

Vernier LabPro®

User's Manual

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Introduction

The Vernier LabPro[®] is a versatile data collection interface that can be used to collect data in a variety of ways in the classroom or in the field. It can be used with a computer, TI graphing calculator, Palm[™] and Visor[™] handheld¹, or as a stand-alone data logger. More than forty sensors are available, including an Oxygen Gas Sensor, Relative Humidity Sensor, pH Sensor, Ion Selective Electrodes, Motion Detector, Accelerometers, etc.

By following this guidebook, you will learn to

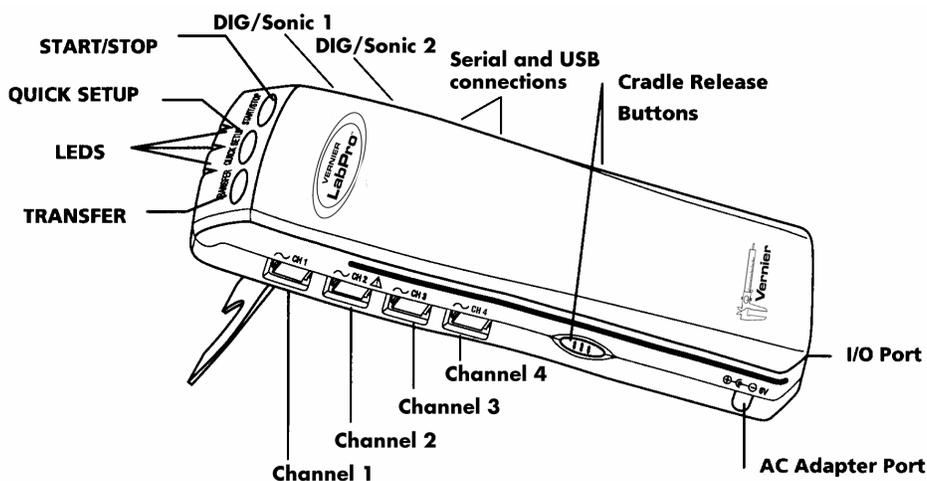
- Set up and collect data with a Macintosh[™] or Windows[™] computer through either the serial or USB port.
- Set up and collect data with a TI-73, TI-73 Explorer, TI-82, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, TI-84 Plus Silver Edition, TI-86, TI-89, TI-89 Titanium, TI-92, TI-92 Plus, or Voyage 200 Texas Instruments graphing calculator.
- Use LabPro as a stand-alone data logger, and then retrieve data with a computer or a TI graphing calculator.

LabPro Components

The LabPro package contains all the parts you need to connect LabPro to a computer or TI graphing calculator. Those parts include

- LabPro interface
- User's Manual
- PC serial cable
- Macintosh adapter for serial cable
- USB cable
- Voltage Probe
- 6-volt AC power supply
- TI graphing calculator cradle (off white) for the TI-84 Plus, TI-84 Plus Silver Edition, TI-89 Titanium
- TI graphing calculator cradle (translucent blue green) for the TI-73, TI-73 Explorer, TI-82, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-86, TI-89.
- 17" and short calculator-to-calculator link cables

The LabPro interface has three buttons, three LEDs, four analog channels (CH 1, CH 2, CH 3, and CH 4), two digital channels (DIG/SONIC 1 and DIG/SONIC 2), a serial computer connection, a USB computer connection, a piezo speaker, and a calculator I/O port.



¹The Vernier Palm Handheld Data Collection Packages (order code DP-LP, DP-UP, DP-VP, and DP-DANA) allow LabPro to work with the most popular Palm and Visor handhelds, and the Dana by AlphaSmart. For details, see www.vernier.com.

Buttons

The three buttons on the top of LabPro are used for the following purposes:

- TRANSFER begins transfer of calculator programs or applications (apps) between LabPro and an attached TI graphing calculator.
- QUICK SET-UP clears any data stored in LabPro's memory, then polls all channels for auto-ID sensors and sets them up to collect data. QUICK SET-UP is used when neither a computer nor a calculator is attached to LabPro and works only with auto-ID sensors.
- START/STOP begins sampling for Quick Set-Up. Sampling continues until the default number of samples is collected or you press START/STOP again. This button also acts as a manual trigger for certain data-collection modes.

Lights

LabPro has three lights that indicate the LabPro status.

- Red indicates an error condition.
- Yellow indicates that LabPro is ready to collect data samples.
- Green indicates LabPro is collecting data.

Beeps

LabPro has a piezo speaker that makes four kinds of sounds or “beeps.” Appendix B contains a complete description of the conditions that cause these sounds.

- A “good” beep is a medium tone followed by a high tone.
- A “caution” beep is a medium tone followed by another medium tone.
- A “bad” beep is a medium tone followed by a low tone.
- A “tick” sound is made when a key is pressed.

Providing Power to LabPro

Batteries or AC power can power LabPro. To use LabPro with batteries, remove the battery compartment cover from the underside of the interface. Insert four AA batteries and replace the compartment cover. To use LabPro with the AC power supply, plug the round plug on the 6-volt power supply into the side of the interface. Shortly after inserting four AA batteries or plugging the power supply into the outlet, the interface will run through a self-test. You will hear a series of beeps and blinking lights (red, yellow, then green) indicating a successful power up. If the self-test is not successful, make sure that the batteries are installed correctly, and that they are still useable.

Connecting Sensors

Sensors can be divided into two basic types—analogue and digital. Examples of analogue sensors are Temperature Probes, pH Sensors, Force Sensors, Oxygen Gas Sensors, etc. Up to four analogue sensors can be connected to LabPro. Four jacks for the analogue sensors (CH1-CH4) are located on the same side as the AC Adapter Port. The analogue ports accept British Telecom-style plugs with a right-hand connector.

Examples of digital sensors are Motion Detectors, Radiation Monitors, Photogates, and Rotary Motion Sensors. Up to two digital sensors can be connected to LabPro. The digital ports (DIG/SONIC), which accept British Telecom-style plugs with a left-hand connector, are located on the same side as the serial and USB computer connections.

Connect the sensor to the appropriate port. An important feature of LabPro is its ability to detect auto-ID sensors, and automatically set up an experiment. If you are not using sensors with the auto-ID ability, you can easily set them up with the experiments provided with the Logger *Pro*[®] software.

Using LabPro with a Computer

This section provides the basics for collecting data with LabPro on a Macintosh or Windows computer. All you have to do is connect LabPro, install the software, attach one or more sensors, start the *Logger Pro* software, and you are ready to collect data.

Computer and Software Requirements

To use LabPro on a computer, you will need *Logger Pro* software² running on a Power Macintosh or Pentium or compatible PC. Check the *Logger Pro* software for system requirements.

Before you continue, check to see that *Logger Pro* is installed on your computer. If not, now would be a good time to install it. The *Logger Pro Quick Reference Guide* describes the software installation.

Attaching LabPro to a Computer

The LabPro computer connection is located on the right side of the interface. The sliding door found there can be moved left to reveal the serial port or to the right to reveal the USB port.



Serial Port and Digital Channels (USB Port is behind the sliding door)

Serial Connection to a Macintosh Computer

Attach the rectangular end of the Macintosh serial adapter to the PC serial cable. Plug the round end of the Macintosh serial adapter into the computer's modem or printer port. Slide the door on the computer connection to the left and plug the other end of the serial cable into the serial connection on LabPro.

USB Connection to a Macintosh Computer

Slide the door on the computer connection to the right and plug the square end of the USB cable into the LabPro USB connection. Plug the other end of the USB cable into the USB port on the Macintosh computer.

Serial Connection to a PC

Slide the door on the computer connection to the left and plug the round mini-DIN end of the PC serial cable into the serial connection on LabPro. Plug the other end of the serial cable into the serial port on the computer.

USB Connection to a PC

Slide the door on the computer connection to the right and plug the square end of the USB cable into the LabPro USB connection. Plug the other end of the USB cable into the USB port on the PC.

² *Logger Pro 3* supports Windows 98 and newer. For Win 95 users, we recommend LP 2.2.1. *Logger Pro 3* supports Mac OS 9.2, and Mac OS 10.2 or newer. For older Mac operating systems, we recommend *Logger Pro 2.2.1*.

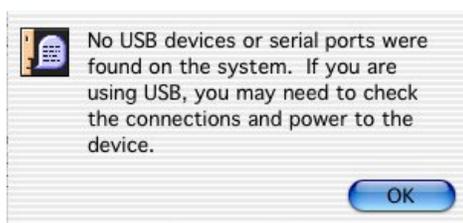
Starting Logger Pro Software and Preparing to Collect Data

Locate the Logger Pro icon on your computer and double-click on it, or use the Start menu (Windows 95/98/2000/NT/ME/XP). An important feature of LabPro is its ability to detect auto-ID sensors, and automatically set up an experiment.³

If Logger Pro does not detect your LabPro and/or a sensor is not connected, the Collect button will be faded . Make certain that you either LabPro, Go! Link, Go! Temp, or an Ohaus balance connected to a serial or USB port of your computer and that it has power. Choose Connect Interface from the Experiment menu. The computer will attempt to communicate with LabPro. If you see the following message⁴, then Logger Pro is having trouble communicating with LabPro. Select the correct port or check your current port and click OK. If this does not work, consult Appendix A.

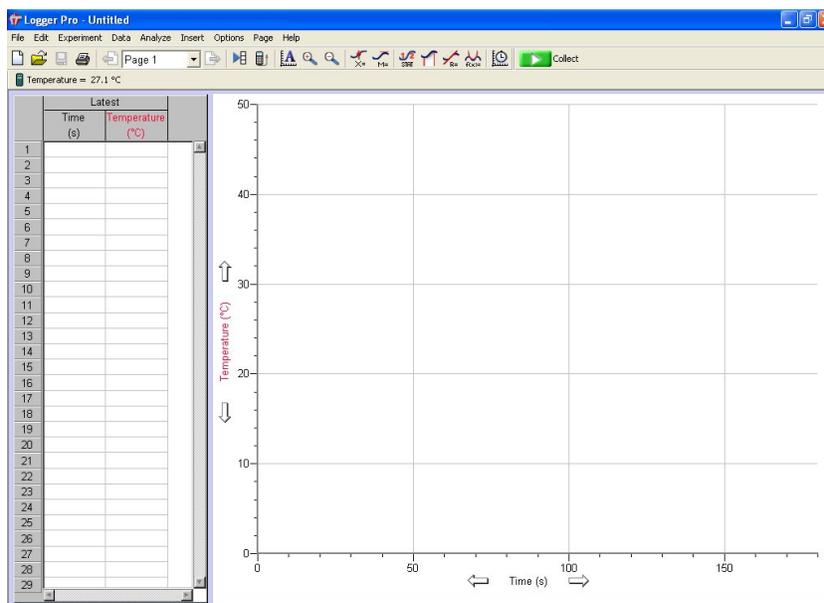


Windows Setup Interface Dialog Box



Mac Setup Interface Dialog Box

If you have connected a Stainless-Steel Temperature Probe and the computer has detected the LabPro interface, for example, you will see the following screen, which shows a graph of Temperature vs. Time along with the current reading at the top.



Notice how the program automatically identified the temperature probe (an auto-ID sensor). The current temperature reading is displayed in the status bar at the top of the screen. The default data collection mode is time graph. In this example, you have a Temperature Probe, reading in Celsius, and collecting data as a function of time for 120 seconds. If you now disconnect the Temperature Probe, connect a different auto-ID sensor, and choose New from the File menu, Logger Pro will set up a new experiment for the new sensor.

³ Logger Pro software contains experiment files for all Vernier lab manuals

⁴ The dialog boxes and screen displayed are from Logger Pro 3. Logger Pro 2 dialog boxes are different.

You are now ready to collect data. The next section is a tutorial that uses our Stainless-Steel Temperature probe to investigate the response time of the temperature probe.

Where to Go Next

Since you may want experiments for a particular course, or detailed information on LabPro or Logger *Pro*, the following manuals provide additional help. They are described in Appendix C. Logger *Pro* tutorials are a great way to get acquainted with LabPro.

Lab Books

Physical Science with Computers
Biology with Computers
Chemistry with Computers
Advanced Chemistry with Vernier
Physics with Computers
Earth Science with Computers
Real-World Math with Computers
Water Quality with Computers
Middle School Science with Computers
Nuclear Radiation with Computers

Manuals

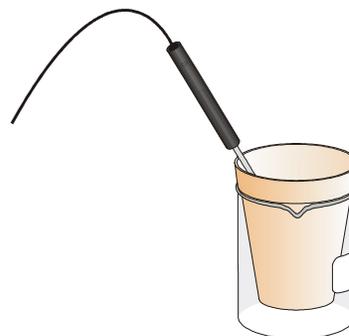
Logger Pro Online Help
Logger Pro Online Tutorials
LabPro Technical Reference Manual

Tutorial: Temperature Measurement with Logger Pro

A good way to get acquainted with LabPro is by performing a simple experiment. Using this tutorial, you will take measurements using a temperature sensor. Follow the simple steps and you are well on your way to collecting and analyzing data with a computer.

MATERIALS

Power Macintosh or Windows PC
LabPro interface
Vernier Stainless-Steel Temperature Probe
One 250-mL beaker or cup
100 mL hot water



PROCEDURE

1. Place about 100 mL of hot water into a 250-mL beaker or a cup.
2. Plug the Stainless-Steel Temperature Probe into channel CH 1 on LabPro, and lay the temperature probe on the tabletop.
3. Start the *Logger Pro* software. *Logger Pro* will detect the auto-ID sensor, set the data collection parameters, and computer display. In this case, collection parameters are 1.0 sample per second and 120 samples. The program displays a graph and data table on the computer. The vertical axis of the graph will have temperature scaled from 0 to 100°C. The horizontal axis will have time scaled from 0 to 120 seconds. You are ready to collect data.
4. Click  to begin data collection.
5. Wait about 10 seconds and place the Temperature Probe into the cup of hot water, as shown above. Allow *Logger Pro* to complete data collection.
6. Notice that the sensor does not read the new temperature instantly; it takes a moment to respond.
7. Now that the run is complete, pull down the Analyze menu and choose Examine. The cursor will become a vertical line. As you move the cursor across the screen, temperature and time values corresponding to the cursor position will be displayed. Move the cursor to the point when the probe was first placed in the hot water. Record that time. Move the cursor to find the highest temperature, and record that time. How long did it take for the temperature sensor to stabilize at the water's temperature?

This tutorial is an example of how easy it is to collect and analyze data with LabPro and a computer. The auto-ID Stainless-Steel Temperature Probe simplified the experiment setup, but the use of non auto-ID sensors is almost as easy. All you have to do is connect the sensor or sensors, and open up an appropriate experiment file. *Logger Pro* software has over 500 experiment files. This set of files is also includes experiments in our lab books.

Using LabPro with a Calculator

This section provides the basic steps for collecting data with LabPro and a Texas Instruments graphing calculator. All you have to do is connect the hardware pieces to the calculator, attach one or more sensors, start the DataMate calculator program, and you are ready to collect data.⁵



LabPro Interface, TI-83 Plus Calculator, and Stainless-Steel Temperature Probe

Calculator Requirements

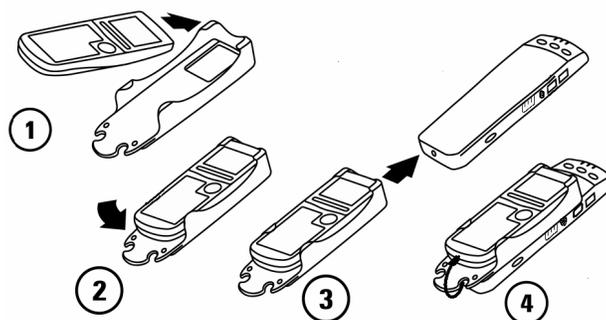
LabPro can be used with any of these TI graphing calculators:

- TI-73, TI-73 Explorer
- TI-82
- TI-83
- TI-83 Plus, TI-83 Plus Silver Edition
- TI-84 Plus, TI-84 Plus Silver Edition
- TI-86
- TI-89
- TI-89 Titanium
- TI-92
- TI-92 Plus
- Voyage 200

Connecting the Equipment

The first step is to connect the calculator and LabPro.

1. Select the proper cradle for your calculator. The off-white cradle accommodates the TI-84 and TI-89 Titanium calculators. The translucent blue green cradle accommodates all other calculators except for the TI-92, TI-92 Plus, and Voyage 200.
2. Insert the upper end of the calculator into the cradle.
3. Press down on the lower end of the calculator until it snaps into place.
4. Slide the bottom of the cradle onto the top of LabPro until it clicks in place.
5. Plug one end of the LabPro-to-calculator cable into the I/O port of the calculator. Plug the other end into the bottom end of the LabPro.



⁵ The DataMate program supports all of the Vernier analog sensors, e.g. temperature, pH, force, drop counters, and the Motion Detector. Calculator support for photogates, radiation counters, rotary motion sensors, and drop counters is through separate programs. See the Beyond DataMate manual for details.

Calculator Program Installation

When it is time to collect data, you will run a program called DataMate on the calculator. Chances are that DataMate is not on your calculator, but it is very easy to install.

1. Prepare the calculator to receive the program:
 - For the TI-73, TI-73 Explorer, TI-82, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, and TI-84 Plus Silver Edition turn on your calculator and press $\boxed{2^{nd}}$ [LINK] (on the TI-73 press \boxed{APPS} , then select Link...). Press $\boxed{\blacktriangleright}$ to RECEIVE, then press \boxed{ENTER} (Waiting... appears on your screen).
 - For the TI-86, turn on your calculator and press $\boxed{2^{nd}}$ [LINK], then press $\boxed{F2}$ (Waiting... appears on your screen).
 - For the TI-89, TI-89 Titanium, TI-92, TI-92 Plus, and Voyage 200, turn on your calculator and make sure that the calculator is on the Home screen. (You do not need to put the calculator into the Receiving mode as is required with the other calculators.)
2. Press the Transfer button on LabPro. "Receiving..." followed by a list of the loaded programs (or application) is displayed on the calculator.
3. A "Done" message on the calculator and two beeps from LabPro will indicate the transfer is complete. Press $\boxed{2^{nd}}$ [QUIT].
4. Verify that the programs have been successfully loaded.
 - On the TI-82, TI-83, press \boxed{PRGM} to see DATAMATE and its subprograms.
 - On the TI-73, TI-73 Explorer, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, and TI-84 Plus Silver Edition press \boxed{APPS} to see DATAMATE.
 - On the TI-86, press \boxed{PRGM} then $\boxed{F1}$ to see DATAMATE and its subprograms.
 - On the TI-89, TI-89 Titanium, TI-92, TI-92 Plus, and Voyage 200, press $\boxed{2^{nd}}$ [VAR-LINK] to see DATAMATE and its subprograms.

Starting the DataMate Program and Preparing to Collect Data

Use the following steps to start the DataMate program on your calculator:

TI-82, and TI-83 Calculators:

Press \boxed{PRGM} , then press the calculator key for the number that precedes DATAMATE (usually $\boxed{1}$). Press \boxed{ENTER} . An introductory screen will appear, followed by the main screen.

TI-73, TI-73 Explorer, TI-83 Plus, TI-83 Plus Silver Edition, TI-84 Plus, and TI-84 Plus Silver Edition Calculators:

Press \boxed{APPS} , then press the calculator key for the number that precedes DATAMATE. Press \boxed{ENTER} . An introductory screen will appear, followed by the main screen.



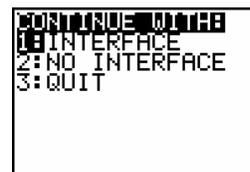
TI-86 Calculators:

Press **[PRGM]**, press **[F1]** to select < NAMES >, and press the menu key that represents DataMate. (< DATAM > is usually **[F1]**). Press **[ENTER]**, and wait for the main screen to load.

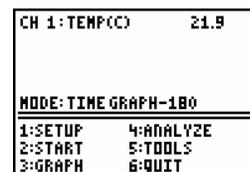
TI-89, TI-89 Titanium, TI-92, TI-92 Plus, and Voyage 200 Calculators:

Press **[2nd]** **[VAR-LINK]**. Use the cursor pad to scroll down to “datamate”, then press **[ENTER]**. Press **[)]** to complete the open parenthesis of “datamate(” on the entry line. Press **[ENTER]**. An introductory screen will appear, followed by the main screen.

After the program begins, the calculator will try to communicate with the interface and check for auto-ID sensors. If this communication is successful, the main screen (shown below) will appear. If the calculator cannot establish a link with LabPro, this menu appears. If you choose Continue With Interface, the program will continue trying to communicate with the interface. If the calculator cannot establish a link with LabPro, a Link Error message will appear. Check that LabPro has power and that the link cable is properly connected. This message will continue to appear until the link problem is fixed.



This is the main screen that appears after the calculator and interface are communicating. In this example a Stainless-Steel Temperature Probe was connected and DataMate automatically identified the Temperature Probe, displayed the channel it was connected to and the current reading. DataMate also sets up a default time graph experiment for auto-ID sensors. In this example, an experiment was set up to collect data for 180 seconds.



You are now ready to collect data. The next section is a tutorial that uses our Stainless-Steel Temperature Probe to investigate the response time of the Temperature Probe.

Where to Go Next

Since you may want experiments for a particular course, or detailed information on LabPro or Logger *Pro*, the following manuals provide additional help. They are described in Appendix C. Logger *Pro* tutorials are a great way to get acquainted with LabPro.

Lab Books

Physical Science with Calculators
Biology with Calculators
Chemistry with Calculators
Advanced Chemistry with Vernier
Physics with Calculators
Real-World Math with CBL 2 and LabPro
Water Quality with Calculators
Earth Science with Calculators
Middle School Science with Calculators
Nuclear Radiation with Computers and Calculators

Manuals

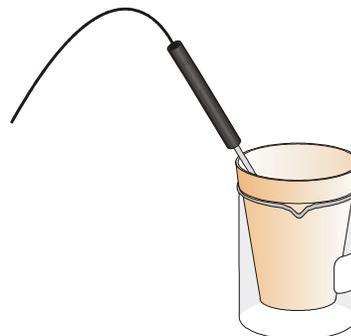
DataMate Guidebook
Beyond DataMate manual
LabPro Technical Reference Manual

Tutorial: Temperature Measurement with DataMate

A good way to acquaint yourself with LabPro is by performing a simple experiment. Using this tutorial you will take measurements using a Temperature Probe. Just follow the simple steps, and you are well on your way to collecting and analyzing data with a calculator.

MATERIALS

TI graphing calculator
LabPro interface
Vernier Stainless-Steel Temperature Probe
One 250-mL beaker or cup
100 mL hot water



PROCEDURE

1. Place about 100 mL of hot water into a 250-mL beaker or a cup.
2. Plug the Stainless-Steel Temperature Probe into channel CH 1 on LabPro, and lay the Temperature Probe on the tabletop.
3. Start the DataMate program. Press **CLEAR** to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading. The experiment will collect temperature for 180 seconds.
4. Select START to begin data collection.
5. Wait about 10 seconds and place the Temperature Sensor into the cup of hot water as shown above. A live graph will appear on the calculator screen. You can either allow DataMate to complete data collection or press the **STO▶** key to stop data collection.
6. After the data collection is complete, an autoscaled graph of the data will appear. Notice that the probe does not read the new temperature instantly; it takes a little while to respond. This is a characteristic of the sensor. Use the **▶** or **◀** keys (or the cursor pad on the TI-89, TI-89 Titanium, TI-92, TI-92 Plus, or Voyage 200) to examine the data points along the displayed curve of temperature vs. time. As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed below the graph. Move the cursor to the point when the probe was first placed in the hot water. Record that time. Move the cursor to find the highest temperature and record that time. How long did it take for the temperature sensor to stabilize at the water's temperature?

This tutorial is an example of how easy it is to collect and analyze data with LabPro and a TI graphing calculator. The auto-ID Stainless-Steel Temperature Probe simplified the experiment setup, but the use of non auto-ID sensors is easy too. All you have to do is select SETUP on the main screen of DataMate. This will take you to the Setup screen. From here you can set up non auto-ID sensors and make changes to the data collection mode. Complete details on these procedures can be found in the *DataMate Guidebook*.

Full sets of experiments are available in our lab manuals.

Using LabPro Remotely

Having a computer or calculator attached to LabPro during data collection is preferable, because it provides much more flexibility in your data collection and provides a screen for immediate feedback of your results. There are times, however, when disconnecting LabPro from the computer or calculator to collect data is useful. For example, remote data collection is perfect for gathering acceleration data on a roller coaster. The following describes remote data collection with Logger Pro 3 and Logger Pro 2 on a computer and with DataMate on a calculator.

Using Logger Pro 3

Note: If you are running a version of Logger Pro 3 older than 3.3, then refer to the program's Help file.

Quick Setup Method

Using the Quick Setup Method, you can collect data with LabPro, then retrieve it using a computer running Logger Pro. This method will work only with auto-ID sensors, and it will collect 99 points for each sensor.

1. Set up LabPro for remote data collection
 - a. Put fresh batteries in the LabPro.
 - b. Connect your autoID sensor(s) to LabPro.
 - c. Press the QUICK SETUP button. A flash of the yellow LED and two beeps will verify setup.
2. Collect data.
 - a. When you are ready to collect data, press the START/STOP button. You will hear a beep indicating that data collection has begun. The green LED will blink each time a reading is made.
 - b. When data collection is completed, the green LED will no longer blink.⁶ You do not need to press the START/STOP button to end data collection. (You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.)
3. Retrieve the data.
 - a. When data collection is finished, go to the computer and attach the interface.
 - b. Start Logger Pro.
 - c. If a Remote Data Available window appears, simply click the YES button and choose to retrieve remote data into the current file. If a window does not appear when the interface is reconnected, choose Remote ► Retrieve Remote Data from the Experiment menu.
 - d. Click to retrieve data into the LabPro Remote data set. You may want to rename the time and data columns after the data are retrieved.

Set Up for Time-Based Method

Using the Set Up for Time Based Method, you will use a computer to set up LabPro, detach it for a real time data collection, and then reattach it to the computer to retrieve the data. This gives you more flexibility than the Quick Setup Method. With this method, you can (a) use any sensors (not just auto-ID), (b) control the time between samples, and (c) control the number of data points collected (up to about 12,000).

1. Set up LabPro for remote data collection.

⁶ The duration of data collection depends on the sensor(s) connected.

- a. Put fresh batteries in the LabPro.
 - b. Set up the sensors, LabPro, and Logger *Pro* just as you normally would to collect data in Time Based mode.
 - c. Instead of clicking the  button, choose Remote ► Remote Setup from the Experiment menu.⁷ A summary of your setup will be displayed.
 - d. Click to prepare the LabPro.
 - e. Disconnect the LabPro from the computer.
 - f. If it has not already been saved, save the experiment file so it can be used to later retrieve the data from LabPro.
2. Collect data.
 - a. When you are ready to collect data, press the START/STOP button.
 - b. When data collection is complete, the yellow LED will flash briefly. You can also stop data collection early by pressing the START/STOP button before data collection is finished.
 3. Retrieve the data.
 - a. Start Logger *Pro* if it is not already running. Choose Continue Without Interface in the Connect LabPro dialog and click .
 - b. Open the experiment file used to set up LabPro.
 - c. Attach LabPro to the computer.
 - d. If a Remote Data Available window appears, click the YES button. Click, which accepts the default to retrieve remote data into the current file. If a window does not appear when the interface is reconnected, choose Remote ► Retrieve Remote Data from the Experiment menu and follow the on-screen instructions.
 - e. The data will be retrieved.

Set Up for Selected Events Method

Using the Set Up for Selected Events Method, you will use a computer to set up LabPro, detach it to collect individual data points, and then reattach it to retrieve the data. With this method, you can use any sensors (not just auto-ID), and collect individual data points whenever you press the START/STOP button.

1. Set up LabPro for remote data collection
 - a. Put fresh batteries in the LabPro.
 - b. Set up the sensors, LabPro, and Logger *Pro* just as you normally would to collect data using the Selected Event mode.
 - c. Instead of clicking the  button, choose Remote ► Remote Setup from the Experiment menu. A summary of your setup will be displayed.
 - d. Click to prepare the LabPro.
 - e. Disconnect the LabPro from the computer.
 - f. If it has not already been saved, save the experiment file so it can be used to later retrieve the data from LabPro.
2. Collect data. Every time you press the START/STOP button, LabPro will collect one data point. The green LED will remain on and the yellow LED will flash with each reading. Repeat as often as you want, for up to 99 readings.

⁷ Sensors that require a warm-up time may have additional on-screen instructions.

3. Retrieve the data.
 - a. Start *Logger Pro* if it is not already running. Choose Continue Without Interface in the Connect LabPro dialog and click .
 - b. Open the experiment file used to set up LabPro.
 - c. Attach LabPro to the computer.
 - d. If a Remote Data Available window appears, click the YES button. Click, which accepts the default to retrieve remote data into the current file. If a window does not appear when the interface is reconnected, choose Remote ► Retrieve Remote Data from the Experiment menu and follow the on-screen instructions.
 - e. The data will be retrieved.

Using Logger Pro 2

Quick Setup Method

The Quick Setup feature is very simple:

1. Set up LabPro for remote data collection.
 - a. Connect your auto-ID sensor(s) to LabPro. (Sensors that are not auto-ID cannot be used with this method. The next two methods allow you to use auto-ID and/or non auto-ID sensors.)
 - b. Press the QUICK SETUP button. The yellow LED will blink twice and two beeps will be heard verifying setup.
2. Collect data.
 - a. When you are ready to collect data, press the START/STOP button. The green LED will flash during data collection.
 - b. When data collection is complete, the green LED will stop blinking.⁸ You do not need to press the START/STOP button to end data collection. (You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.)
3. Retrieve the data.
 - a. Start *Logger Pro* (if it is not already running).
 - b. Select Retrieve Data from LabPro from the Remote menu.
 - c. Connect LabPro to the computer.
 - d. The data will be transferred from LabPro into *Logger Pro*. The labels and the units in the column headings and on the graph may need to be changed to match the sensor.

Set Up for Time-Based Data Collection

Using the Setup for Real-Time Collect Method, you will use a computer to set up LabPro, detach it for a real-time data collection, and then reattach it to the computer to retrieve the data. This gives you more flexibility than the Quick Setup Method. With this method, you can (a) use any sensors (not just auto-ID), (b) control the time between samples, and (c) control the number of data points collected (up to 12,000).

1. Set up LabPro for remote data collection.
 - a. Set up the sensors, LabPro, and *Logger Pro* just as you normally would to collect data in Real-Time Collect mode.
 - b. Be sure to save this setup in an experiment file.

⁸ The duration of data collection will vary from sensor to sensor.

- c. Instead of clicking the  button, select Remote→Remote Setup from the Experiment menu.
 - d. Click the Setup button. The yellow LED on LabPro will come on, indicating that it is ready to collect data.
 - e. Disconnect LabPro from the computer. Exit the Logger *Pro* program.
2. Collect data.
 - a. When you are ready to collect data, press the START/STOP button. The green LED will flash each time a reading is made.
 - b. When data collection is complete, the green LED will stop blinking. You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.
3. Retrieve the data.
 - a. Connect LabPro to a computer.
 - b. Start the Logger *Pro* software.
 - c. Click the Open Experiment button, and open the experiment file you used in setting up the remote experiment.
 - d. A dialog box labeled “LabPro Has Data” will appear. Click the Retrieve Data button on the dialog box. (If this dialog box does not appear, select Remote→Retrieve Remote Data from the Experiment menu.)
 - e. The data will be transferred from LabPro into Logger *Pro*.

Set Up for Selected-Events Data Collection

Using the Setup for Selected Events Method, you will use a computer to set up LabPro, detach it to collect individual data points, then reattach it to retrieve the data. With this method, you can use any sensors (not just auto-ID), and collect individual data points whenever you press the START/STOP button.

1. Set up LabPro for remote data collection
 - a. Set up the sensors, LabPro, and Logger *Pro* just as you normally would to collect data using the Selected Events mode.
 - b. Be sure to save this setup in an experiment file.
 - c. Instead of clicking the  button, select Remote→Remote Setup from the Experiment menu.
 - d. Click the Setup button. The yellow LED on LabPro will come on, indicating that it is ready to collect data.
 - e. Disconnect LabPro from the computer. Exit the Logger *Pro* program.
2. Collect data.
 - a. Every time you press the START/STOP button, LabPro will collect one data point. Up to 99 data points can be collected.
3. Retrieve the data.
 - a. Connect LabPro to a computer.
 - b. Start the Logger *Pro* software.
 - c. Click the Open Experiment button, and open the experiment file you used in setting up the remote experiment.
 - d. A dialog box labeled “LabPro Has Data” will appear. Click the Retrieve Data button on the dialog box. (If this dialog box does not appear, select Remote→Retrieve Remote Data from the Experiment menu).
 - e. The data will be transferred from LabPro into Logger *Pro*.

Remote Data Collection with DataMate

Quick Setup Method

The Quick Setup feature is very simple:

1. Set up LabPro for remote data collection.
 - c. Connect your auto-ID sensor(s) to LabPro. (Sensors that are not auto-ID cannot be used with this method. The next two methods allow you to use auto-ID and/or non auto-ID sensors.)
 - d. Press the QUICK SETUP button. The yellow LED will blink twice and two beeps will be heard verifying setup.
2. Collect data.
 - c. When you are ready to collect data, press the START/STOP button. The green LED will flash during data collection.
 - d. When data collection is complete, the green LED will stop blinking.⁹ You do not need to press the START/STOP button to end data collection. (You can, however, stop data collection early by pressing the START/STOP button before data collection is finished.)
3. Retrieve the data.
 - a. You can retrieve the data by connecting the interface to a TI graphing calculator and starting DataMate. A message will appear stating “DATA COLLECTION IS DONE. . .”
 - b. Press to proceed to the main screen.
 - c. Select TOOLS from the main screen.
 - d. Select RETREIVE DATA from the TOOLS menu. The data will be retrieved and one or more graphs made available.

Set Up for Time-Based Data Collection

This method gives you more control of the data collection than the Quick Setup method, because you have control of which sensors and what data collection sample interval will be used. This is how it works:

1. Attach one or more sensors to LabPro. These sensors can be auto-ID or non auto-ID sensors.
2. Start the DataMate program. The program will detect auto-ID sensors. Non auto-ID sensors can be set up manually. (Refer to the *DataMate Guidebook* for help.)
 - a. Select SETUP from the main screen.
 - b. Press to select MODE and press .
 - c. Select TIME GRAPH from the SELECT MODE menu.
 - d. Select CHANGE TIME SETTINGS from the TIME GRAPH SETTINGS menu to set the data collection rate.
 - e. Enter the time between samples in seconds (remember to finish your entry with).
 - f. Enter the number of samples.
3. Set up the interface for manual triggering.
 - a. Select ADVANCED from TIME GRAPH SETTINGS.
 - b. Select CHANGE TRIGGERING from ADV. TIME GRAPH SETTINGS.
 - c. Select MANUAL from SELECT TRIGGERING.

⁹ The duration of data collection will vary from sensor to sensor.

- d. Select OK three times to return to the main screen.
4. Select START to prepare LabPro for data-collection. The yellow light will come on, two beeps will be made, and a message will appear stating that remote data collection has been set up.
5. Press **ENTER** to return to the main screen and choose Quit.
6. Disconnect LabPro from the calculator. To start data collection, press the START/STOP button on LabPro. The yellow light will go off and the green light will blink during data collection.
7. When the green LED stops blinking and data collection is done, attach LabPro to the same calculator and start the DataMate program. The program will detect that data has been collected by LabPro and will display a message about retrieving the data. Press **ENTER** on the calculator. On the main screen, select TOOLS, and then select RETRIEVE DATA on the TOOLS menu. The data will be retrieved and one or more graphs made available.

Sensor Warm-up Times

Some sensors require a certain warm-up period before an accurate measurement can be taken. LabPro handles this automatically in remote modes by warming up each sensor for the appropriate amount of time. The Turbidity Sensor, for example, requires a 2-second warm-up period. The table below lists all sensors with warm-up times of 2 seconds or longer. If a sensor is not on this list, its warm-up time is negligible.

Sensor	Warm-up Time (s)
Ammonium Ion-Selective Electrode	2
Calcium Ion-Selective Electrode	2
Chloride Ion-Selective Electrode	2
CO ₂ Sensor	90
Colorimeter	300
Conductivity Probe	2
Dissolved Oxygen Probe	600
Dual-Range Force Sensor	2
Electrode Amplifier	30
Flow Rate Sensor	2
Force Plate	2
Nitrate Ion-Selective Electrode	2
Oxygen Gas Sensor	2
pH Sensor	30
Turbidity Sensor	2
UVA Sensor	2
UVB Sensor	2

The following sensors cannot be set up to collect remote data:

Digital Control Unit	Radiation Monitor
Drop Counter	Student Radiation Monitor
Heat Pulser	Rotary Motion Sensor
Photogate	

Using LabPro with a Palm Handheld

In addition to using LabPro with a computer, a calculator, or as a stand-alone device, LabPro can also be used to collect data with a Palm handheld. The Vernier Palm Handheld Data Collection Packages allow LabPro to work with the most popular Palm and Visor handhelds.



Each package includes the following:

- Data Pro software on CD
- Palm-to-LabPro cradle
- Palm-to-LabPro cable

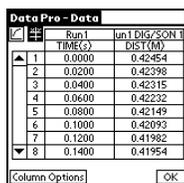
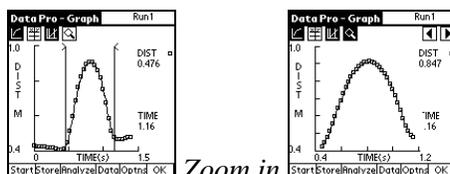
In short, load Data Pro software onto your Palm or Visor handheld, connect the handheld to your LabPro (with our Palm-to-LabPro cable and cradle), attach a Vernier sensor, and begin collecting data. For details, see <http://www.vernier.com/palm>.

Data Pro Software

- Supports more than 30 Vernier sensors using LabPro's analog and digital channels.
- Supports Vernier auto-ID sensors. Data Pro is able to identify the sensor, load calibrations, and assign labels and units.
- Using the Palm stylus, you can quickly navigate between the data table, graphs of data, and analysis tools, or zoom in on regions of data on graphs.

Supported Handheld Devices

- Palm handheld, Palm OS 3.3 or newer recommended:
 - m125, m130, m500, m515, m705
 - m100, m105, III, IIIe, IIIx, or IIIxe
 - Zire 71, Tungsten T/T2/C/W
- Visor-connector handheld: Visor, Titanium, Visor Neo, Visor Prism, Visor Pro
- Dana by AlphaSmart



Run 1	TIME (s)	DIST (m)
1	0.0000	0.42454
2	0.0200	0.42398
3	0.0400	0.42315
4	0.0600	0.42232
5	0.0800	0.42149
6	0.1000	0.42093
7	0.1200	0.41982
8	0.1400	0.41954

View your collected data in a data table

Appendix A: Troubleshooting Tips

Problem	Cause/Solution
<p>When LabPro is used with the computer the Logger <i>Pro 3</i> Collect button is faded (or the Logger <i>Pro 2</i> Collect button does not appear).</p>	<p>The Collect button does not appear because the computer could not communicate with the interface. Check each of the following:</p> <ul style="list-style-type: none"> • Make sure the cables are firmly attached. • Make sure LabPro is connected to the correct port on the computer. • Confirm that the port on the computer is working properly. • Make sure the interface has power—either AC or battery.
<p>When LabPro is used with a TI graphing calculator, I get a link error message</p>	<p>This message appears when the calculator cannot communicate with the interface. Check the following:</p> <ul style="list-style-type: none"> • Make sure the cables are firmly attached to the calculator and LabPro. • Make sure the interface has power—either AC or battery. • Note: To use the TI-83 Plus Silver Edition with LabPro you need to have the latest version of the Operating System on your Graphing Handheld. For the TI-83 Plus Silver Edition, you need to download version 1.15 or higher of the TI-83 Plus Operating System from http://education.ti.com
<p>The sensor is not working.</p>	<p>This may be happening because the sensor is not plugged into the correct port. Since LabPro has 4 analog and 2 digital ports, make sure that the sensor is connected to the proper port.</p>
<p>The readings are noisy.</p>	<p>LabPro may be picking up interference from other electrical devices, such as a computer. Move the LabPro interface at least 30 cm from another computer.</p>
<p>When LabPro is plugged into AC power, the lights and beeps are not generated.</p>	<p>When LabPro powers up, lights and beeps signal a successful self-test. If batteries are already installed in LabPro, the self-test will not be performed.</p>
<p>When connected to USB, a light can be seen blinking inside the interface.</p>	<p>This is normal operational when LabPro is used through a USB port.</p>

Appendix B: Beep Sequences

LabPro makes four kinds of sounds or “beeps.”

- A “good” beep is a medium tone followed by a high tone.
- A “caution” beep is a medium tone followed by another medium tone.
- A “bad” beep is two high tones.
- A “tick” sound is made when a key is pressed.

The following bullets explain when beep sequences occur and what the beep sequences mean:

- When LabPro completes initialization, you will hear the startup sequence: bad beep, caution beep, good beep (6 total beeps, plus LEDs light up in this order: red LED, yellow LED, and green LED)
- When you press the QUICK SETUP button:
 - the caution beep sounds if a sensor is attached to LabPro.
 - the bad beep sounds if no sensors are attached to LabPro.
- When LabPro is connected to a calculator during sampling commands:
 - the caution beep sounds when initializing data collection.
 - the caution beep sounds when starting data collection (transition from pre-store to store).
 - the caution beep sounds when completing data collection.

Note 1: If the sampling timing causes the beeps to run together, the LabPro software may not sound all the beeps.

Note 2: You will not get all the beeps when Fast Sampling is enabled.

Note 3: You will not get all the beeps when using triggering.

- When you set LabPro for manual trigger and press the START button, a caution beep sounds.
- When you press the TRANSFER button:
 - the good beep sounds when the transfer succeeds.
 - the bad beep sounds if the transfer fails for any reason.
- When an overcurrent condition is detected, five bad beeps sound. (This causes an error, which causes even more beeps to sound.)
- When LabPro begins a full self-test, three good beeps sound.
- When self-test completes:
 - the good beep sounds if self-test passes.
 - the bad beep sounds if self-test fails.
- When LabPro’s base code detects an error in the commands sent from the host, a bad beep sounds twice.
- When LabPro powers up:
 - two bad beeps sound if the base code is not loaded.
 - three bad beeps sound if the power-up self-test fails.
- During base code download, three bad beeps sound when any errors occur. (The unit resets and then the two bad beeps mentioned in the previous bullet sound.)

Appendix C: Support Materials for LabPro

Sensors

Sensor	Order Code
3-Axis Accelerometer	3D-BTA
25-g Accelerometer	ACC-BTA
Low-g Accelerometer	LGA-BTA
Barometer	BAR-BTA
CO ₂ Gas Sensor	C02-BTA
Colorimeter	COL-BTA
Conductivity Probe	CON-BTA
Current Probe	DCP-BTA
Differential Voltage Probe	DVP-BTA
Digital Control Unit	DCU-BTD
Dissolved Oxygen Probe	DO-BTA
Drop Counter	VDC-BTD
Dual-Range Force Sensor	DFS-BTA
EKG Sensor	EKG-BTA
Exercise Heart Rate Monitor	EHR-BTA
Extra Long Temperature Probe	TPL-BTA
Flow Rate Sensor	FLO-BTA
Force Plate	FP-BTA
Gas Pressure Sensor	GPS-BTA
Instrumentation Amplifier	INA-BTA
Ammonium Ion-Selective Electrode	NH4-BTA
Calcium Ion-Selective Electrode	CA-BTA
Chloride Ion-Selective Electrode	CL-BTA
Nitrate Ion-Selective Electrode	NO3-BTA
Light Sensor	LS-BTA
Magnetic Field Sensor	MG-BTA
Microphone	MCA-BTA
Motion Detector	MD-BTD
ORP (Oxidation-Reduction Potential) Electrode	ORP-BTA
O ₂ Gas Sensor	O2-BTA
pH Sensor	PH-BTA
Radiation Monitor	RM-BTD
Relative Humidity Sensor	RH-BTA
Respiration Monitor Belt (requires GPS-BTA)	RMB
Rotary Motion Sensor	RMS-BTD
Sound Level Meter	SLM-BTA
Stainless Steel Temperature Probe	TMP-BTA
Student Radiation Monitor	SRM-BTD
UV-A and UV-B Sensors	UVA/UVB-BTA
Turbidity Sensor	TRB-BTA
Thermocouple	TCA-BTA
Vernier Photogate	VPG-BTD
Voltage Probe	VP-BTA

Adapters for Older Sensors

Vernier sensors purchased prior to the introduction of LabPro can probably be adapted to work with LabPro. Most of our analog sensors were previously manufactured with a round, 5-pin “DIN” plug. If you have one of these older DIN sensors, you will need a DIN-to-BTA adapter (order code DIN-BTA, \$5). This chart shows some of the adapters or replacement cables that can be used with other sensors. You may have sensors that do not appear in this table. Contact us to discuss your situation.

Sensors Purchased Prior to 2000	Adapter or Cable	Order Code
Vernier Analog 5-pin DIN sensors	DIN to BTA adapter	DIN-BTA
Vernier Photogate (with removable cable)	Digital Photogate Cable	PG-BTD
Radiation Monitors	Radiation Cable	RAD-BTD
Motion Detector (with removable cable)	Motion Detector Cable	MDC-BTD
Motion Detector (without removable cable)	CBL-RJ11 Adapter	CBL-RJ11
Rotary Motion Sensor	Rotary Motion Adapter	ROT-BTD

Additional Manuals

There are a number of additional manuals that can help you use LabPro with a computer or calculator.

LabPro Technical Reference – The reference provides detailed information on the LabPro hardware and the software command structure. This manual is available free from our web site, www.vernier.com.

Logger Pro Tutorials – This manual provides an excellent introduction to the *Logger Pro* software. The tutorials show you how to collect data with a Temperature Probe and a Motion Detector. It also introduces you to the analysis features of the program.

Logger Pro User's Manual – This manual is a complete reference to the software. This manual and the *Logger Pro Tutorials* are a part of the *Logger Pro* package. The User's Manual can also be found on the *Logger Pro* software CD.

DataMate Guidebook – This guidebook provides a complete look at the DataMate calculator program. This manual can also be downloaded from our web site, www.vernier.com.

Lab Manuals - Lab manuals in physical science, biology, chemistry, advanced chemistry, earth science, physics and water quality enable you and your students to quickly begin using LabPro in the classroom and in the field. Each manual contains

- Ready-to-use student experiments.
- Teacher section for each experiment with complete directions, helpful hints, and sample graphs and data.
- Word processing files of the student sections on CD, so labs may be edited to your specifications.

Physical Science with Computers PSC-LP
Physical Science with Calculators PSCALC

Some of the experiments are

- Energy Content of Foods and Fuels
- Reflectivity of Light
- Acid Rain
- First-Class Levers and Pulleys
- Lemon “Juice”
- Graphing Your Motion

Biology with Computers BWC-LP
Biology with Calculators..... BWCALC

Some of the experiments are

- Diffusion through Membranes
- Transpiration
- Biological Membranes
- Cellular Respiration
- Photosynthesis
- Watershed Testing

Chemistry with Computers CWC-LP
Chemistry with Calculators..... CWCALC

Some of the experiments are

- Vapor Pressure of Liquids
- Hess’s Law
- Determining the Concentration of a Solution
- Conductivity of Saltwater
- Acid-Base Titration
- Pressure-Temperature Relationship in Gases

Advanced Chemistry with Vernier CHEM-A

Some of the experiments are

- Standardizing a Solution of Sodium Hydroxide
- The Molar Mass of a Volatile Liquid
- The Synthesis and Analysis of Alum
- Determining the Half-Life of an Isotope
- Acid-Base Titration
- Determining Avogadro’s Number

Physics with Computers PWC-LP
Physics with Calculators..... PWCALC

Some of the experiments are

- Newton’s Second Law
- Projectile Motion
- Ohm’s Law
- Bungee Jump Accelerations
- Sound Waves and Beats
- Accelerations in the Real World

Real-World Math with Computers RWC-LP
Real-World Math the CBL 2 and LabPro RWCALC

Some of the experiments are

- Interpreting Graphs
- Periodic Phenomena
- Straight Line Distance Graphs
- Exponential pH Change
- How Objects Cool
- The Inverse Relationship

Water Quality with Computers..... WQ-LP

Water Quality with Calculators WQCALC

Some of the experiments are

- Total Solids
- BOD
- Fecal Coliform
- Ammonium Nitrogen
- Dissolved Oxygen
- Phosphates, Ortho- and Total
- Nitrate
- Stream Flow

Middle School Science with Computers..... MSC-LP

Middle School Science with Calculators MSCALC

Some of the experiments are

- The Greenhouse Effect
- Solar Homes
- Graphing Your Motion
- Heart Rate and Exercise
- A Water Field Study
- Soil Study

Earth Science with Computers ESC-LP

Earth Science with Calculators ESC-CALC

Some of the experiments are

- The Greenhouse Effect
- Solar Homes
- Soil pH
- Water Treatment
- UV Light and Clothing
- Wind Power

Nuclear Radiation with Computers and Calculators..... NRCC

Some of the experiments are

- Distance and Radiation
- Counting Statistics
- Half-Life Measurements
- Background Radiation Sources
- Counting Statistics
- Alpha, Beta, and Gamma

Appendix D: Updates to the LabPro Operating System

Since LabPro has Flash memory, you can update your interface with the most recent operating system, also called firmware. There are two methods of updating the Flash on your interface. You can use either the LabPro serial or USB cable or a TI-GRAPH LINK™ cable to upgrade the operating system. In either case the files you need and the instructions for the update can be downloaded from the Vernier web site (www.vernier.com/calc/flash.html).

Please note that if you connect a LabPro with an outdated operating system to a computer and start *Logger Pro 3*, the program will display a message stating that the operating system needs to be updated. You will need to perform the update. Since the update can take several minutes, it is recommended that you use the LabPro USB cable to perform the update. If you select Cancel Update, *Logger Pro 3* will not be able to communicate with your LabPro.



If you are not prompted to update your LabPro but the Update LabPro button from the LabPro sensor dialog is highlighted, it means there is a newer operating system available. You can continue to use LabPro without a problem if you choose to skip this update.

Note: The operating system update is much faster with a USB connection than with a serial connection.