



**Instrumentation
Northwest®**

**Manufacturer of Groundwater Monitoring
Systems and Submersible Sensors**

AquiStar® DL-2 Data Collection System

INSTRUCTION MANUAL

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Notice to *AquiStar*[®] Users

This program is supplied freely on an “as is” basis to users of our older data loggers. INW is not responsible for any problems caused by the use of this program, but we will make our best efforts to make users aware of any problems that may be caused by the operation of this program.

This program will not work with *AquiStar*[®] DL4/8/12/16 family.

Operation of this program will remove the PGM3 program from data loggers it is used with and will change the default communication speed from 1200 to 9600 baud. **You will not be able to use the TERRA3 program to communicate with your data logger once you have used this program unless you reset the data logger operation.**

If you find problems using this program and wish to return to the use of TERRA3, then refer to Appendix 7 on returning to the use of the Terra3 program and PGM3.

The most recent version of the software is available for download from our web site at www.inwusa.com/dl2.htm. If you find any problem with the use of this program, or wish to be advised about updates to the program, please contact us.

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Quickstart

(This assumes the Windows® Operating System and the Aqua 4 program are installed)

1. Connect the data logger to the serial port of your PC.

Use a straight-through (not a “null-modem”) type cable. The serial port is a 9 pin socket inside the data logger enclosure.

If you have never used the software before, use “COM1” port if available - if you use a different serial port you will have to go into Configuration - System menu and pick the correct COM (serial) port before you can communicate with the data logger.

2. Turn on your computer and start Windows (if not running).

3. Start the Aqua 4 program:

Double click on the Aqua 4 program icon.

4. If you are switching between DL-1 and DL-2 data loggers use Configuration - System - Data Logger:

The correct communications protocol differs between the two data logger types. You must configure the software to use the right protocol for your type of data logger.

5. Check the status screen: (Logger - Status)

Items of concern will be highlighted. If you have changed batteries in the data logger, be sure to reset the logger time. Due to communications difficulties under Windows, you may have to try a couple times to establish communications with the data logger.

6. To retrieve data: (Logger - Retrieve)

Select the “Data and Hex File” option, then the Retrieve button. In the dialog box, enter a name and directory for the data (i.e. where it will be stored on your PC).

Once the file is transferred, it is a good idea to make a back-up copy on floppy disk.

To quickly check your data, use Data - Display, and then the Graph button to get a quick graphical plot of your data file.

7. To configure the logger before collecting data (Logger - Configure)

If you have retrieved data and you do not want to change the setup, you do not need to do configuration again.

On the **Logging** page (click on tab marked “Logging”), make sure the channels you want to store are checked as active.

Pick one of the interval types. Set the interval(s). If you want a non-standard single interval, click the user button, and then set your custom interval.

On the DL-2 data logger, using the “fast scan” (10 samples per second) mode, the readings will be slightly less stable than with other intervals because software averaging is unavailable. See Appendix 3 for more information about averaging.

On the **Channels** page (click on tab marked “Channels”), click on a channel in the list box at the top to enable editing of the information for that channel. You can use the AutoConfigure to set up the information for typical sensors (except for the channel description).

On the **Logger** page (click on tab marked “Logger”), enter or change the description of the Logger/Site. This information is included in the data file and is provided to help you differentiate, if you have a multiple logger site.

Make sure you use the Store Configure button to save any changes into the data logger before you leave this window.

8. To check that your channel setup is correct (Logger - Monitor)

Check the box for the channel(s) you wish to view, and then click the Start button. You will get a display in engineering units for the channels as configured by the channel setup. You can monitor while the unit is collecting data. Click the Stop button to stop monitoring before you leave the window.

9. To start the logger collecting data (Logger - Collect)

If you want to specify a start time, use the Specified Time selection. Click the clock button to select a date and time. (This can be used to synchronize logging on the hour or with other data loggers.)

Clicking the Start button will start data collection. Clicking Cancel or using any other method to exit the window before clicking the Start button will not start the collection of data. **Make sure you receive a “Logging Started” confirmation.**

10. Check the Status screen again: Make sure that the battery capacity will be sufficient for your data collection, and check the time memory will be full (please read Appendix 6 about data compression), as well as the next scan time to make sure everything is okay. Updating status does not recalculate the battery capacity. This only occurs the first time status is used.

11. To export the data file information to a spreadsheet (Data - Export)

If you have transferred a data file with the current session of Aqua 4, the data file should already be present and does not need to be opened. To open a different data file, click on the Open button, navigate to, and then select your data file.

Choose the channels to export to your spreadsheet file by selecting the channels in the Channels panel. You can select a certain time frame by using the clock buttons in the Time Window panel. The defaults will use the entire data file.

The Date Time panel sets the format(s) for the column(s) of timing information of the samples. (Most spreadsheets can not handle date and time display in a single column.) A separate column in the output will be included for each of the items selected.

Click the button in the Output Format panel that matches your spreadsheet program, and then click on the Export button at the bottom of the screen. You will be prompted for the file name (and path) for the file. ***Note that, depending upon the number of data points and the output format, you may end up creating multiple data columns in your spreadsheet.***

Once the file is created, you must use the correct method to bring it into your spreadsheet.

In **Lotus**, (For newer Windows version start the “Classic” interface by the “/” key) use File - Import - Numbers, and enter the .prn file name you used in data export. This method imports the data into the current spreadsheet starting at the highlighted cell (and will overwrite existing data), so be sure you are in cell A1 of the desired worksheet before importing.

In **Excel**, use File - Open. In the “File Type” box, select “Text Files (*.prn),” and then navigate to the file you exported. Click on Open.

The “Text Import Wizard” step 1 should default to Delimited. Click on the Next button.

In step 2, make sure the Text Qualifier is the “ (double-quote) key, and that Delimiters has only the Comma box checked. Click the Next button.

Step 3 allows limited formatting of the columns of data. but we recommend you just click the Finish button and do the formatting of the date and/or time columns later. This method creates a new worksheet with the data.

In **Quatro Pro**, use File - Open, and select text as the file type, then select the file previously exported by Aqua 4. You may also use the Quatro Pro menu item: “Tools - Data Tools - Quick Columns” to import other saved formats (such as .PRN files) into your worksheet.

Installing the Aqua 4 Software

Requirements: The Aqua 4 software requires a 80386 or better PC with Windows 3.1 or better, and a free serial port for communication with the data logger (not required for only viewing data files). We have tried the Aqua 4 program under Windows® 95/98/ME, in an OS/2® Win/OS2 session, and under Windows NT® 3.51 and 4.0 and found no problems.

A serial cable (**not** a null modem type) is required to connect from your serial port to the 9 pin serial connector inside the data logger (typically you will require a 9 pin male to female cable).

The Aqua 4 diskette includes an SETUP.EXE program which is run to automate the installation of the Aqua 4 program under Windows 3.1. The setup program will copy the files to a specified location on your hard disk, and add the Aqua 4 program to your specified program group. Under Windows 95/98/ME/NT, the setup program will copy the files, but you may have to create your own icon for the program. The software does not require any changes to be made to the Windows .INI files. The program will create a AQUA4.INI file to store the settings last used in the program into the same directory as the AQUA4.EXE file. A file called BATTERY.LIF is put in the same directory with the Aqua 4 program.

(The most recent version of the software is available for download from our web site at www.inwusa.com/software.htm.)

Running Aqua 4 Software for the First Time

The first time you run the software, it will not know which serial port on your computer to use to communicate with the data logger. Consult your PC documentation to check which serial port you are using to connect to the data logger.

Use the **Configuration - System** menu item to configure the software. This consists of three “pages,” the Data Logger page, the Directory page, and the Options page. Select the page you wish to view by clicking on the corresponding tab.

The **Data Logger page** sets the communications port and the data logger type.

The **Directory page** sets the default directory for the location of files (data files, exported files).

The **Options page** allows company information for inclusion in data display windows. Other options allow for saving your program window size and location at the time the program was last closed and your data display view options.

The date and time format display (i.e. 97/12/31 or 12/31/97) is taken from your Windows setup (Control Panel - Regional Settings).

Once these settings have been made, they are saved in the AQUA4.INI file for future sessions of the program.

For further explanation of the Configuration menu, see Parts of the Aqua 4 Program - Menus later in this manual.

Parts of the Aqua 4 Program

The Program Window

The Aqua 4 program window is sizable like all Windows programs by dragging the borders. If the screen information for the currently displayed page can not be seen in the window, scroll bars will appear to allow scrolling through all the information. The sizing buttons in the upper right of the program window function like other Windows programs. Clicking the close button (button with an **X**) on the upper right corner of the program window will close the program.

At the bottom left of the window is a status line that displays one line help that explains the functions of the area of the program window under the cursor. If you are not sure what the check boxes, radio buttons, or other buttons on the screen are for, let the cursor rest over the item, and see what appears in the lower left corner of the main program window for more information.

Items in the menus or on the screen that are grayed out and cannot be selected are either not applicable to the current window, or are unavailable in the current state of the data logger. For example, the View menu item is only applicable to the subwindows of the Data Display window, and will remain grayed out until one of those windows is open. Another example is the "Start" button in the Logger Collect window will be grayed out if the data logger is already collecting data.

The Menus

The menus allow the selection of different display items in the program window, as well as File and print operations and the launching of the Help display. If an item is not applicable to the currently display screen, or is not a valid option, it will be grayed out to indicated the item is not currently available. While the program or data logger is busy processing commands, the hourglass pointer may temporarily change back to an active pointer, but with the system menus unresponsive. Once the last command has finished processing, the system should respond normally.

File Menu

Depending upon the active selection in the program window, items under the File menu may be grayed out. This means they are not available as actions for the current display.

Open, Save, Save As operate on various data file types, depending on the currently selected display window.

Close closes the current sub-window.

Print prints the currently active display to your printer. You can change your printer selection or its settings using the Setup button in the Print dialogue box.

Exit ends the Aqua 4 program.

Edit Menu

Available when editing user input boxes.

Cut, Copy, Paste, Delete, Select All - these items comply with the Windows standards, and work when editing user text boxes. The shortcut keys of Ctrl-X for cut, Ctrl-C for copy, and Ctrl-V for paste, will also work.

View Menu

Available when a data window is active.

The selections available under this menu change depending upon whether a data, graph or statistics display window is currently active. The choices are outlined further on in the manual under Data - Display.

Logger Menu

Logger - Status

Available when logger is connected to the PC.

The status screen items reflect the status of the logger at the time the screen was first opened, but can be updated using the Update button (except for the battery status which is only updated the first time).

Logger/Site Description - This reflects the information entered by the user on the Logger - Configure Menu (Logger page). You must select that page to change this information.

Serial Number - Assigned at manufacture, assists in tracking loggers.

Run Status - Indicates whether the logger is currently logging or not.

Memory - If any data memory write errors have occurred in the logger, then the status will indicate FAILURE. The data logger should be returned to the manufacturer for service. Installed memory in the logger will indicate if the logger has been fitted with 32k or 64k of memory. Remaining indicates the amount of memory available to store data, and the Time Full indicates the expected date for the memory of the logger to be filled by the last data reading. This time is calculated in the DL-2 data logger assuming no data compression is possible. See Appendix 6 for information about data compression.

Clocks - If the PC and logger time are far apart, they will be highlighted. You can use the Synchronize button to set the logger time to match the PC time, or if the PC time is incorrect, you should use the Set Logger button to program the correct time into the logger. ***When you change the batteries in the DL-2 logger, then the logger clock will start at Jan. 1, 1900.***

If the data logger is collecting data, you will not be able to change the data logger clock until you have stopped collecting data.

Logging - This panel displays the number of currently programmed channels to log, the number of readings taken and the estimated number of readings remaining before memory is full. The next scan time will be blank if the logger is not currently collecting data, otherwise it will show the time for the next data reading (as of the last screen update time).

Battery Estimates - ***These figures are based on having put a new set of Alkaline batteries into the logger when the batteries were changed.*** The battery status measurement in AH (amp-hours) highlights when replacement is recommended. The battery status will not function if the temperature is below -20 Deg. C., as it is outside the operational specification for the data logger.

Logger - Collect

Start or Stop may not be available depending on the state of the logger

Start time **Immediate** starts the logger scanning based upon its current configuration information. **Specified Time** delays the start of data collection until the specified time. If Specified Time is selected, a time display appears on the panel. This time can be set by clicking the Clock button. The Specified Time can be used to synchronize data collection between several loggers, to synchronize readings to the hour, or to preset data collection before deploying the logger to the collection site.

Start enters the action into the logger. ***If you cancel or exit this screen by any other means, the logging will not be started. Make sure you see the “Logger Started” confirmation.***

Stop terminates data collection in the data logger.

Logger - Retrieve

Not available if no data has been collected.

Data Information - Displays information about the data stored in the logger. The data file size gives a only a rough estimate of the data file size on the PC file when transferred.

Options - Select the type or types of files you wish to export. You should use the "Data and Hex File" option unless you need to conserve disk space. The .hex file serves as a backup source for regenerating your data file, and as assistance to technical support should you encounter any problems. Once you are sure your data files are good, you can delete the .hex file. A System Dump creates a data file and .hex file for the entire memory space of the data logger, which can be used in some cases to recover portions of overwritten data, or to recover data once memory has been reset. A system dump will take the longest time, Data File Only will be the quickest.

Retrieve - Click the Retrieve button to initiate retrieval. A dialog box will prompt you for the data file name for storing the data in your PC. The default extension for retrieve data files is .dat, and this is the expected extension when opening files for Data Display. A file with a .hex extension will also be created if that option is selected.

Logger - Monitor

Not available until communications have been established with the logger by other commands. (Note: This option is not available with the DL-1 Logger while collecting data.)

This menu item opens a window that allows you to select channels and start and stop monitoring those channels.

Use the Channels check boxes to select the channels that you wish to monitor.

Click the Start button to start monitoring. This display will reflect the current gain and offset values that have been configured into the data logger for the channels.

Once monitoring has started, the Start button turns into the Stop button, which can be clicked to halt monitoring.

Logger - Configure

VERY IMPORTANT: No configuration changes are made to the data logger unless the STORE CONFIGURATION button at the bottom of the window is used to exit the window. The logger cannot be collecting data when a change to configuration is made.

The Logger-Configure menu item opens a three paged window for configuring the data logger. Click on the tabs at the top to change to the different pages.

Logging Page

Use the Logging page to enter scanning information and select channels for scanning.

The Channels check boxes indicate which channels will have data stored to memory. **Only those with checked boxes will have data stored.**

The Interval radio buttons select whether a *single* interval will be used over the data collection, or a *multiple* interval series.

The Single button turns on a display of some common preset intervals. The User radio button lets you enter any interval of up to 24 hours.

The Multiple button displays the current variable intervals. Use the Change button to open the window for editing the values. From the Set Multiple Intervals window you can load and save predefined interval series, as well as compose a series of intervals. (Note: On the DL-1 data loggers, a maximum of 30 different intervals can be entered.)

Scan Display Panel - The right portion of the window displays a list of programmed scans. If the display is empty, no scans have been programmed. Click a line to select it for editing. Note that highlighting a line transfers the values into the setting boxes, and you must use the Update button to change the interval if you change the values in the settings boxes.

Type of Scan - Select a scan type, either Regular or Fast@100ms. If selecting a Regular scan, set the number of scans and the hours, minutes and seconds for the scan interval. If selecting Fast@100ms, set the number of seconds.

Update Button - Click the Update button to update the currently highlighted line to the new values you have set on the left.

Add Button - Click the Add button to add a new line at the *end* of the list. This new line will have the new values you have set.

Insert Button - Click the Insert button to add a new line *before* the currently highlighted line. This line will have the new values you have set.

Delete Button - Click the delete button to remove the currently highlighted line.

OK Button - Click the OK button to transfer your settings to the Logging page on the Configure window. **This does not save your settings into the data logger until you click the Store Configuration button on the Configure window.**

Cancel Button - Click the Cancel button to discard your changes and return to the Logging page on the Configure window.

Load Button - Click the Load button to load a previously saved interval series.

Save Button - Click the Save button to save the current interval series to disk. Note: this saves to your PC, not to the data logger.

Channels Page

Use the Channels page to set up the channel information.

Highlight a channel in the listing box at the top of the window to transfer the data to the setting boxes below. You can use the AutoConfigure panel to quickly set the Units, Gain, Offset and Warm-up for various pressure transducers.

The down arrows beside the settings boxes in the AutoConfigure panel display a drop down list that lets you quickly select your desired information without requiring any typing. These values assume a perfectly calibrated sensor, and so may require manual tuning, however they do present you with the ideal starting point.

The Zero Baseline Data button provides a shortcut that automatically takes a reading using the currently set Gain for the active channel and computes the Offset to give a resulting reading of zero for the channel at that moment. This Offset value is automatically entered into the Offset field for the sensor on the left side of the screen.

The Logger page is used to enter a site description that will be embedded in the data files to help you identify the source of the data.

Data Menu

Data - Display

Always available.

When the Display menu item is selected, the Display Selection window displays. This window controls the range of data to be displayed.

If you have just retrieved a data file, the data file will be opened when you enter

the Display Selection window. If you do not have a data file open, the File Open dialog box will appear, allowing you to select a data file. Data files have an extension of .dat. If you want to open a different data file, use the File - Open menu item.

Once a file has been opened, summary information about the data file is displayed.

Start/End Time

If you do not wish to view the entire file, use the Start/End time panel to select a “time window” within your data file for viewing. Only data between the two selected times will be displayed. Click the clock buttons beside the times to change the start/end time. This time window filters the data used by all of the display windows - Data, Statistics, Graph, or Info.

Channels

Mark the checkboxes for the channels you wish to display.

The *Data*, *Statistics*, *Graph* and *Info* buttons are used to display your selected data in various ways.

Data Button

The Data button opens the Data Display window and presents the data in a tabular format.

When the Data Display window is the active window, use the View menu to select the types of data to display. The following data items are available: Index (line number), Date, Time, Elapsed Time (in different units), and Units (in different types).

Right click (click the right mouse button) on any column to set the number of decimal places to display for that column. If you go to the header of a column, you can use your left mouse button to drag the column dividers to a new column width.

To print the data, select the File - Print menu item. Caution: if your file contains a large number of data points, this will create a very large printout.

Statistics Button

The Statistics button opens the Statistical Data Display window.

This window displays the channel’s description and units along with several optional data items. Use the View menu to select the data items to display. The following data items are available: the maximum, minimum, mean, variance and standard deviation value for each channel for the selected time window.

If you go to the header of a column, you can use your left mouse button to drag the column dividers to a new column width.

To print the data, select the File - Print menu item.

Graph Button

The Graph button displays a graphical view of the data selected in the Display Selection window. You can change the start/end time for the data being displayed, while the graph window is open. Simply, click the start or stop time clock button on the Display Selection window and make a new selection. (The display of the graph is delayed by a few seconds to prevent the drawing update from delaying system response, if you wish to make multiple changes to selections.)

While the Graph is the active window, you can select the View - Edit menu item to change several aspects of the graph display. Note: after making your selections, you must click the Apply button to update the graph display.

Time Interval

Use this panel to set the time interval marks across the X-axis. (Note: the X-axis *range* is controlled by the Start/End Time on the Data Selection Window.) Set the time interval by selecting either Months, Days, Hours, Minutes, Seconds, or a pre-determined Default. For all but the default, you can enter a numeric interval in the Interval box.

Grid

If you wish to display grid marks on your graph, check the Grid checkbox.

Title

The graph title, displayed above the graph, defaults to the Logger/Site Description that was embedded in the data file during creation. If you want your graph to display a different title, enter the new title here.

Serial Number

If this box is checked, the logger serial number displays at the lower left on the graph.

Company

If this box is checked, the company name displays at the lower center of the graph. The company name is set on the Options page under the Configuration - System menu item.

File Name

If this box is checked, the data file name displays at the lower right of the graph.

Description

The description is the name of the channel being displayed. This displays at the top of the graph. To change this name, double-click on the name, which is thus highlighted, and then type a new name. (If your data points hide the channel description label, you may want to increase the maximum setting for the channel (see below) to clear space at the top of the chart.)

Units

This is a description of the Y-axis units, which displays vertically along the left edge of the graph. To change this description, double-click on the description, which is thus highlighted, and then type a new description.

Minimum and Maximum

These values set the minimum and maximum Y-axis data range. To change these values, double-click on the values, which are thus highlighted, and then type new values. The automatic scaling of the Y-axis for the graph will be limited to a minimum of 1% of full scale range. To have a closer look at stable data, use these values to manually expand the Y-axis range.

Major

This value sets the scaling increment marks on the Y-axis. To change this value, double-click on the value, which is thus highlighted, and then type a new value. If you wish to revert to auto scaling for the Y-axis, put a zero in the major column for the channel.

To print the graph, select the File - Print menu item.

Info Button

The Info button opens the Data Information Display window showing information about the opened data file, including the channel setup information for the channels: Description, Units, Gain and Offset. These reflect the channel setup values that were entered into the data logger using the Logger - Configuration menus.

To print the information window, select the File - Print menu item.

Data - Export:

Always available

If you have retrieved a data file with the current session of Aqua 4, the data file should already be present and does not need to be opened. To open another data file, click on the Open button and navigate to, then select your data file.

You can choose to export only a selection of your data file by two methods. You can choose the channels to transfer to your spreadsheet file by selecting channels

in the Channels panel. You can also select only a certain time interval by using the clock buttons by the start and end display in the Time Window panel. The defaults will use the entire data file.

The Date Time panel sets the format(s) for the column(s) of timing information of the samples. (Most spreadsheets can not handle date and time display in a single column of data.) A separate column in the output will be included for each of the items selected.

Click on the button in the Output Format panel that matches with your spreadsheet program, then click on the Export button at the bottom of the screen. You will be prompted for the file name (and path) for the file. ***Depending upon the number of data points, and the output format, you may end up creating multiple data columns in your spreadsheet.***

Once the file is created, you must use the correct method to bring it into your spreadsheet.

In **Lotus**, (For newer Windows version start the “Classic” interface by the “/” key) use File - Import - Numbers, and enter the .prn file name you used in data export. This method imports the data into the current spreadsheet starting at the highlighted cell (and will overwrite existing data), so be sure you are in cell A1 of the desired worksheet before importing.

In **Excel**, use File - Open. In the “File Type” box, select “Text Files (*.prn),” and then navigate to the file you exported. Click on Open.

The “Text Import Wizard” step 1 should default to Delimited. Click on the Next button.

In step 2, make sure the Text Qualifier is the “ (double-quote) key, and that Delimiters has only the Comma box checked. Click the Next button.

Step 3 allows limited formatting of the columns of data. but we recommend you just click the Finish button and do the formatting of the date and/or time columns later. This method creates a new worksheet with the data.

In **Quattro Pro**, use File - Open, and select text as the file type, then select the file previously exported by Aqua 4. You may also use the Quattro Pro menu item: “Tools - Data Tools - Quick Columns” to import other saved formats (such as .PRN files) into your worksheet.

Configuration Menu

System

The Configuration - System menu opens a three paged window for configuring the software.

The **Data Logger** page sets the type of data logger that is connected to the PC. The correct communications protocol differs between the two data logger types. You must configure the software to use the right protocol for your type of data logger. The DL-1 setting includes the Aquistar® DL-1 and DL-1A data loggers.

You must also specify the correct port for communication to the data logger, the software can not automatically detect the serial (COM) port connected to your data logger. If you are unsure about which port is available for connection, refer to your PC documentation.

The **Directory** Page sets the default directory for the opening and saving of files. Type in the path, or use the dialog box to navigate to point to a file in the directory you wish to use, then click on OK.

The **Options** Page lets you set options for the following:

The Company will display in some of Data Display windows.

Autosave - Desktop reuses the last size and location of the Aqua 4 program windows when it is closed (if not enabled the program opens up as a full screen size).

Autosave - Data Display saves the sizes and locations of the windows last opened under the Data - Display control.

Help Menu

There is currently no on-line help manual available for the software. The Help - About button displays a dialogue box indicating the version of the software you are running. This information may be of assistance to technical support.

Appendix 1 - Sensor Connection

The DL-2 data logger provides power for 4-20 milliamp current loops. The total loop voltage is a minimum of 13.5 volts at 20 milliamps. The data logger uses a 121 ohm resistor as the loop sensing resistor, which drops 2.4 volts at 20 milliamps. The guaranteed voltage available for the sensor and wiring is 11 volts. The negative reference of the current sensing resistor is at the data logger 0 Volts.

The current loop power is short circuit protected. The current loop is not isolated from the serial port, so you must be wary of using the data logger in an externally powered current loop monitoring application. If you use a computer that connects to ground through its power supply, this power supply ground will be the ground point of the data logger once a serial cable is connected. If there is a difference in the ground potential from the current loop supply and the ground point of the computer, or the ground of the data logger, then excessive ground currents will flow and likely damage equipment, or at least cause erroneous readings. If you use a battery powered laptop computer, not connected to a charger, then the ground potential of the computer can float, and there will not be a problem.

The sensor connection for single channel 4-20 milliamp current loop (data logger power) is:

Pin B - Excitation (sensor +)	Pin D - signal return (sensor -)
Pin C - Ground (not used)	Pin F - Cable shield (optional)

The sensor connection for dual channel 4-20 milliamp current loops on a single connector (tubular model) are:

Pin A - Excitation (sensor +) channel 2	Pin D - Signal return (sensor -) channel 1
Pin B - Excitation (sensor +) channel 1	Pin E - Signal return (sensor -) channel 2
Pin C - Ground (not used)	Pin F - Cable shield (optional)

The sensor connection for 4-20 milliamp current loops (externally powered) is:

Pin C - negative side of loop (data logger ground - should be at most negative point of loop)
 Pin D - positive side of loop

The sensor connection for 0 to 2.5 volt input data loggers is:

Pin B - Excitation +
 Pin C - Excitation - (also signal negative)
 Pin D - Signal +

Appendix 2 - Calculating Sensor Gain and Offset

The DL-2 Data logger (with gain of 1 and no offset) treats a 4 milliamp signal as a “0” and a 20 milliamp signal as a “1”. There are allowances for over and under range signals. For the Gain, use the full scale range (for 4-20 milliamps), in the units you wish to display, of the sensor.

Example - If you had a pH sensor with a 0 to 14 pH range, and you wanted the display to be in pH, you would use the full scale range of 14 as your Gain.

Example - If you had a conductivity sensor that had a full scale range (representing a 4-20 mA signal) of 1000 uS/cm, and you wanted display in uS/cm, then you would use a Gain of 1000.

Example - If you had a 10 psi sensor, and you wanted your output in inches of water, then you would use $(10 \text{ psi} * 2.3067 \text{ ft H}_2\text{O/psi} * 12"/\text{ft} =) 276.8$ as your Gain.

The DL-1 Data logger (with gain of 1 and no offset) treats a 4 milliamp signal as a “1” and a 20 milliamp signal as a “5”. (This is the voltage produced across the current sensing 249 ohm resistor in the data logger.) Use the full scale range, in the units you wish to display, divided by 4 as the Gain. Use the negative of the Gain as the offset.

Example - If you have a pH sensor with a 0 to 14 pH range, then use $14/4 = 3.5$ as the Gain, and -3.5 as the offset.

The terms Gain and Offset do not imply any changing of the capabilities of the hardware to resolve signals, they are only implying software conversion to display results in Engineering units for convenience. Increasing the Gain does not in any way amplify the input signals, nor does applying an Offset shift the input signal level in any way. You can not resolve signals below 3.8 milliamps in the DL-2 data logger, nor can you get finer conversion steps by increasing the Gain in the Configure-Channels settings.

The DL-2 has 15 bits representing the digitized signal at a resolution of 1 part in 32,000 or 0.003 percent.

The DL-1 has 12 bits representing the digitized signal at a resolution of 1 part in 4,000 or 0.025 percent.

Appendix 3 - Determining Sensor Warm-up Time

For users of PS9000 sensors, the default warm-up time of 100 milliseconds will be adequate.

For users of other sensors:

The DL-2 data logger has two modes of excitation operation.

The first mode is when the logger scanning is set for 100 milliSec or Fast @ 100 msec. In this mode the excitation provided by the data logger is always on, and the warm-up time setting is irrelevant. When running in this mode, the data logger only has time to read the Analog to Digital converter once per channel for the stored reading, no averaging of readings is done.

The second mode is when the logger scanning is set for 1 second or greater. In this mode, the excitation is switched on, and after the specified Warm-up setting, the Analog to digital converter is read 4 times per channel, and the average of these readings is stored. Each of these readings takes 50 milliseconds per 2 available channels, so the last readings come after the excitation has been on for 300 milliseconds more than the warm-up time setting.

The averaging of the readings dilutes the effects of insufficient warm-up time. The best way to determine the required warm-up time is to collect some data with a stable input from your transducer, and variable scan intervals set using both 100 millisecond and 10 seconds intervals, and see if the data changes between the two intervals. If the data changes noticeably, increase the warm-up time for the sensor and repeat until the difference is acceptably small.

Appendix 4 - Battery Life

If you see the battery capacity is below 50% you should seriously consider replacing the batteries. In almost all cases the cost of new batteries is small compared to the cost of losing your data. As you become more experienced you will be able to tell what capacity you require to complete your data acquisition without battery failure.

The estimated battery life can only really be an estimate. Battery life is affected by several factors, such as the temperature of the batteries and the power consumed by the sensors. If for any reason the batteries should run out of power, the data logger will first stop collecting data. If operation of the data logger continues, or if the batteries are left to discharge even more, then the data logger will go into reset mode, and drain the batteries. The integrated circuits used for data memory retain their data even if power is lost, so your data will not be lost.

The battery capacity of standard alkaline batteries is adversely affected by cold temperatures. The capacity of alkaline batteries at -20 degrees Celsius is only 20% of the capacity available at a temperature of + 20 degrees Celsius.

When the data logger is indicating the estimated battery life, it is measuring the battery voltage and the temperature of the data logger. It uses this temperature in its estimate of the battery life remaining. If you read the battery status when that data logger is cold, then the reading will be much less than if you read the status when the data logger is warm.

You will get the most accurate reading of the remaining capacity if you read the status when the data logger is at the average temperature that data logger can expect to see over the data collection period. If you check the status of the battery when the data logger is much warmer than you anticipate the data logger will be during data collection, you should consider the effects of temperature.

Our tests have shown that the batteries recover some of their capacity if they are warmed above freezing before more power is taken from them. This means that in cold climates it would be better to place the data loggers in locations where they will be warmed by the sun during the day, even if that location may experience colder temperatures at night. The data loggers are thermally compensated, so the temperature swings experienced by the data logger will not affect the accuracy of the readings.

The power consumed by the 4-20 milliamp current loops for the sensors are the largest part of the power consumed by the data logger. If the sensors are all at the low end of their range and use only 4 milliamps, then the battery life will be much longer than if the sensors are at the 20 milliamp point. The software assumes worst case conditions of the sensors using 20 milliamps in estimating the battery capacity remaining.

Appendix 5 - Changing Logger Batteries

The DL-2 data logger is designed to work with standard alkaline “D” cell batteries, which may be recognized by trade names such as “Energizer” or “Duracell”.

You should mark on the batteries the date of installation when installing them to keep track of battery life for your future reference, and to avoid confusion of old and new batteries.

When you change the batteries, the data logger will stop operation during the change. The clock of the data logger will be reset to time zero. Do not change batteries while the logger is collecting data. If data logging is underway when the batteries are changed, then it will continue, but the time data for all data records after the battery change will only be estimates based upon reverse calculation from the time of the data retrieval.

Do not attempt to use rechargeable batteries in the data logger. The data logger was designed to utilize the characteristics of alkaline batteries.

If you have trouble communicating with the data logger when you have installed new batteries, make sure the spring clips are making good contact with the batteries at the terminals. You may have to remove the batteries and bend the clips to establish good contact. A thin coat of Vaseline or other white petroleum jelly may assist in preventing any corrosion of the contacts.

Appendix 6 - Data Compression

To allow more readings to fit into data memory, the data logger uses data compression of readings where possible. The data logger calculates the time for memory to be full on the status screen of the logger software using the worst case basis of requiring two bytes to store each data point, so this time is a guaranteed minimum. You may find that data collection continues on beyond this time because of the data compression, but this can not be predicted by the software in advance. In the case of very slowly changing data, you will find that you may get up to twice as many samples stored in the available memory as expected.

The compression works in the following manner: If the change in readings between two samples is very small, then only one byte of memory is used to store the difference from the last reading. If the reading change is larger than can be encoded by this one byte record, then a two byte record is used to store the absolute reading for the channel. The software automatically decodes the compressed readings and always gives you the absolute reading for every sample record in your data file.

Appendix 7 - Restoring to Terra3 and PGM3

Method 1 Easy - loses all data - must open logger:

Open your data logger, disconnect the main battery, then access the small push button switch on the circuit board and press and hold for a few seconds. Connect the logger to your PC and run the Terra3 as before. When you wake the data logger, you will have to reload the PGM3 program by entering:

```
Load"PGM3" <Enter> (must use capital letters for PGM)
RUN <Enter>
```

This should bring you to the familiar prompt menu.

Method 2 More difficult - loses all data - do not need to open logger:

Start your Terra3 program, but before entering Terminal Mode, select Change Baud Rate, and select a 9600 baud rate.

Wake your data logger with the capital "C" key as before. You will see a different command line selection show up. Ignore this. Use a Ctrl-A combination. You should see:

```
BREAK IN xxx
OK
>
```

Type :

```
COLD <Enter>
```

You should see:

```
ARE YOU SURE ?
```

Type:

```
YES <Enter>
```

You should see a bunch of strange characters on your screen. Use the <Esc> key to exit Terminal Mode on the Terra3 program, then choose Change Baud Rate, and select 1200 , then select Terminal Mode again. Use the <Enter> key, and you should see a ">" prompt, if not you may have to use the "C" key to wake the data logger again.

Then type:

```
Load"PGM3" <Enter>
```

You should see

```
OK
>
```

Then type:

```
RUN <Enter>
```

Method 3 Most difficult - does not lose data - does not need to open logger:

Start your Terra3 program, but before entering Terminal Mode, select Change Baud Rate, and select a 9600 baud rate.

Wake your data logger with the capital "C" key as before. You will see a different command line selection show up. Ignore this. Use a Ctrl-A combination. You should see:

```
BREAK IN xxx
OK
>
```

Type :

```
POKE 16723,161 <Enter>
```

You should see:

```
OK
>
```

Type:

```
NEW <Enter>
```

You should see:

```
OK
>
```

Type:

```
SLEEP* <Enter>
```

(continued on next page)

Use the <Esc> key to exit Terminal Mode on the Terra3 program, then choose Change Baud Rate, and select 1200 , then select Terminal Mode again. Use the “C” key to wake the data logger again. You should see:

```
TERRABASIC V2.2/90
WARM START
OK
>
```

If you see some “C”s after the “>”, then press <Enter> again.
Then type:

```
Load"PGM3" <Enter>
```

You should see

```
OK
>
```

Then type:

```
Run <Enter>
```

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