 communications cable.

LC-2 model 8002-1-3 provides hard-wired transducer connection by means of an internal terminal strip (see Figure 1, pg. 4). LC-2 model 8002-1A-3 provides transducer connection by means of a 10-pin connector. Refer to section 3.1 Transducer Installation to connect the vibrating wire transducer to the LC-2 datalogger.

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 $\pm$ 2 minutes/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.

For more information regarding setup and operation of the RS-485 LC-2 models, refer to APPENDIX F - NETWORKING.

3. GETTING STARTED

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

1. Set of (2) alkaline 'D' cell batteries.
2. One desiccant pack inside the enclosure.
3. 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)
4. LogWare CDROM containing both LogWare and the LC-2 USB drivers
5. Model LC-2 Single Channel Datalogger Instruction Manual.

If any of these items are missing or damaged contact the factory for replacements. The following are optional accessories;

- RS-485 interface cable(s).
- S-8001-5 or S-8002-5 RS-485 computer interface.
- Vibrating Wire Sensor with built-in thermistor.

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.

Open up the LC-2 by unscrewing the 4 captive screws on the top of the LC-2 enclosure. Make sure that no dirt, water or other contaminants are allowed to enter the LC-2 enclosure. Install the 2 'D' cells into the battery pack, being careful to observe the correct polarity. Note that there is a ziplock bag containing four desiccant packs shipped along with the batteries: So, as soon as the batteries are installed, take the desiccant packs out of the ziplock bag and put them inside the enclosure, then immediately close and reseal the lid. This will help to prevent condensation of moisture within the enclosure.

3.1. Transducer Installation:

For LC-2 models 8002-1-1, 8002-1-2 and 8002-1-3, install the transducer to the LC-2 by removing the white plastic plug (which is used to keep the enclosure sealed during shipment), thread the transducers cable through the bulkhead fitting on the front of the LC-2 enclosure and wire the cables 5 conductors into the terminal strip per Table 1 and Figure 1:

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

Table 1 Transducer Cable Connections
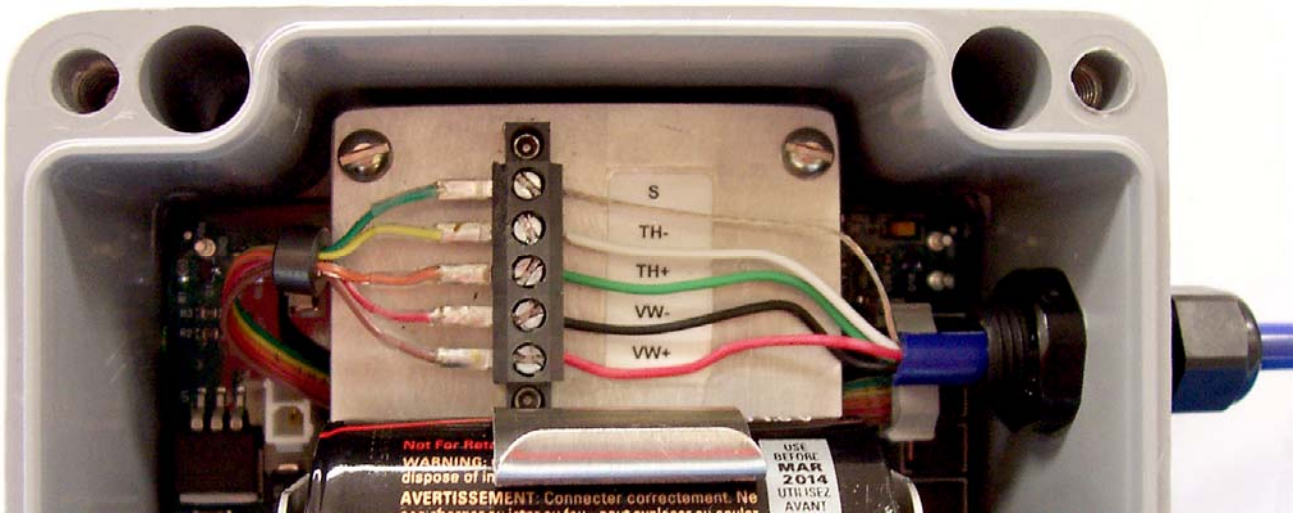
Figure 1 Transducer Cable Connections

When complete, reinstall the top of the LC-2 enclosure.

Refer to APPENDIX B – CONNECTOR PINOUTS for LC-2s supplied with 10-pin **Transducer** Connector.

3.2. Software Installation

LogWare has been supplied as a means of communicating with the datalogger using an IBM or compatible personal computer. Other general purpose communication programs (i.e. Windows Hyper Terminal™) are equally well suited for use with the Model LC-2. LogWare, along with the LC-2 USB drivers, will arrive on a single CDROM.

Please refer to APPENDIX G: LOGWARE COMPATIBILITY for notes on using Logware with the LC-2.

Perform the following steps to install LogWare software with USB drivers for each computer that will connect to a LC-2. These instructions are for computers running Windows XP. The installation procedure for computers running Windows 2000 and Windows 98 is very similar. For specific information regarding installation on these and other operating systems, consult the installation guides (PDF format) located in the LC2_USB_Drivers folder on the LogWare CD. This installation procedure needs to be performed just once for each computer that will run LogWare 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

Making sure that the (2) 1.5V D-cell alkaline batteries are installed in the datalogger (See section 5.3 BATTERIES for instructions) and that the LC-2 datalogger is not connected to the computer at this time:

Logware Installation:

1. Insert the LogWare installation CD in the computers CD drive. The LC-2 USB drivers will load automatically, and then the LogWare installation program will begin.
2. Click "**Next >**" when the **Welcome** window appears.
3. Click "**Yes**" when the **Software License Agreement** appears.
4. Enter the User information and click "**Next**".
5. Click "**Next >**" when the **Choose Destination Location** window appears.
6. Click "**Next >**" when the **Select Program Folder** window appears.
7. Click "**Finish**" when the **Setup Complete** window appears.
8. Click "**Start**" – "**Logware**" to start LogWare.
9. Click the "**Connection**" tab in the **LogWare Configure Measurements** window.
10. **For LC-2 models 8002-1-1 and 8002-1A-1 (and 8002-1-3 or 8002-1A-3 with 8001-5 RS-485 Network Interface):**

    Under **"Connection Settings"**, click the **"COM Port"** pulldown and select the appropriate COM port that the LC-2 will be connected to (typically COM1 or COM2).

11. **For LC-2 models 8002-1-2 and 8002-1A-2 (and 8002-1-3 or 8002-1A-3 with 8002-5 RS-485 Network Interface):**

     Under "**Connection Settings**", click the "**COM Port**" pulldown and **note the available COM ports**.

12. Click "**File**" – "**Exit**" to exit LogWare.

13. Remove the LogWare installation CD from the computers CD drive.

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 computers COM port that was selected in Logware installation step 10.

Configure LogWare:

1. Click "**Start**" – "**Logware**" to start LogWare.

2. Click the "**Connection**" tab in the **LogWare Configure Measurements** window.

3. Under "**Connection Settings**", click the "**COM Port**" pulldown and select the desired COM port**.**

4. Click **"√ Make the Connection!"** - the "**Checking connection**" window should appear.

5. After several seconds, **"The connection is working!"** should appear – click "**OK**".

6. Click "**File**" – "**Exit**".

7. Click "**Yes**" to save the changes.

8. Make sure the displayed file name is "**default.cfg**" and click "**Save**".

LC-2 Connection (8002-1-2, 8002-1A-2):

Connect the supplied LC-2 USB Communications cable (COM-109) 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 USB-A end of the USB cable into an available USB-2.0 port on the host computer.

1. The "**Found New Hardware – USB Serial Converter**" information box should appear.

2. The **"Found New Hardware – USB Serial Port"** information box should appear.

Configure LogWare:

1. Click "**Start**" – "**Logware**" to start LogWare.

2. Click the "**Connection**" tab in the **LogWare Configure Measurements** window.

3. Under "**Connection Settings**", click the "**COM Port**" pulldown and select the **new** COM port**.**

4. Click **"√ Make the Connection!"** - the "**Checking connection**" window should appear.

5. After several seconds, **"The connection is working!"** should appear – click "**OK**".

6. Click "**File**" – "**Exit**".

7. Click "**Yes**" to save the changes.

8. Make sure the displayed file name is "**default.cfg**" and click "**Save**".

LogWare is now configured correctly for the LC-2 datalogger.

3.3. Example Setup

For 8002-1-1 and 8002-1-2: Route the vibrating wire transducer cable into the LC-2 enclosure through the SENSOR bulkhead fitting. Referring to Table 1, Figure1 or Appendix B.1A. Transducer Cable Connections, connect the cable wires to the datalogger's 5 pin internal terminal strip, located on the battery pack mounting plate.

For 8002-1A-1 and 8002-1A-2: Connect the vibrating wire transducer cable to the SENSOR connector on the LC-2 enclosure.

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 LogWare (or other communications program) so that the LC-2 can be recognized by the computer as a virtual COM port.

If using LogWare software, refer to the LogWare manual for proper setup and operation of the LC-2.

If using a terminal emulator program such as Microsoft Windows Hyper Terminal™, proceed with the following steps:

1.   Configure the selected COM port to 9600 baud, 8 data bits, 1 stop bit, no parity, XON/XOFF.

2.   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 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 sections 4.18. thru 4.22. for additional information.

3.   Type ? <ENTER> to display the Help list. See section 4 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	Gage information, where;
	nn = gage type
	szzzz = zero reading with sign
	sffff = gage factor with sign
	soooo = offset with sign
IDddddddddddddddddd	view current ID,set to ddddddddddddddddd

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)**
TR,TR0	**display TRap count, zero TRap count**
WF	**Wrap Format(0=don't wrap memory,1=wrap memory**
X	**Single Reading - NOT stored**
*	

4.   Type R and <ENTER> to reset the memory pointers. Type Y <ENTER> to the confirming "Are you sure(Y/N)?" question. The datalogger should respond with "Memory Cleared";

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

5.   Type C <ENTER> to display the current real time clock setting. See section 4.2. if adjustments need to be made;

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

6. Next, the configuration for the type of gage being read must be specified. See section 4.6. for additional information.

    Assume a Geokon Model 4500S-50 Vibrating Wire Pressure Transducer with a gage factor of 0.01234 psi/digit (found on the calibration sheet). 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 gage measurements a zero reading needs to be determined for proper operation.   Enter the gage type and clear the zero reading, gage 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
      *
    ```

7   Make sure logarithmic intervals are disabled by typing **LD** and <ENTER>;

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

8   Enter a scan interval of 10 seconds by typing **SC10** and <ENTER>;

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

9   Enable real-time display of the readings by typing **ME** <ENTER>;
    *ME
    Monitor mode enabled.
    *

10 Start datalogging 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 gage reading of the transducer.

    See APPENDIX D – SAMPLE DATA FILES for additional information on the array format.

11   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 the purpose of 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 into the datalogger's memory. Press **SP** <ENTER> to stop logging. Enter the zero reading and gage 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
*
```

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

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

13   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:

1)   The battery goes dead.
2)   The stop command is issued (section 4.35).

14.   Press **E** <ENTER> to end communications with the datalogger and enter the low power sleep mode.

Consult the LogWare manual or see [APPENDIX C – DATA FILE TRANSFER TO IBM PC] *of this manual in regard to collecting data.*

4. COMMAND LIST

The commands listed here are to be used if communications between the LC-2 and the host
computer are established via a terminal emulator (i.e. Windows Hyper Terminal). If using LogWare,
these commands can be ignored. To send commands and receive information from the Model LC-2
the communications mode must be established between the host computer and the datalogger (see
section 3.2 and section 3.3).

Pressing **?** <ENTER> while in the communications mode displays this 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	**Gage information, where;**
	nn = gage type
	szzzz = zero reading with sign
	sffff = gage factor with sign
	soooo = offset with sign
IDdddddddddddddddd	**view current ID,set to dddddddddddddddd**
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)**
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 of these 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.

4.1.   C

Display 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
*
```

4.2.   CSmm/dd/yy/hh:mm:ss

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. Leading zeros are not needed except on the minutes and seconds entries. Illegal combinations will be ignored (i.e. CS02/30/97 or CS///12:60). Fields can be left blank to avoid changing (i.e. CS//97 to just 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 (i.e. 3 seconds), logging may need to be stopped and re-started, depending on whether or not the internal "next time to read" register becomes unsynchronized with the current time. This is true with both the command line interface and setting the datalogger clock within LogWare.

4.3.   DEFAULT

Load the 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.
*

*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

*

4.3. DF

Display or set the 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
```

4.4. Dnnnn

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 over-writing the oldest arrays. If it is at 8000 and WF = 0, then the memory has been filled and logging has stopped. Figure 3 illustrates the ring memory scheme.
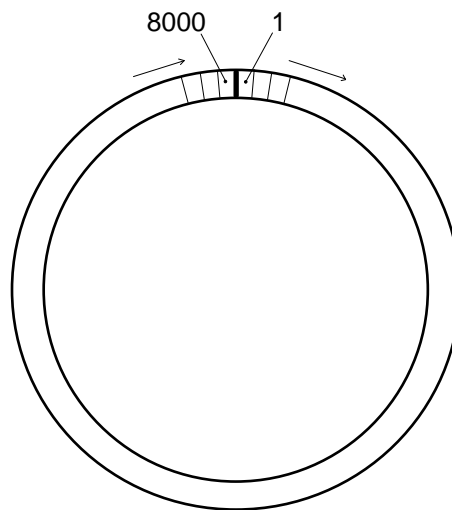
Figure 2 - Order of Array Usage

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 re-position 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 D for a sample data file. See Appendix C in regards using the D command to collect data. When the array display is finished the memory pointers are displayed.

4.5.   E

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 will enter sleep mode regardless if no command is received in a period of approximately 15 seconds, or immediately after the 2nd reading (whichever comes first).

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

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

4.6.   Gnn/szzzz/smmmm/soooo or Gnn/saaaa/sbbbb/scccc

When using linear conversion (LC) of the instrument reading, the G command is used to select the gage type and enter the gage zero reading, gage factor, and gage offset. When using polynomial conversion (PC) , the G command is used to select the gage type and enter the three polynomial coefficients, A, B and C. Entering just G will return the current gage 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 gage number, or the configuration of the datalogger's input channel (see Tables 1&2 in this section), szzzz represents the zero reading for the transducer being read, smmmm represents the multiplier (calibration or gage factor) that will be applied to the reading to convert to engineering units and soooo is the offset that will be applied to the gage reading. The zero reading, gage 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 5 places to the right of the decimal point.

For the vibrating wire instruments (Gage Types 0-5), the basic formula for calculation of displayed and stored values is as follows;

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

Equation 1 - Displayed Gage Reading using Linear Conversion

Given the above equation the default readings (no zero reading, multiplier or offset values entered) will be negative. Consult the following table to determine the sign on the multiplier entry.
NOTE: When using linear conversion, the default reading units is frequency squared x 10^{-3}

Polynomial Conversion

The command is described further as follows; nn represents the gage number, or the configuration of the datalogger's input channel (see Tables 1&2 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 5 places to the right of the decimal point.

For the vibrating wire instruments (Gage Types 0-5), 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 2 - Displayed Gage 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, typically the calibration units for vibrating wire instruments is 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 is used as is.

Geokon Model	Gage Type	Description	Linear Factor Sign
4000	3	Strain Gage	–
4100	1	Strain Gage	–
4200	3	Strain Gage	–
4210	1	Strain Gage	–
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 2 - Vibrating Wire Gage Factor Signs

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
6-84	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 3 - Gage Type Listing

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 3 - 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 4 - 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_2O	m H_2O	"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_2O	704.32	25.399	304.788	1	1000	345.32	13.595	10332	10.197	10197	101.97	101970
m H_2O	.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 4 - Engineering Units Multiplication Factors

4.7.   IDddddddddddddddddd

Displays or sets the 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>.

4.8.   LC

Selects the linear conversion method for the instrument reading. See the G command section for more information.

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

4.9.   L

Display all 6 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 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: 100/58

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 the `Ln/lllll/iii` command section to modify intervals.

4.10. Ln/lllll/iii

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, i.e. `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 5 lists possible logarithmic interval lengths and iterations. Any combination of lengths and iterations is permissible.

Interval	Length	Iterations	Elapsed Time
1	3 seconds	3	.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 5 - Logarithmic Intervals List

4.11. LD

Disable use of 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
*
```

4.12. LE

Enable use of 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
*
```

4.13. M

Display the 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.
*
```

4.14. MD

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

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

4.15. ME

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

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

4.16. MS

Display the 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.
*

4.17. N

Display 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
*
```

4.18. NA

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 2 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
```

4.19. NAddd

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 2 different dataloggers on the RS-485 network.

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

<ENTER>
<ENTER>
#20<ENTER>
Network address: 20
*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 may not be changed while networked. Direct connect to the datalogger via USB in order to change the network address.

4.20. ND

Network Disable the datalogger. Disables networking of 2 or more LC-2 dataloggers.

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

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

4.21. NE

Network Enable the datalogger. Enables networking of 2 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. **If using LogWare software, make sure that the "Use Network Address" checkbox is not checked.**

4.22. NS

Display the current network status.

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

Or;

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

4.23. PC

Selects the **P**olynomial **C**onversion method for the instrument reading. See the **G** command section for more information.

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

4.24. Pnnnn

Position the 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
*
```

4.25. R

Reset memory pointers to default settings. Gage 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 1 (or more) readings and then position the memory pointers via the **P** and **D** commands to recover previously taken readings.

4.3.   RESET

RESET (re-boot) 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
*
```

4.26. RT

Readings **T**otal. 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**
> *****

4.27. SR

Synchronize **R**eadings. Displays status of reading synchronization

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

4.28. SR0

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**

4.29. SR1

(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

4.30. RT8

Sets the **T**otal number of **R**eadings to **8**000.

> ***RT8**
> **8000 readings maximum**
> *****

4.31. RT16

Sets the **T**otal number of **R**eadings to **16**000.
> ***RT16**
> **16000 readings maximum**
> *****

Note: when used with LogWare software, the maximum number of readings allowed is 8000.

4.32. S

Display the datalogger **S**tatus.
> ***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	3.4, 3.24
2	Gage information	3.6
3	Scan interval setting	3.30
4	Start/Stop status	3.32, 3.33
5	Stop time (optional)	3.32
6	Log interval status	3.11, 3.12
7	Monitor mode status	3.13

Table 6 - S Command Information

4.33. SCnnnnn

Enter the **SC**an 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).**
>
> *****

4.34. SS

Display the **S**ystem **S**tatus 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.

*
```

Line	Description
1	Signature of RAM bank 1. (checksum)
2	Signature of RAM bank 2. (checksum)
3	Signature of RAM bank 3. (checksum)
4	Signature of RAM bank 4. (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.

Table 7 - SS Command Information

4.35. SPhh:mm

Sto**P** 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.

4.36. SThh:mm

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
*
```

4.37. SV

Return the **S**oftware **V**ersion of the datalogger's operating system software. Consult the factory to check on latest versions available.

```
*SV
Software version: 4.12.0
*
```

4.38. TEST

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

    *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 (GAGE TYPE 1)
    B   EXTERNAL INPUT (GAGE TYPE 2)
    C   EXTERNAL INPUT (GAGE TYPE 3)
    D   EXTERNAL INPUT (GAGE TYPE 4)
    E   EXTERNAL INPUT (GAGE 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: gage type 1
B	External test input configuration: gage type 2
C	External test input configuration: gage type 3
D	External test input configuration: gage type 4
E	External test input configuration: gage type 5
X	Exit and return to normal operations

Table 8 – TEST Menu Information

4.39. TF

Display the current **T**ime **F**ormat display option setting. This setting determines how the time information will be displayed in the array when the Monitor mode is active (see **M** command section) 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
*
```

4.40. TR

Display the current **TR**ap 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.

4.41. TR0

Reset the **TR**ap count register to **0**.

4.42. WF

Display the 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 section 3.4.Dnnnn).

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, 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
*
```

4.43. X

Take and display 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. 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.
*
```

5. MAINTENANCE

The 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.

5.1 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.

5.2. 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 so 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.

5.3. 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 approximate operating times for the various types of 'D' cell batteries that may be used with the Model LC-2.

Battery Chemistry (2 D-cells)	Battery Pack Voltage	Battery Capacity	2 Second Scan Rate	1 Minute Scan Rate	1 Hour Scan Rate	1 Day Scan Rate
Lithium	7.2V	19 AHr	10.4 days	613 days	≥2 years	≥2 years
Alkaline	3.0V	14 AHr	3.2 days	188 days	≥2 years	≥2 years
Carbon-Zinc	3.0V	5 AHr	1.1 day	66.2 days	≥1 year	≥1 year

Table 9 - 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 6V (external 12V battery). 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 5.5V (external 12V battery). In this event, a new set of batteries must be installed before the datalogger becomes operable again. 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 stopped itself due to low battery voltage, it will resume logging as soon as new batteries are installed.

Note: **The "fuel gage" display in Logware is not accurate when used with the LC-2**. Refer to APPENDIX G : Logware Compatibility with regard to measuring the battery voltage and determining to available battery power remaining.

Battery replacement instructions:

1) Remove the 4 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 and install new batteries. Note the polarity outline on the bottom of the battery holder for proper battery installation. The datalogger will not be damaged because one or both of the batteries are installed backwards.

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

6. 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.

6.1. Unit will not respond to communications.
- ✓ Wrong COM port selected in LogWare. See LogWare manual
- ✓ The internal batteries of the datalogger may be low or dead and RS-232 or RS-485 communications is being used. Replace the batteries.

6.2. Vibrating wire gage measurement reads -999999.0
- ✓ Using an ohmmeter, check connections to the vibrating wire gage leads. Resistance should be between 90 and 180 ohms (pins A&B on the 10-pin connector, see Appendix B). Remember to correct for cable resistance (approximately 15 Ω/1000' or 50 Ω/km, double for both directions). If resistance reads less than 100 Ω the cable is probably shorted. If resistance reads infinite or in the megohms range the cable is probably cut.
- ✓ Check the datalogger with another gage. If it reads okay, the datalogger may be malfunctioning.
- ✓ Check that the proper gage type is selected and connected properly (see TABLE 1 TRANSDUCER CABLE CONNECTIONS and TABLE 3 GAGE TYPE LISTING).

6.3. Gage 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}.

6.4. Vibrating wire gage 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 gage type is selected (see TABLE 1 TRANSDUCER CABLE CONNECTIONS and TABLE 3 GAGE TYPE LISTING).

6.5. 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 E – THERMISTOR TEMPERATURE DERIVATION details the resistance versus temperature relationship. It should read between 10K ohms and 2.4K ohms (0° to +30° Celsius). If thermistor checks out okay consult the factory to schedule repair of unit.

<u>APPENDIX A - SPECIFICATIONS</u>

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: <200 mA
Quiescent current: <500 µA
RTC battery type: 3V lithium coin cell – 20mm
               (Panasonic CR2032)
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 over-write)
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)
Oscillator: 32.768kHz
Accuracy: ±2 minutes per year

A.5. Serial Interface
Speed: 9600 bps

Parameters: 8 data bits
                1 stop bit
                no parity
                full duplex
Handshake: XON/XOFF
Data output format: ASCII text

A.6. RS-485 Network
Maximum nodes: 255 LC-2 Dataloggers
Maximum cable length: 4000', 1.22 km

A.7. Vibrating Wire Measurement
Excitation sweep range:
        Gage Type 0: 400 Hz to 4500 Hz
        Gage Type 1: 1400 Hz to 3500 Hz
        Gage Type 2: 2800 Hz to 4500 Hz
        Gage Type 3: 400 Hz to 1200 Hz
        Gage Type 4: 1200 Hz to 2800 Hz
        Gage Type 5: 2500 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)
Transducer accuracy: ±0.5° C
Measurement accuracy: 0.5% FSR
Resolution: 0.01° C
Linearization error: 0.02% FSR
Temperature range: −40 to +60° C
Overall accuracy: 1.0% FSR (±1°)

A.9. MAIN BATTERY MEASUREMENT

<u>3V Battery:</u>
      Range: 0 to 7.5 VDC
      Accuracy: ±1.831mV
      Resolution: 0.01 VDC
<u>12V Battery:</u>
      Range: 0 to 15 VDC
      Accuracy: ±3.662mV
      Resolution: 0.01 VDC

APPENDIX B - CONNECTOR PINOUTS

B.1A. Transducer Cable Connections

Terminal Strip 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 +	GREEN
TH-	Yellow	4	Thermistor -	WHITE
S	Green	5	Analog Ground (shields)	BARE WIRE

Table B-1A Transducer Cable Connections

B.1B. Sensor Connector Pinout
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 +	Green
D	Yellow	Thermistor -	White
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 B-1B Sensor Connector Pinout

B.2. COM Connector Pinout
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	Rx
C	Orange	3	USB DP	Tx
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 B-2 COM Connector Pinout

B.3. RS-485 Connector Pinout (optional)

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 B-3 RS-485 Connector Pinout

APPENDIX C - DATA FILE TRANSFER TO IBM PC

Data can be downloaded to the PC either via LogWare software (refer to the LogWare manual) or Windows Hyper Terminal, which is supplied with most personal computers as part of the Accessories| Communications option of the Start Menu. The steps to download the data using Hyper Terminal are as follows:

Start HyperTerminal: Start | Programs | Accessories | Communications | Hyper Terminal

Enter a name for the New Connection – Select OK:
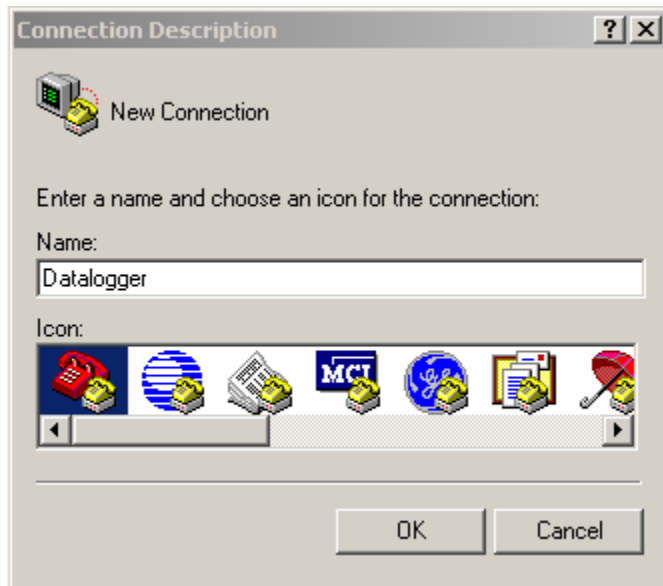
Change the Connect using setting to the appropriate COM port (in this case COM4 - See section 3.3 EXAMPLE SETUP) – Select OK:

Enter the Port Settings. Select Apply. Select OK:

With the cursor in the display screen, push the Enter key a few times to verify that communications has been established. Upon confirmation of communications, select Transfer | Capture Text:

Enter the path and name of the file you wish to create, either directly or with the Browse button. Hint: It may be helpful to specify .CSV as the file extension to allow direct formatted entry into a spreadsheet program.

Select Start:

```
Capture Text                                    ? X

 Folder:    C:\LoggerData.TXT

 File:      C:\LoggerData.TXT          Browse...


                          Start        Cancel
```
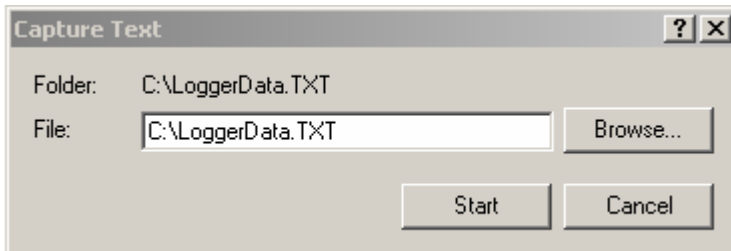
With the cursor in the display screen, push the Enter key a few times to wake-up the datalogger.

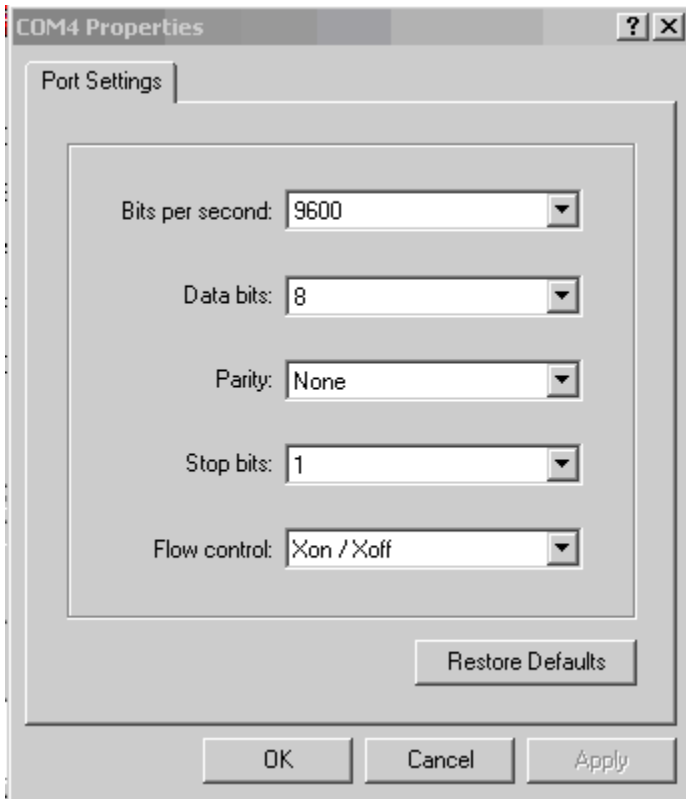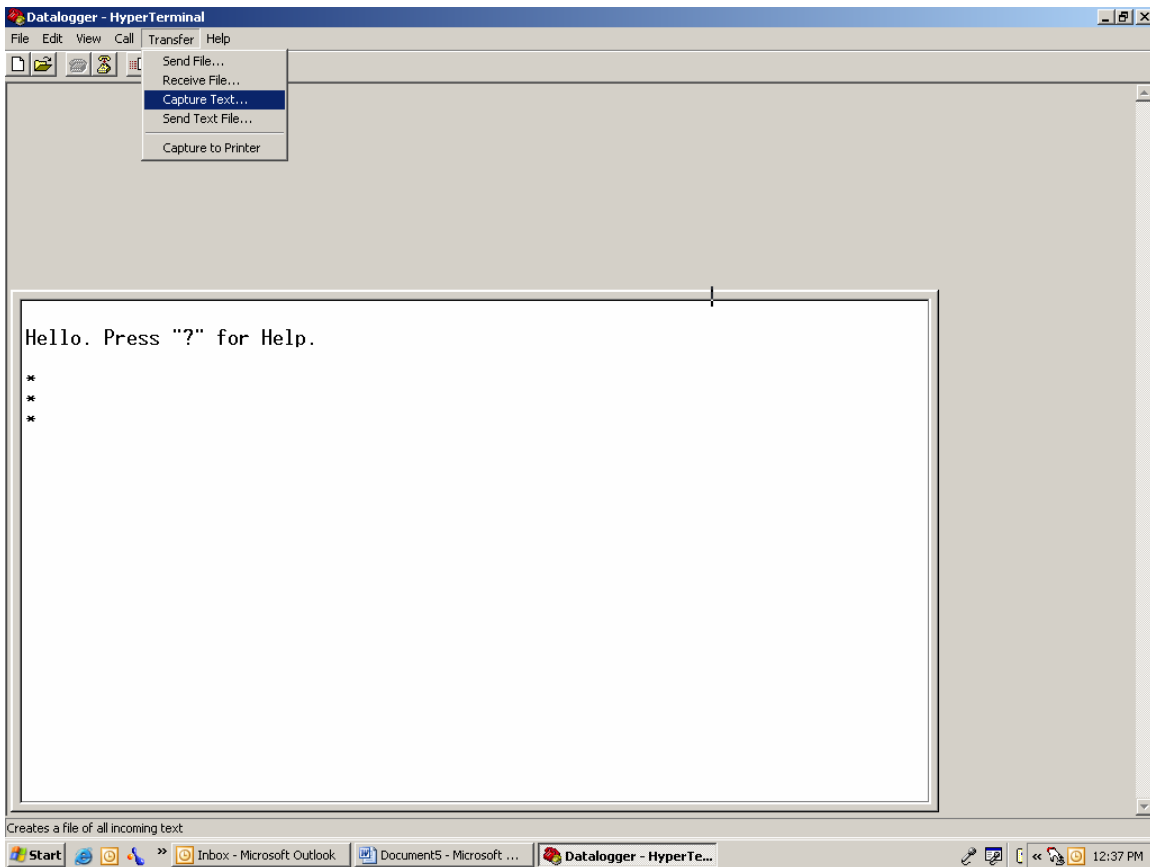Type "S" to get the Status of the datalogger.
Type "P1" to position the data array Pointer at location 1.
Type "D11" to Display the readings stored in memory.
Select Transfer | Capture Text | Stop.

```
LC-2_9600 - HyperTerminal                                          _ □ X
File   Edit   View   Call   Transfer   Help

*

*S
MS:11    OP:12    UP:12
GT: 1    ZR: 0.00000    GF: -1.00000    GO: 0.00000
Scan interval: 15 second(s).
Logging stopped.
Log intervals disabled.
Monitor mode enabled.
*P1
MS:11    OP:12    UP:1
*D11
Logger,2007,348,1300,0,3.11,23.24,9156.698,22.6,1
Logger,2007,348,1300,15,3.11,23.30,9156.785,22.7,2
Logger,2007,348,1300,30,3.11,23.30,9156.798,22.7,3
Logger,2007,348,1300,45,3.11,23.33,9156.681,22.7,4
Logger,2007,348,1301,0,3.11,23.36,9156.681,22.7,5
Logger,2007,348,1301,15,3.11,23.36,9156.718,22.7,6
Logger,2007,348,1301,30,3.11,23.36,9156.718,22.7,7
Logger,2007,348,1301,45,3.11,23.36,9156.748,22.7,8
Logger,2007,348,1302,0,3.11,23.39,9156.965,22.7,9
Logger,2007,348,1302,15,3.11,23.39,9156.760,22.7,10
Logger,2007,348,1302,30,3.11,23.39,9156.896,22.7,11

MS:11    OP:12    UP:12
*

Connected 0:22:14    Auto detect   9600 8-N-1   SCROLL   CAPS   NUM   Capture   Print echo
```

The data are now stored in the specified file.

APPENDIX D - SAMPLE DATA FILES

D.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

where;
Column 1 represents the year when the array was stored.
Column 2 represents the julian day (or day, month format, see section 3.5.).
Column 3 represents the time (or hh,mm format, see section 3.26.).
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.

D.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 E - THERMISTOR TEMPERATURE DERIVATION

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

Resistance to Temperature Equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

Equation E-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 E-1 Thermistor Resistance versus Temperature

APPENDIX F - NETWORKING

F.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 out to a total distance of 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. 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, for a total of 255 dataloggers.

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 daisychain 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 1 and 2. Depending on the LC-2 circuit board used, this jumper will be located either on a "daughterboard" mounted on top of the main circuit board – designated JP1, or on the main circuit board itself – designated JP-2. On all the remaining networked LC-2 dataloggers, ensure that this jumper is set across pins 2 and 3.

In order 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 section 4.7) to agree with the network address. This will tend to eliminate any confusion when collecting data.

For further information, refer to sections 4.7(ID), 4.18(NA), 4.19(NAddd), 4.20(ND), 4.21(NE) & 4.22(NS).

F.2. Example of a 4 Datalogger Networking Session

1. This session assumes that there are 4 dataloggers running at 5 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.

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 numbers 3 & 4 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 G – Logware Compatibility

G.1. Battery Gauge:

The battery gauge display in Logware is inaccurate when used with the LC-2 datalogger and alkaline D-cell batteries.

Refer to the table below for the actual remaining battery life:

Battery Voltage Display	Actual % Life Remaining	Logware Battery Gauge Display
3.2	100	100
3.0	100	85.71
2.68	90	62.85
2.52	80	51.43
2.45	70	46.43
2.38	60	41.43
2.31	50	36.43
2.26	40	32.86
2.20	30	28.57
2.12	20	22.86
2.00	10	14.29
1.60	0	0

Table G-1 Actual Battery Life vs. Logware Battery Gauge