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Instruction Manual

Model LC-2x4

4 Channel VW Datalogger

(Doc Rev F, 08/09)

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1. INTRODUCTION

The Model LC-2x4 4 Channel Datalogger is a low cost, battery powered and easy to use measurement instrument designed to read up to 4 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 #.

Internal math is calculated using 32 bit floating point notation (IEEE). Math operations on the instrument readings, such as application of zero readings, gage 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 may be configured and monitored using any standard terminal emulator software, such as Microsoft Windows Hyper Terminal™ along with the LC-2x4 Command Set (see section 3).

The following three communications options are available for the LC-2x4:

LC-2x4 Model #	**Communication**
8002-4-1	RS-232
8002-4-2	USB
8002-4-3	RS-485

8002-4-1: Communication with the LC-2x4 is implemented via the host computer's RS-232 COM port. See section 2.3 Communications for further information.

8002-4-2: 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 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. See section 2.3 Communications 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 2.3 Communications and Appendix F Networking 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 ± 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.

Figure 1 LC2X4 4-Channel VW Datalogger

2. GETTING STARTED

The following equipment will arrive with the Model LC-2x4 datalogger;

1. Set of (2) alkaline 'D' cell batteries.

2. Accessories:
   8002-4-1: P/N S-8001-6 (DB-9F to 10-pin Bendix Male) RS-232 Communication Cable

   8002-4-2: P/N COM-109 (USB-A to 10-pin Bendix Male) USB Communication Cable
   LC-2x4 USB drivers CD

   8002-4-3: Communications Cable dependant on S-8001-5 (RS-232) or S-8002-5 (USB) RS-485 computer interface

3. Model LC-2x4 4 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-8001-5 (RS-232) or S-8002-5 (USB) RS-485 computer interface.
- Vibrating Wire Sensor with built-in thermistor (4 maximum).

This section will outline the basic steps needed to install the communications software, establish communication with the Model LC-2x4 and configure the datalogger in the context of water level monitoring using a Geokon model 4500S Vibrating Wire Pressure Transducer.

2.1. Transducer Installation

Open up the LC-2x4 by unscrewing the 4 captive screws on the top of the LC-2x4 enclosure. Route the vibrating wire transducer cable(s) into the LX-2X4 enclosure through the bulkhead fittings. Referring to Table 1 (or Appendix B.1.) Transducer Cable Connections, connect the cable wires to the datalogger's 5 pin internal terminal strips, located on the LC-2x4's Multiplexer circuit board. Wire each cable's 5 conductors into the terminal strip per Table 1.

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

TH3+	3	Thermistor +	GREEN
TH3-	3	Thermistor -	WHITE
SHLD3	3	Analog Ground (shield)	BARE WIRE
VW4+	4	Vibrating Wire +	RED
VW4-	4	Vibrating Wire -	BLACK
TH4+	4	Thermistor +	GREEN
TH4-	4	Thermistor -	WHITE
SHLD4	4	Analog Ground (shield)	BARE WIRE

Table 1 Transducer Cable Connections

2.2. 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 3 feet (1m). A copper grounding lug is supplied on the exterior of the LC-2x4 enclosure to provide connection to this wire from the grounding rod.

2.3 Communications

2.3.1 8002-4-1 (RS-232):

Install the (2) 1.5V D-cell alkaline batteries into the datalogger (See section 4.2 for instructions) and replace the datalogger cover. Using the supplied S-8001-6 RS-232 communication cable, connect the LC-2x4's 10-pin Bendix COM port to an available COM port (typically COM1 or COM2) on the host computer. Proceed to section 2.4 Example Setup

2.3.2 8002-4-2 (USB) Driver Installation:

Perform the following steps to install the USB drivers for each computer that will connect to a 8002-4-2 USB LX-2x4. 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 LC-2x4 USB Drivers CD. This installation procedure needs to be performed just once for each computer that will communicate with a LX-2x4 datalogger.

Install the (2) 1.5V D-cell alkaline batteries into the datalogger (See section 4.2 for instructions) and make sure that the LX-2x4 datalogger is <u>not connected</u> to the USB port at this time:

<u>USB Driver Installation:</u>

1. Insert the LC-2x4 USB Drivers installation CD in the computer's CD drive. The LX-2x4 USB drivers will load automatically..
2. Remove the LC-2x4 USB Drivers installation CD from the computer's CD drive.

<u>LX-2x4 Connection:</u>

1. Connect the supplied LX-2x4 Communications cable (COM-109) to the COM port of the LX-2x4 datalogger and an available USB 2.0 port on the computer. Plug the USB-A end of the USB cable into the host computer's USB port.
2. The "**Found New Hardware – USB Serial Converter**" information box should appear.
3. The **"Found New Hardware – USB Serial Port"** information box should appear.

2.3.3 8002-4-3 (RS_485):

Setup the COM port per section 2.3.1 (RS-232) or 2.3.2 (USB), and then refer to **Appendix F: Networking** to establish communications.

2.4. Example Setup

<u>NOTE: If using a 8002-4-2 USB LC-2x4, it is important that the LX-2x4 first be connected to the computer's USB port before attempting to communicate so that the LX-2x4 can be recognized by the computer as a virtual COM port.</u>

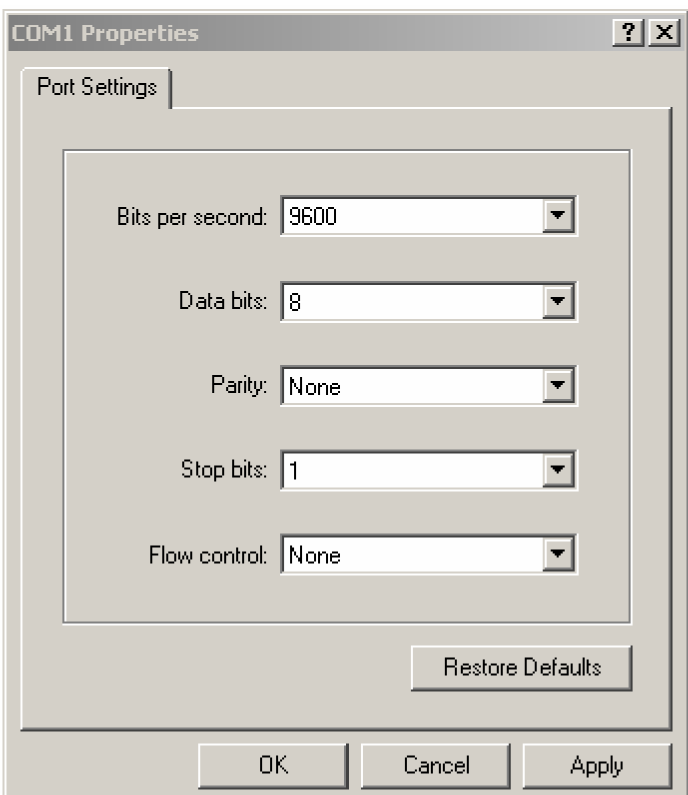
Proceed with the following steps to connect with the datalogger using a terminal emulator program such as Microsoft Windows Hyper Terminal™.

1. Start Hyper Terminal by running Start → All Programs → Accessories → Communications → Hyper Terminal.

2. Enter a name for the New Connection and click OK:

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

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



<u>8002-4-1 (RS-232):</u> Configure the COM port (typically COM1 or COM2) as 9600 Bits per second, 8 Data bits, no Parity, 1 Stop bit, no Flow control.
<u>8002-4-2 (USB):</u> Configure the <u>new</u> COM port that is added when the LX-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 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 sections 3.20. thru 3.24. for additional information.

7. Type **?** <ENTER> to display the Help list. See section 3 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 gage 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

Gage information, where;

nn = Channel #
c = Conversion Type(L/P)
tt = Gage Type

For Linear (L) Conversion:
szzzzzz = zero reading with sign
sffffff = gage 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)
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

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 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.

3. COMMAND LIST

3.1. 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
*
```

3.2. 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. Illegal combinations will be ignored (i.e. CS02/30/07 or CS///12:60). Fields can be left blank to avoid changing (i.e. CS//07 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.

3.3. DEFAULT

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

All channels Enabled
All Gage Types set to 1
All Zero Readings set to 0.00000
All Gage Factors set to 1.00000
All Gage 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

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

3.4. 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.

*DF1
Date format is month,day.

*DF0
Date format is julian.
```

3.5. DL

Display the current datalogger mode setting.

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

3.6. Dnnnnn

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 1. 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 2 illustrates the ring memory scheme.

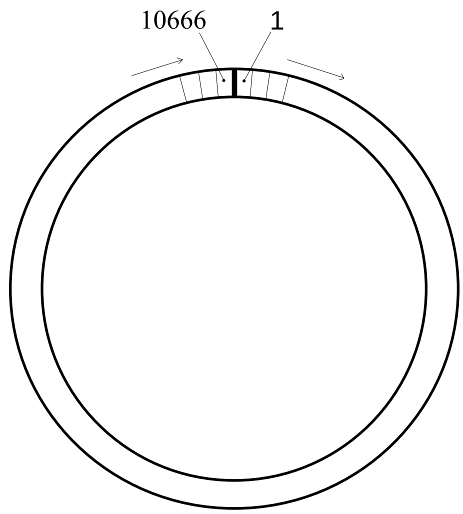


Figure 2 - Order of Array Usage

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 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.

3.7. 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.

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 the **NA,ND** and **NE** command sections for additional information.

3.8. Gnn/c/tt/szzzzzz/sffffff/soooooo or Gnn/c/tt/saaaaaa/sbbbbbb/scccccc

The **G** command is used to set up each of the 4 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 2 - Vibrating Wire Gage Factor Signs (pg.14) and Table 3 - Gage Type Listing (pg.14) for a description of each gage 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 LX-2x4)
c = Conversion Type(L/P) where L=Linear and P=Polynomial
t = Gage Type:
- 0: Channel Disabled (will display "---")
- 1: VW Gage Type 1
- 2: VW Gage Type 2
- 3: VW Gage Type 3
- 4: VW Gage Type 4
- 5: VW Gage Type 5

szzzzzz = zero reading with sign
sffffff = gage factor with sign
soooooo = offset with sign

Example: To setup Channel 1 as a model 4000 VW Strain Gage with a Zero Reading of 490 digits, a Gage Factor of –0.0015 and a Gage Offset of 0, enter:

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

The LX-2x4 will return:

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

Note: If selecting Gage Type 0 to disable the channel, the LX-2x4 will only return ''. Use the **MXS** command (pg.18) to view the disabled channels.

When using linear conversion (L) 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.

Linear Conversion is described further as follows:
szzzzzz represents the zero reading for the transducer being read, sffffff represents the multiplier (calibration or gage factor) that will be applied to the reading to convert to engineering units and soooooo 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 vibrating wire instruments (Gage Types 1-5), 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 Table 2 - Vibrating Wire Gage Factor Signs 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:

Gnn/c/tt/saaaaaa/sbbbbbb/scccccc

Where:

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

When using polynomial conversion (P) , the G command is used to select the gage 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 5 places to the right of the decimal point.

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

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

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		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

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_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 4 - Engineering Units Multiplication Factors

3.9. IDdddddddddddddddd

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:
*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>.

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

3.11. 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	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

<u>Table 5 - Logarithmic Intervals List</u>

3.12. 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#1,2007,11,25,11,41,17,2.92,20.63,9.055,-999999.0,-999999.0,
-999999.0,22.5,-99.0,-99.0,-99.0,549
*
```

3.13. 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#1,2007,11,25,11,42,56,2.92,21.51,9.042,-999999.0,-999999.0,-
999999.0,22.5,-99.0,-99.0,-99.0,622
```

3.14. 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.
*
```

3.15. MD

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

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

3.16. ME

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

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

3.17. MXS

Display the Multiplexer Status.

***MXS**

LC-2MUX 4-Channel Multiplexer Setup:

CH 1: ENABLED
GT: 3   PA: 0.00000   PB: 1.00000   PC: 0.00000

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

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

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

*****

3.18. MXn

Select the maximum number of channels (4 or 16) of the multiplexer. For a LX-2x4, this is 4 by default:

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

3.19. 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.

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

3.20. 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
```

3.21. 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 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>
#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 may not be changed while networked. Direct connect to the datalogger via USB in order to change the network address.

3.22. ND

Network **D**isable the datalogger. Disables networking of 2 or more LX-2x4 dataloggers.

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

3.23. NE

Network **E**nable the datalogger. Enables networking of 2 or more LX-2x4 dataloggers.

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

Note: If a networked LX-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.

3.24. NS

Display the current network status.

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

Or;

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

3.25. Pnnnn

Position the 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
*
```

3.26. 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.

3.27. 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

*

3.28. S

Display the datalogger **S**tatus.

```
*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	3.6, 3.25
2	Multiplexer Type	3.18
3	Scan interval setting	3.28
4	Start/Stop status	3.30, 3.32
5	Stop time (optional)	3.29
6	Log interval status	3.12, 3.13
7	Monitor mode status	3.14, 3.15, 3.16

Table 6 - S Command Information

3.29. SCnnnnn

Enter the **SC**an interval, in seconds. Range of entry is 3 to 86400 and is dependant 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).

*
```

3.30. SS

Display the **S**ystem **S**tatus 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 7 - SS Command Information

3.31. 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.
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.

3.32. SR

Synchronize **R**eadings 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,-99.0,2
3.8,23.9,6645

*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,-99.0,2
3.8,23.9,6648

*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,-99.0,2
3.8,23.9,6650
```

3.33. 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
*
```

3.34. 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: 2.4.0
*
```

3.35. TEST

TEST is 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 (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)
    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 Gage Type 1 filter configuration
B	External Input with Gage Type 2 filter configuration
C	External Input with Gage Type 3 filter configuration
D	External Input with Gage Type 4 filter configuration
E	External Input with Gage Type 5 filter configuration
X	Exit and return to normal operations

Table 8 – TEST Menu Information

3.36. 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.

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

3.37. 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.

3.38. TR0

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

3.39. VL

Display the Lithium 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
*****

3.40. V3

Display the 3V D-cell battery pack voltage. Replace the batteries when this voltage is less than 1.8V

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

3.41. V12

Display the external 12V battery voltage. Replace or recharge the battery when this voltage is less than 6V

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

3.42. 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 3.6.Dnnnnn).

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 1.6V.

```
*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
*
```

3.43. 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.

***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.

4. MAINTENANCE

The Model LX-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.

4.1. 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 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.

4.2. 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 approximate operating times for the various types of 'D' cell batteries that may be used with the Model LX-2x4.

Battery Type	Battery Capacity	4 Second Scan Rate	1 Minute Scan Rate	1 Hour Scan Rate	1 Day Scan Rate
Lithium	19 AHr	54 hours	128 days	≥1 year	≥4 years
Alkaline	14 AHr	20 hours	47 days	≥6 months	≥2 years
Carbon-Zinc	5 Ahr	6 hours	16.5 days	≥3 months	≥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. 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 it's internal 3V (or external 12V) battery pack.

Batteries should be replaced when the measured voltage drops below 1.8 VDC (internal 3V battery) 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 3V battery) or 5.5V (external 12V battery). In this event, a new set of batteries must be installed (or USB connection must be made) 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 or as soon as it is connected to a USB port.

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. Install the 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.

5. TROUBLESHOOTING

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

5.1. Unit will not respond to communications.

- ✓ Wrong COM port selected.
- ✓ The USB Drivers may not be properly installed. See Section 2.3.2 8002-4-2 (USB) Driver Installation.
- ✓ The internal batteries of the datalogger may be low or dead and RS-232 or RS-485 communications is being used. Replace the batteries.
- ✓ If RS-485 communications is being used, the **<ENTER>,<ENTER>,#,datalogger address**, **<ENTER>** key sequence is not being sent. Refer to Appendix F – NETWORKING for further information.

5.2. 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 known good transducer. If it still reads –999999.0, the datalogger may be malfunctioning.
- ✓ Check that the proper gage type is selected (see Tables 1&2).
- ✓ Check that the transducer shield wire is not shorted to either the red or black wire.

5.3. 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}.

5.4. 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 cables away from the power lines or electrical equipment.
- ✓ Check if the proper gage type is selected (see Tables 1&2).

5.5. 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 F 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.

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: 3V lithium coin cell
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)
Oscillator: 32.768kHz
Accuracy: ±2 minutes per year

A.5. Serial Interface

8002-4-1: RS-232
Speed: 9600 bps
Parameters: 8 Data bits
1 Stop bit
no Parity
no Flow control
Data output format: ASCII text

8002-4-2: USB 2.0 Virtual COM Port
Speed: 9600 bps
Parameters: 8 Data bits
1 Stop bit
no Parity
no Flow control
Data output format: ASCII text

8002-4-3: RS-485
Speed: 9600 bps
Parameters: 8 Data bits
1 Stop bit
no Parity
no Flow control
Data output format: ASCII text

A.6. RS-485 Network

Maximum nodes: 255
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)
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°)

Resolution: 0.01 VDC

A.9. Main Battery Measurement

3V Battery:
Range: 0 to 7.5 VDC
Accuracy: ±1.83mV
Resolution: 0.01 VDC

12V Battery:
Range: 0 to 15 VDC
Accuracy: ±3.662mV

A.10. Multiplexer Relay

NAIS TXS2SA-4.5V

0.1 ohm (max) contact resistance
1A (max) switching current

APPENDIX B - CONNECTOR PINOUTS

B.1 Transducer Cable Connections

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

Table B-1 Transducer Cable Connections

B.2. RS-232 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
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 B-2 RS-232 Connector Pinout

B.3. USB 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
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 B-3 USB Connector Pinout

B.4. 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

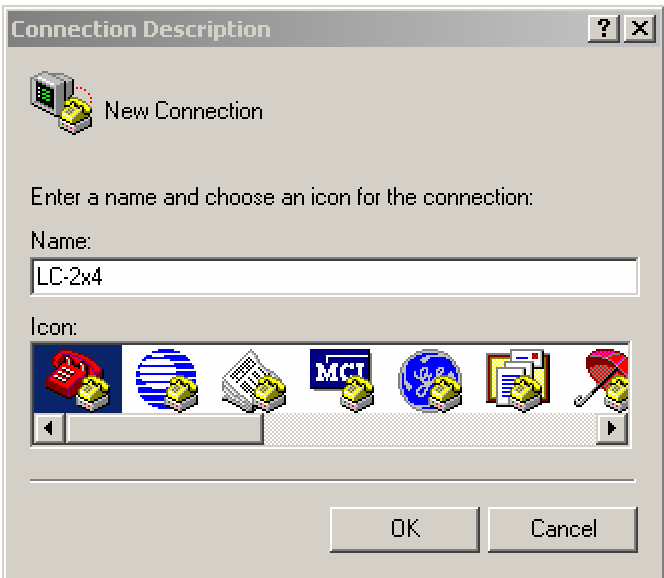
Table B-4 RS-485 Connector Pinout

APPENDIX C - DATA FILE TRANSFER TO IBM PC

Data can be downloaded to the PC via 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:

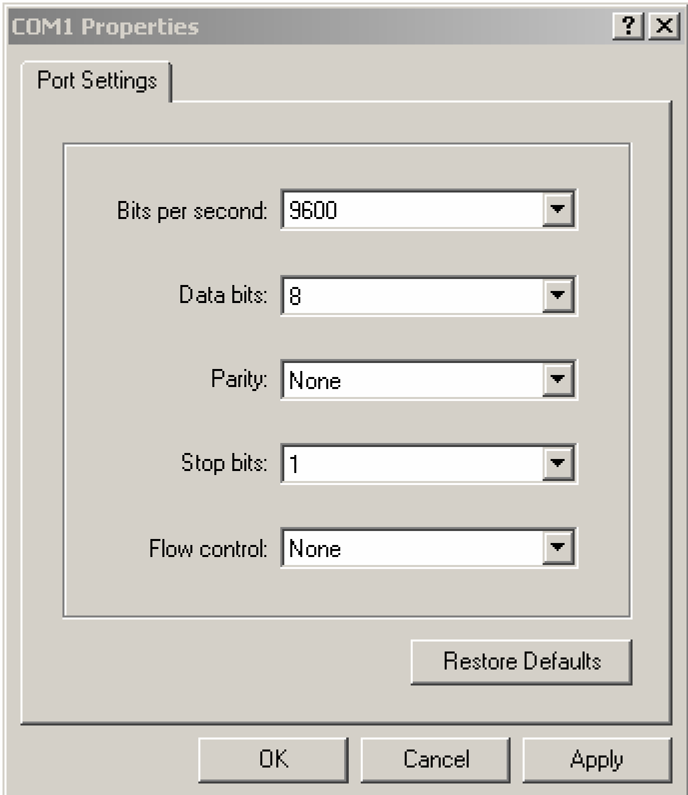
Start HyperTerminal: Start → Programs → Accessories → Communications → Hyper Terminal

Enter a name for the New Connection – Select OK:

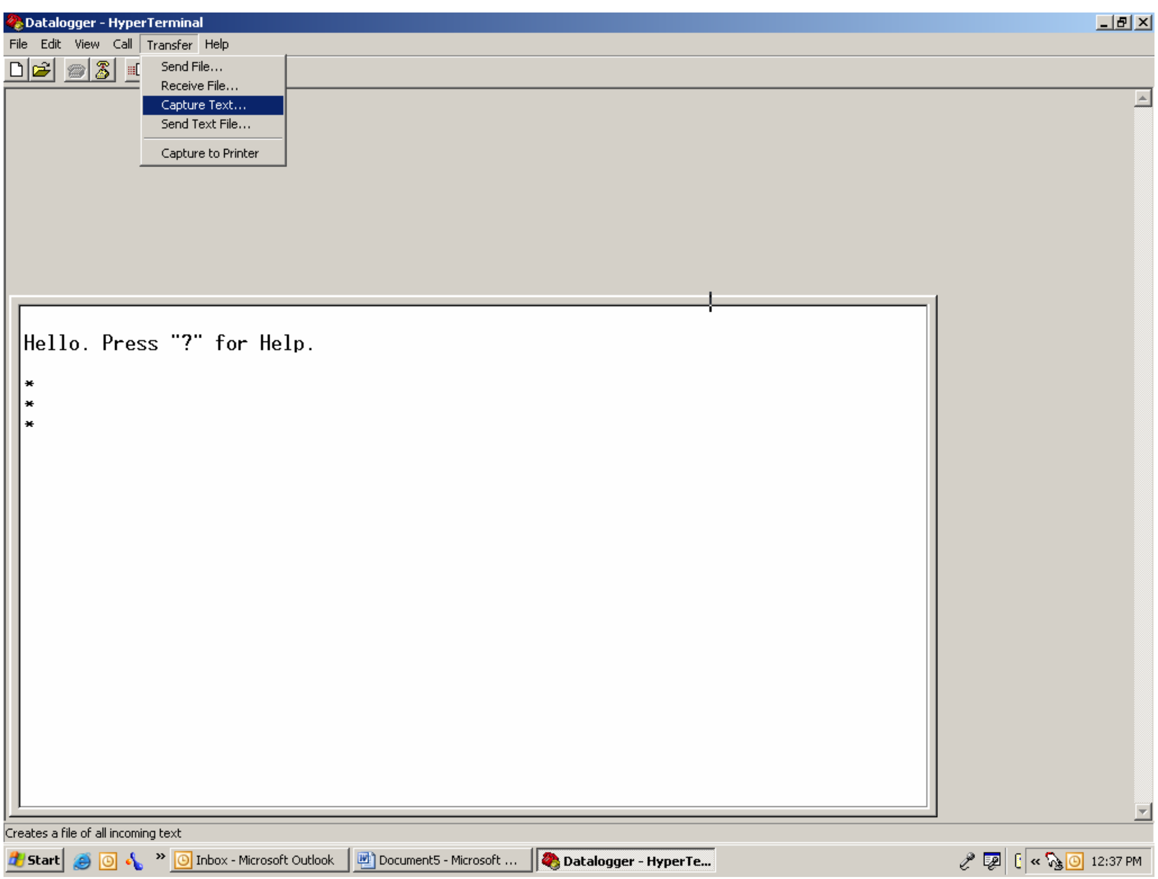


Change the Connect using setting to the appropriate COM port (in this case COM1 - See section 2.4 Example Setup) – Select OK:

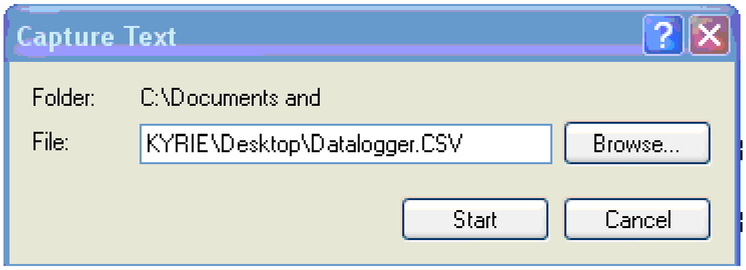
Enter the Port Settings. Select Apply. Select OK:



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. Select Start:



Note: Specifying a filename with a .CSV extension will allow data to be directly imported into common spreadsheet programs such as Microsoft Excel™

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 "D5" to Display the readings stored in memory.
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
*
```

The data are now stored in the specified file.

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
Column:      1     2    3   4  5  6    7      8     9 10 11 12 13 14 15 16
```

where;
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 section 3.5.).
Column 4 represents the time (or hh,mm format, see section 3.26.).
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 - THERMISTOR TEMPERATURE DERIVATION

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

Resistance to Temperature Equation:

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

Equation E-1 Convert Thermistor Resistance to Temperature

where: T = Temperature in °C.

LnR = Natural Log of Thermistor Resistance

$A = 1.4051 \times 10^{-3}$ (coefficients calculated over the −50 to +150° C. span)

$B = 2.369 \times 10^{-4}$

$C = 1.019 \times 10^{-7}$

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 LX-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 255 Model LX-2x4 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 it's inherent noise immunity and it's 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 it's 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.

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 JP-2 (located adjacent to J5 – the COM connector cable termination on datalogger the circuit board) is positioned between pins 1 & 2 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 section F.2. 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 sections 3.9(ID), 3.20(NA), 3.21(NAddd), 3.22(ND), 3.23(NE) & 3.24(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, 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 it's 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.

<u>NOTE</u>: If no commands are received after 60 seconds, the datalogger will automatically go to sleep and disconnect itself from the bus. It will continue to wake up periodically (scan rate setting) to take readings.

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 numbers 3 & 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
```