Quantum II Desktop and a Special

Stand Alone Real Time BIA Data Logging Application

for Scientists, Engineers and Technicians

A scientific research instrument for exploring the changes of
bioelectrical resistance and reactance in real time,
from 1 millisecond to days, in living organisms.

Introduction

The Quantum II Desktop contains an optional real time BIA logging application that does not require a PC or computer to acquire real time data. BIA data logging functions can be set up with the miniature PS/2 keyboard and can continue to run without any interaction from the operator or PC. BIA data and a time stamp are saved in the safe internal battery backed memory. When an experiment or observation is recorded, the instrument is moved to a PC so that the results can be downloaded in a spreadsheet format (csv) and a new real time observation can begin. Events can range from milliseconds to days, and more than 15,000 real time records with individual record time stamps can be saved. In addition, the Quantum II Desktop can be *paged* during data capture to observe real time resistance and reactance changes on *page* zero (series model) and *page* one (parallel model) while displaying a record count on *page* five. The applications described in this document are for investigational research only.

- Real time examples -

All living organisms exhibit some form of bioelectrical resistance and reactance that change with respect to time. This is present in normal physiological functions such as breathing, circulation, growth and death in animals and humans. BIA changes can also be utilized in other applications ranging from how fruits and vegetables spoil to the freshness of beef, poultry and fish that are purchased at the market.

To demonstrate how the Quantum II Desktop can be used, stand alone measurements were taken on a fresh piece of fish for one week.

Fresh fish

How fresh is "Fresh Fish Daily" ?

A fillet of fresh Pickerel (Lake Erie) was analyzed with
with a RJL Systems Quantum II Desktop where resistance
and reactance samples were taken every hour. This data shows
that fresh fish should not be refrigerated for more than three
days at 40 degrees Fahrenheit from the time it was processed.
A phase angle of 5.0 should be the critical point of freshness.

Graph was created with Gnuplot

This example is only for fresh, unfrozen fish with a short amount of time elapsing from catch to market. Each sample was taken at one hour intervals (168 samples). This experiment demonstrates the sensitivity of BIA to directly measure cell destruction (reactance) and non-cellular electrolytes (resistance). Frozen fish will have a low reactance and phase angle because the cells have been destroyed by freezing. More data on fish freshness will be available soon. An in-depth discussion on the subject of series and parallel resistance and reactance concerning this experiment is available upon request.

Vegetables - potato cooking

To further illustrate real time BIA applications, cooking an Idaho potato demonstrates the sensitivity of BIA to directly measure cellular and non-cellular composition in living things. When the potato is placed in boiling water, reactance drops rapidly while resistance has a slower change due to the fact that most of the cells are between the skin and the pulp of the potato. Resistance indicates when the potato is fully cooked (about 40 minutes). Once the potato is removed from the boiling water, resistance rises linearly because of the relationship between ionic conductivity and temperature. Reactance remains relatively unchanged because all cells have been destroyed from cooking and is, therefore, not temperature dependent. Sampling rates where taken at ten second intervals.

Resistance start 92.2 ohms
Reactance start 46.6 ohms
Phase angle start 26.83 degrees

Potato was removed from boiling water

Resistance

Phase angle

Reactance

Phase angle (degrees)

Reactance (ohms)

Resistance (ohms)

Minutes (calculated from real time record time stamp)

Potato was placed in boiling water

Cooking an Idaho potato and real time BIA measurements using a Quantum II Desktop and stand alone data logging

Graph was created with Gnuplot

Respiration - left lung only

Two detecting electrodes were placed on the left side of the chest spanning the rib cage. One electrode was placed just under the arm pit and the second was placed just below the bottom rib. Two source electrodes where placed on the left thigh and shoulder. The sampling rate was set to 10 milliseconds and 10,000 records were saved. The sensitivity of resistance and reactance changes are 0.1 ohms, which does not provide enough resolution for shallow or labored breathing. Amplifying the basic BIA module by a factor of 10 without affecting signal to noise ratio is currently under development. This improvement (0.01 ohms resolution) should allow quantitative measurements of actual volume air flow. The addition of a second BIA module with common source electrodes will create a simultaneous measurement of right and left lung respiration.

Left lung normal and forced breathing
using a Quantum II Desktop and stand alone BIA data logging

Graph was created with Gnuplot
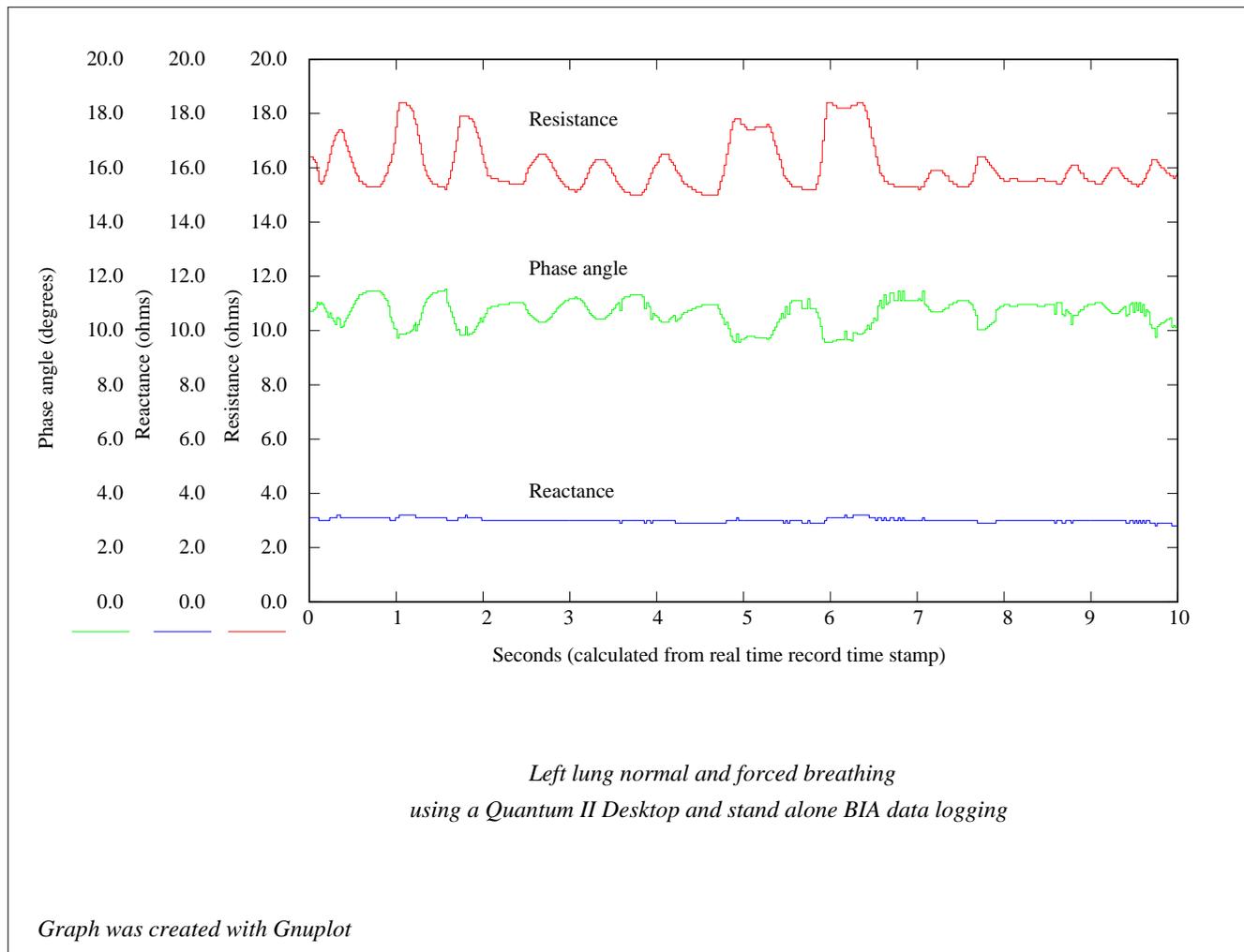
Other real time measurements

The Quantum II Desktop has additional modality slots that can accommodate other functions or sensory measurements. The data acquisition module has eight analog inputs where two are taken by the BIA module. RJL Systems will design and build special signal conditioning or real time event modules for specific industrial or medical application upon request.

Operation - User interface
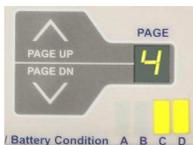
Stand alone (autonomous) real time BIA measurements (*Page* 4)

Before any real time parameters can be set in the Quantum II Desktop, the supplied keyboard must be plugged into the PS/2 connector on the back of the instrument (top right). The keyboard can be tested by observing the three green Num Lock, Caps Lock and Scroll Lock LEDs on the top right of the keyboard. All three lights should blink briefly when the Desktop is turned on. The PgUp and PgDn keys can also be pressed to *page* through other applications, diagnostics and local time/date settings. The *paging* counter on the front panel will indicate the current *page*.

Edit function keys

There are 5 function keys that are used to edit fields (lines) of various Desktop applications - four arrow keys (lower right) and the Backspace (upper right) key. The Enter key will save the selected values and sequence to the next parameter. However, the arrow and *paging* keys may still be used for editing in case a parameter requires editing. These 5 keys are the only way to edit a specific field.

To begin the Desktop stand alone data logging application, **First** press the PgUp, PgDn keys or the front panel *paging* buttons to *page* 4. The display should mirror the image to the right. If the display is blank, then the stand alone real time BIA application is not installed in the Desktop.

```
    Sample Period:
       10_____
  X ms _ sec _ min
  _ hours   _ days
```
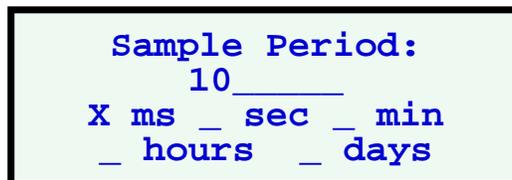
Second, given that more than 15,000 records can be saved in the Desktop, the nature of the experiment, sampling time and storage should be considered. All memory locations do not have to be filled. In fact, only a few memory cells can be used. The beginning and ending record numbers are internally saved in the Desktop and are part of the download protocol. Therefore, only one experiment can be recorded at a time because no file names are associated with the data. Data logging can be interrupted at any time by turning off the Desktop without losing any information. The Desktop is turned off by the F12 key or the front panel off button. The last record number recorded during shutdown will be shown in the batch dialog display on *page* 5 after the Desktop is turned back on.

Third, set a numeric sampling rate from 1 to 10,000 on line two of the dialog display. Generally, large numbers are not necessary because of the time units range. With the arrow keys, move to the time units fields and select the desired time unit (ms, sec, min, hours, days). The shortest sampling rate is 1 millisecond.

```
Log Length:_____
          samples.
```

Once a time unit has been selected use the Enter key to mark the time unit with a X and save the sampling time. This will advance the dialog display to the number of samples to be taken (Log Length _ _ _ _ _ _). Enter any number from 1 to 15,000 and press enter. A '-1' can be used to fill all available memory locations (15,330).

The last step is to actually start the Quantum II Desktop logging real time data. When sampling time and number of samples have been entered, the start logging dialog display will appear. Press "r" and real time BIA data logging will begin.

```
Press 'R' to begin
or use the up arrow
to go back.
```

```
     Batching Log
        2356
    samples taken
```

Once real time logging is initiated, the dialog screen changes to *page* 5 and the number of samples are displayed in real time. Any *page* on the Desktop can be viewed at this time by using the *paging* keys or front panel buttons.

For example, *page* 0 contains the actual resistance and reactance value measured. *Page* 1 has the parallel equivalent of resistance and reactance. *Page* 4 has the original sampling rates and number of log samples.

At this point, the keyboard is not required and may be removed for long time events. Data Logging can only be interrupted by turning off the Desktop, recorded data will not be erased in doing so.

When the number of real time samples taken equals the number of samples set by the user, the finished dialog display will appear on *page* 5. The finished batching log samples will remain on *page* 5 and is ready for data downloading.

```
     Batching Log
        5000
    samples taken
   Logging Finished
```

RJL Systems Data Logger - PC Application
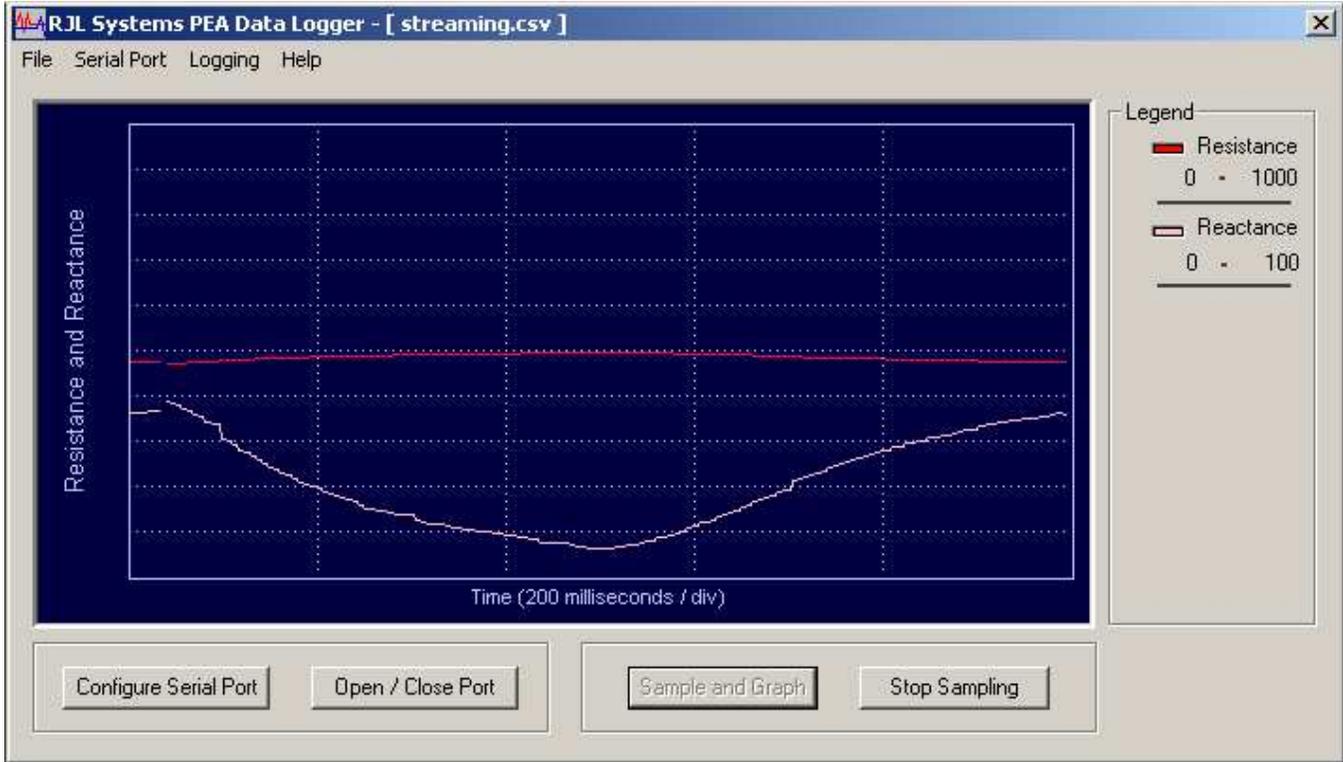
System Requirements

- Windows NT 4.0, 2000, or XP (Windows 3.11, 95, 98 and Millennium Edition are not supported).
- 128 MB of memory
- Pentium-II 600 MHz or greater. This is the minimum speed that will allow a resistance and reactance graph to be updated every 2.0 milliseconds.
- One available RS-232 serial port or USB port.

If the computer does not meet or exceed these requirements, with the exception of the serial port, the setup program will not allow the Data Logger software to be installed.

If the computer lacks an RS-232 port, (typically a 9-pin male connector on the back of the computer) and has an available USB ports, a USB to RS-232 adapter cable can be purchased or supplied by RJL Systems. There are many USB adapters available. RJL Systems has tested and rated a few common ones listed in the table below:

center tab(|); cfB s s s s s c c c c c c 1 1 c 1 n l. USB to RS-232 (serial) adapters

Manufacturer	Model	Driver Required	Available	Price	Rating
IOGear	GUC232A	No	Comp USA, Best Buy	$39.95	Good
Zonet	ZUC3100	Yes	Computer Warehouse	$19.95	Average
Radio Shack	26-183	Yes	Radio Shack	$39.95	Poor

Rating is based on plug and play capabilities. The IOGear did not required any driver and was immediately recognized by the Data Logger application. The Radio Shack adapter is older technology and did not work on a HP Windows XP computer after loading their driver. The Zonet worked after installing the supplied (CDROM) driver.

Installation

Installation of the RJL Systems Data Logger is generally an automatic process. Simply place the CD in the appropriate drive and the CD icon should appear then the installation dialog should begin. If the setup program does not automatically begin when the disk is inserted into the CD drive, select "Run" from the "Start Menu." In the box which opens, type "D:\setup" to begin the setup process. (Substitute the letter of the appropriate CD-ROM drive for D.)

The setup process consists of the following windows:

A.   Introduction

B.   License Agreement

C.   Select Destination Location

D.   Select Entry for Start Menu

E.   Verification of Installation Tasks

F.   Finish

Most users will accept the default options when installing

I. Main Program Start-up

A.   **Start the Data Logger** application by either double-clicking the icon on the desk top, or by selecting the shortcut from the "Start" menu.
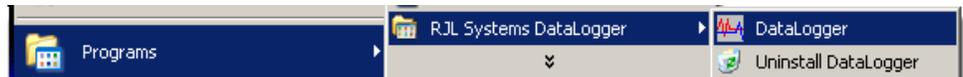
B.   **Open a log file** by selecting the "Open Log File" from the "File" menu. This will open a standard "file chooser" window. Type the name for the log file and select the folder in which to save it and click "OK." The name of the log file will now appear in the title bar at the top of the Data Logger window.

C.   **Configure the serial port** by either clicking the "Configure Serial Port" at the bottom of the window, or selecting "Configure Serial Port" from the "Serial Port" menu. Select which serial port to connect to the Quantum Desktop with. The Data Logger application will scan the available serial ports and create a list that can be selected from.

The hardware setting in all cases should be as follows:

Baud Rate: 38.4k
Data Bits: 8
Parity: None
Stop Bits: 1

All of the checkboxes should be empty.
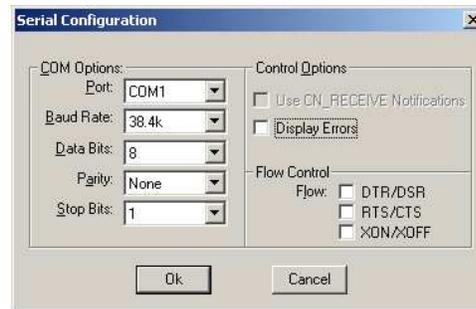
D.   **Verify the serial port and options** by clicking the "Open / Close Port" button at the bottom of the main window. If the DataLogger is able to communicate with the Desktop, the "Sample and Graph" button will become active. (The text will become black instead of grayed-out.)

If the DataLogger is unable to communicate with the Desktop, an error box will appear. Verify that the above settings are correctly set, and ensure that the Desktop is on, and connected to the computer. If communication continues to be a problem, try selecting a different port in the "Serial Configuration" window.

II. Stream or Continuous Mode

The RJL Systems Data Logger has two modes of operation. The stream or continuous mode will continuously stream resistance and reactance values, (0.1 ohms resolution) to the PC at user specified sampling rates. The data can be dynamically displayed as a continuous real time graph and/or saved in a file.

A.   **Sampling rate** can be set to milliseconds, seconds, minutes, hours and days to any value and is set by the "Sampling Options" window. This window is opened by selecting "Set Sample Rate and Duration" from the "Logging" menu. The minimum time period between samples is 1 millisecond per channel or 2 milliseconds for resistance and reactance data. The maximum sampling rate is 45 days.

B.   **Number of samples** is specified in the Log Length field and can be any number from 1 to 1,000,000. To take samples continuously until the "Stop Sampling" button is pressed, set the log length to '-1'.
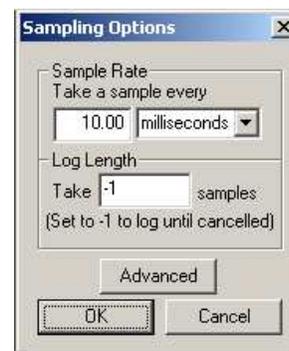
C.   **Graphing options** can be changed by clicking the "Advanced" button in the "Sampling Options" window. This window contains the following advanced graphing options:

1. **Pixels per sample** will spread the graph out and make details easier to read by raising this value. Its default value is 1.

2. **Sample skipping.** Computers with a slower processors may not be able to keep up with faster sample rates. As a result, it may be desirable to log samples at a fast rate (for later processing) and only graph every other sample. The default is to plot every sample logged on the graph.
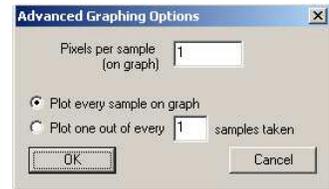
D. **Graph Ranges** (**minimum and maximum**) can be changed to any integer value to improve graphic resolution. The default range is 0-1000 for resistance, and 0-100 for reactance. The two ranges can be overridden by selecting "Graphing Options" from the "Logging" menu". Changing the range while logging is in progress will cause the graph to clear, but will not affect the values saved in the log file.
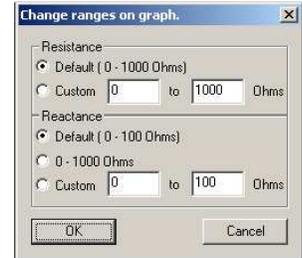
Streaming Samples. The "Sample and Graph" button instantly retrieves and graphs resistance and reactance data in real time. If log file is not open, a window will appear asking if the data is to be saved to a log file. Data retrieval will begin immediately after this window is closed. The sample period must be greater than the amount of time required to transmit a sample. If the sample period is too small to accommodate data transmission, a window will appear with the minimum allowable sample rate for accurate real time data retrieval.

When data is streaming from the Desktop, the "Sample and Graph" button is disabled, and the "Stop Sampling" button becomes active.

Logging will continue until one of three things happens:

1   The "Stop Sampling" button has been pressed.
2. The desired number of samples have been taken and saved to the log file (see part D.)
3. The application is closed

In all cases, when logging has finished, the log file will be closed and be marked with the date and time at when it was completed.

Log File Format generated by the data logger application are standard comma-separated files. (*.csv) The first line in the file contains the timestamp of when the first sample was taken. The second line specifies what the sample period is. The last line contains the timestamp when the log file was closed.

The remaining lines have the following format:
>   **Column A:** sequential record ID number.
>   **Column B:** Resistance Value (0.1 ohms).
>   **Column C:** Reactance Value (0.1 ohms).

III. Stand Alone or Autonomous Mode

The Quantum II Desktop may contain an optional real time BIA logging application that does not require a PC or computer to acquire real time data. This reduces the nuisance of cables and computers in space critical areas. BIA data logging functions can be set-up with the miniature PS/2 keyboard or from the Data Logger application. Once the Desktop is set to acquire real time data, it can continue to run without any interaction from the operator, PC or keyboard. BIA data, including a time stamp, is saved in the safe internal battery backed memory. Once an experiment or observation is recorded, the instrument is moved to a PC so that the results can be downloaded in a spreadsheet format (csv) fi le. See manual on stand alone data logging.

The Autonomous Logging window functions.

The autonomous Logging window can only be selected from the Logging menu bar when it is highlighted in black. This requires that the serial port be confi gured properly and the open/close port button be pressed to open the serial port. (See section I)
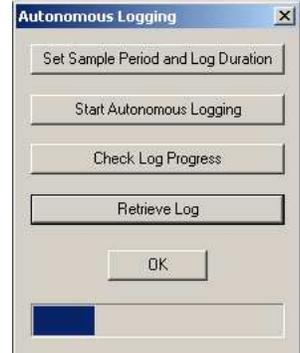
1. **Start a batched log** by setting the same parameters (sampling time and log length) for download-ing to the Desktop for stand alone operation (emulate the keyboard). Once the Desktop is set-up then the "Start Autonomous Logging" button can be pressed to begin stand alone real time data logging. The number of actual samples taken can be observed on *page* 5 using the *paging* buttons on the front panel of the Desktop. *Page* 4 does not reflect the sampling time or the log length download from the PC. Pressing the "Check Log Progress" simply states that logging is still in progress or stopped. Logging can be restarted by clicking the "Start Autonomous Logging" button again, which will reset the Desktop record number to zero and start logging over. However, there isn't any way to stop logging except by turning the Desktop off with the front panel off button. When taking samples over a long period of time, the PC may no longer be required and can be removed from the serial port.

2. **Retrieve the logged data** by clicking the "Retrieve log" button to begin downloading the saved real time data from the Desktop. A log fi le must be opened to retrieve data from the Desktop. If a log fi le is not opened a prompt will appear to open one. Once the data begins to download, a progress bar at the bottom of the window will indicate the status of the retrieved real time records (data). When the entire log (real time data) has been downloaded, the log fi le will automatically close. A pop-up window will appear that indicates the download is complete.

The autonomous logging time stamp is not the same as the record ID discussed in section II. The fi rst column of a batched log fi le represents the number of timer "ticks" passed since logging was started. A tick is almost, but not quite, equal to one millisec-ond. To convert from ticks to milliseconds, multiply this number by 1.024. Divide the number of milliseconds by 1000 to get sec-onds. Divide again by 60 to get minutes, etc.

	A	B	C	D
1	Logging Began: Mon May 23 09:14:37 2005			
2	Taking a sample every: 2000 milliseconds.			
3	1953	501.8	2.5	
4	3906	501.8	2.5	
5	5859	502	2.6	
6	7812	502.1	2.4	
7	9765	502	2.5	
8	Logging Finished: Mon May 23 09:14:48 2005			

Exiting From the Application by clicking on the "X" button in the upper-right corner, or select "Exit" from the "File" menu.