Xplorer GLX™ Datalogger

Users' Guide

- Using the Xplorer GLX Standalone
- Using the Xplorer GLX with a Computer
- Sample Activities

New Features:

- *File storage on USB flash drive, p. 83*
- *Update firmware from flash drive, p. 93*
- *Instant data monitoring in Digits and Meter displays, pp. 37 & 38*
- *Voice and Text Data Annotation, p. 25*

(more on page ii)

PASCO

012-08950F

About this Guide

The Xplorer GLX Users' Guide is divided into two parts.

Part 1 contains detailed information about operating the GLX, including descriptions of every screen, window and menu within the GLX environment, and instructions for common procedures.

Part 2 contains step-by-step instructions for science activities and experiments that can be done with the GLX, its standard included equipment, and commonly available supplies.

This is revision F of the User's Guide, for version 1.4x of the GLX firmware. Visit www.PASCO.com/glx/ for downloadable updates to the Users's Guide and firmware. If you have updated your GLX from a previous version, be sure to check out these new features:

New for Version 1.4x	Update firmware from USB flash drive, p. 93 Cell-selective manual sampling with Table display, p. 60 Instant data monitoring in Digits and Meter displays, pp. 37 & 38 Automatic calculation creation from Linear Fit, p. 22 Export data to text file, p. 32
New for Version 1.3x	Swap Cursors, p. 21 Toggle Active Data, p. 21 Zoom Tool, p. 25
New for Version 1.2x	Voice and Text Data Annotation, p. 25 USB flash drive support, p. 83 GLX-to-GLX data transfer, p, 84
New for Version 1.1x	Scope Mode, p. 22 Output-control Calculations, p. 50 Built-in Sound Sensor, p. 58 Data Collection with *ScienceWorkshop* Sensors pp. 59, 67

Technical Support

For assistance with the Xplorer GLX and other PASCO products, contact PASCO Technical Support at:

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA, 95747-7100 USA

Phone: (800) 772-8700 (in the U.S.)
(916) 786-3800 (worldwide)

Fax: (916) 786-7565

Web: www.pasco.com/support/

Email: support@pasco.com

PASCO Manual Number 012-08950F

How to Store the Xplorer GLX™

Even when the screen is blank, the GLX is active: it powers its memory, it periodically checks its battery, and it monitors its keypad. Like other hand-held computers, the GLX never turns off—it just goes to sleep.

Before you put your GLX away, read these instructions.

With proper care, you can ensure that your GLX will be ready for use whenever you need it.

Storage Time	*What You Should Do*
WHENEVER POSSIBLE	**Leave the GLX Plugged In** Leave the GLX connected to AC power so it can keep its battery charged and store data files indefinitely. This is the *best* way to store the GLX for any length of time.
Unplugged for MORE THAN A FEW DAYS	**Backup Your Data** Data files stored in RAM are temporary. If you want to keep your data files, transfer them to the GLX's internal Flash memory, a USB Flash drive, or a computer. See pages 78–84 and 100 of the Users' Guide for more information. **Fully Charge the Battery** Put the GLX away with a full battery to keep the RAM active (for up to two weeks) and ensure that the battery has power the next time you use it. Any time within two weeks, simply press and hold the power button to turn it on. Data saved in RAM will still be there. After two weeks, plug in the AC adapter to turn on the GLX (or press the reset button on the back) and retrieve data files from your backup location.
Unplugged for MORE THAN A MONTH	**Put the GLX into Deep Sleep*** In deep sleep mode, an internal switch opens to disconnect the battery. To put the GLX into deep sleep: backup your data; allow the battery to fully charge; unplug the AC adapter; go to the settings screen, press F3, and press ✓; follow the on-screen instructions. ***Why is deep sleep important?*** Nickel metal hydride batteries last longer when they are kept as fully charged as possible. Deep sleep mode prevents unnecessary discharging. ***What if I forget to put it into deep sleep?*** Don't worry. If the GLX is left unplugged and unused from more than two weeks, it puts itself into deep sleep. ***How do I wake up the GLX from deep sleep?*** When you're ready to use it again, just plug in the AC adapter (or press the reset button on the back) and retrieve data files from your backup location.

***Note for early hardware versions:** Early versions of the GLX do not support deep sleep mode. If you have one of these GLXs, leave it plugged in *or* remove the battery for long-term storage. (But don't plug in the AC adapter when the battery in not installed.) See page 95 of the Users' Guide for more information.

TAPE THIS SHEET TO THE INSIDE LID OF THE GLX STORAGE BOX OR POST IT WHERE THE GLX WILL BE STORED.

Visit www.pasco.com/glx to download the latest GLX firmware update and Users' Guide.012-08950F

Contents

Part 1:

Users' Guide

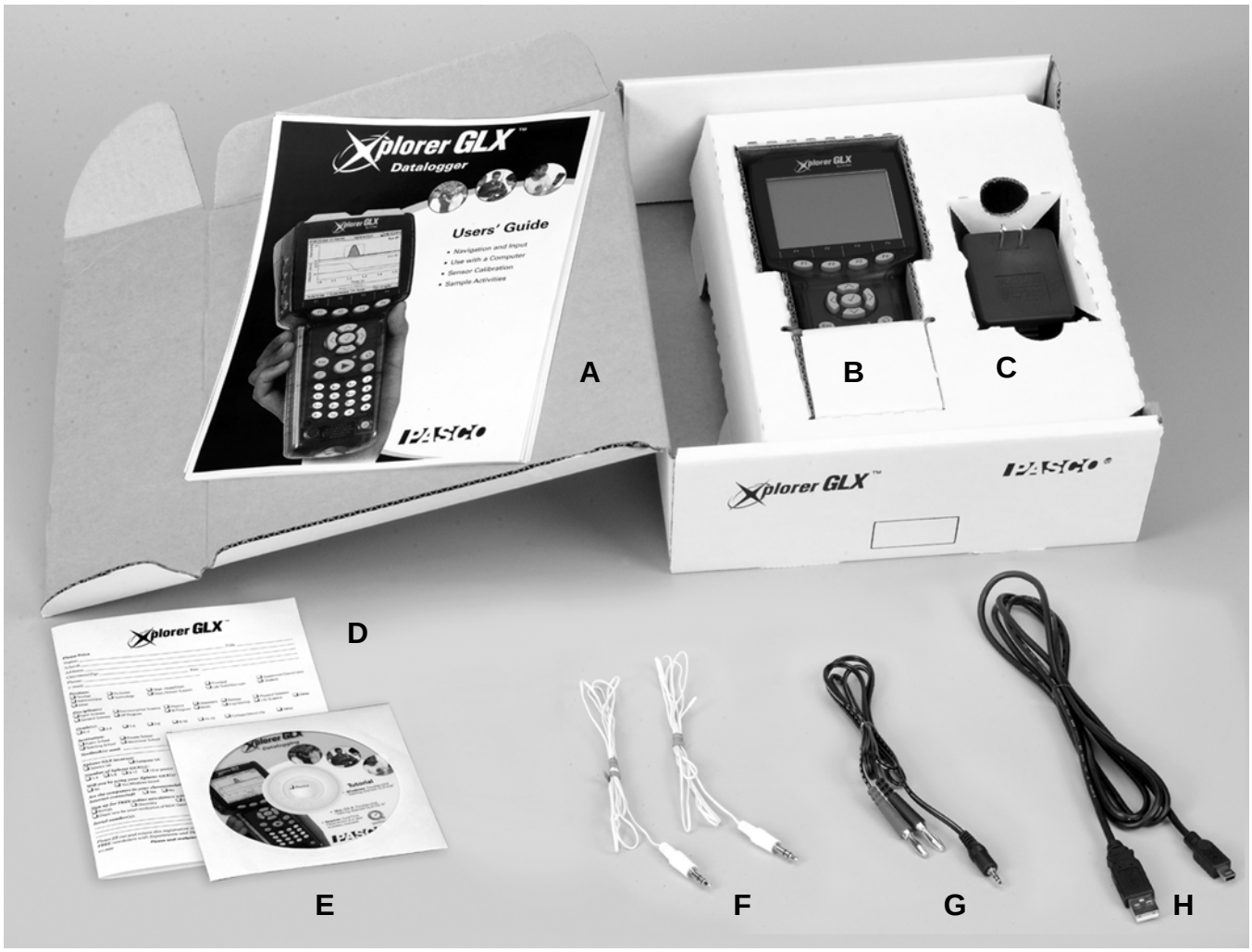
Introduction

The Xplorer GLX is a data collection, graphing, and analysis tool designed for science students and educators. The Xplorer GLX supports up to four PASPORT sensors simultaneously, in addition to two temperature probes and a voltage probe connected directly to specialized ports.

An optional mouse, keyboard, or printer can be connected to the Xplorer GLX's USB ports. The Xplorer GLX contains an integrated speaker for sound generation and a stereo signal output port for optional headphones or amplified speakers.

The Xplorer GLX is fully functional stand-alone handheld computing device for science. It also operates as PASPORT sensor interface when connected to a desktop or laptop computer running DataStudio software.

Included Equipment



A) GLX Users' Guide

B) Xplorer GLX

C) AC Power Adapter

D) Registration Card

E) Getting Started with the Xplorer GLX CD-ROM

F) Two Fast-response Temperature Probes (-10 to 70 °C)

G) Voltage Probe (-10 to +10 V)

H) USB Host-connection Cable

I) Poster (not pictured)

Quick Start

Getting started with the GLX is easy—simply plug in the AC adapter, connect one of the included sensors, and collect data. In the example below, you will start the GLX and collect temperature data.

1. Plug In the AC Adapter

Connect the AC adapter to the power port on the right side of the GLX and plug the adapter into a power outlet (100 to 240 VAC, depending on your location). When you connect the AC adapter, the GLX turns on automatically.

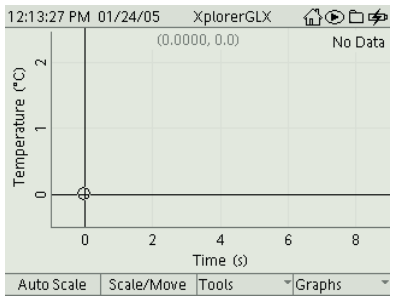
The first time you use the GLX, leave it plugged in overnight (at least 14 hours) to allow the battery to fully charge.

If the battery has already been charged, you can use the GLX without the AC adapter. To turn it on using battery power, push the power button at the lower-right corner of the keypad (⏻) and hold it for about one second.

2. Connect a Sensor

Connect a temperature probe to one of the temperature ports on the left side of the GLX.

In most cases, the Graph display will launch automatically with the axes labeled "Temperature (°C)" and "Time (s)."

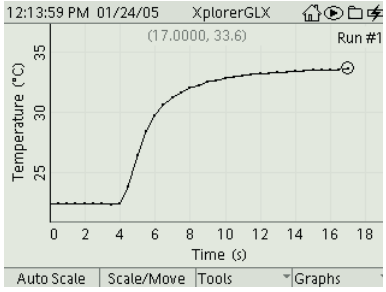


3. Collect Data

Press ▶.

The GLX is now recording and graphing data from the sensor. Press F1 to automatically scale the graph.

Hold the end of the temperature probe in your hand and observe how the data plotted on the Graph react.



To stop data recording, press ▶ again.

You have just collected and graphed a run of temperature data. To collect additional data runs, press ▶ again.

There are several different ways to collect data with the GLX. This is the simplest and most common. See “F1 Mode” on page 57 for other options. You can find a complete description of the Graph display starting on page 13.

Overview of the GLX

The example above represents just a small part of the GLX’s capabilities. This overview will outline some of the set-up options to customize your GLX and prepare it for an activity; then (starting on page 9) survey the GLX’s Home Screen as a gateway to the entire GLX environment.

Equipment Set-up Options

Power Source Whenever possible, it is a good idea to use the GLX connected to the AC power supply. For maximum operating time on battery power, first connect the GLX to AC power for at least 14 hours, or until the Battery Gauge indicates a full charge.[1]

[1]See “Battery Gauge” on page 11.

Power On The power turns on automatically when you plug in the AC adapter. If the GLX is running on batteries, or if the AC adapter is already connected, push and hold the power button (⏻) for about 1 second to turn it on.

By default, the GLX is set to start with a new data file; however, if the Startup Action of the GLX has been set to “Open Last Experiment,” it will automatically open the most recently saved file. See page 86 for more information.

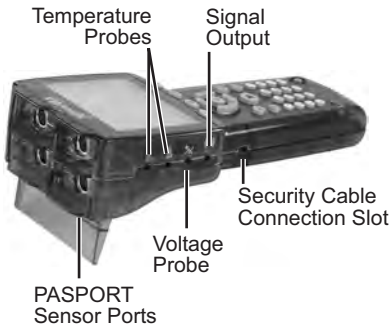
Back Light To turn on the screen’s back light, press and hold ⌂ while you press ✓.[2]

[2]The backlight and other aspects of the Xplorer GLX can also be adjusted in the Settings Screen. See page 85.

Screen Contrast There are 21 levels of screen contrast. Push and hold ⌂, then use the up and down arrow keys (▲▼) to adjust the contrast to a comfortable level.

Language In its factory configuration, the GLX is set up to operate in English. If you would like to change the language, refer to “Settings Screen” on page 85.

PASPORT Sensors Connect up to four PASPORT sensors to the main ports on top of the GLX.



In some cases, the GLX may automatically launch the Graph or other display when you plug in a sensor. See “Sensor Auto-Display” on page 86 for more information about this feature.

Temperature Probes Connect the included fast-response probes or other PASCO temperature probes to the two temperature ports on the left side of the GLX. The range is -10 to +70 °C with fast-response probes, or -10 to +135 °C with stainless steel probes.

Voltage Probe Connect the included voltage probe to the voltage port on the left side of the GLX to measure voltages between -10 and +10 V. The voltage probe should be connected to voltage sources *only* when it is also connected to

the GLX. Do not connect a voltage source until after the probe is connected to the GLX; remove any voltage sources before disconnecting the probe.

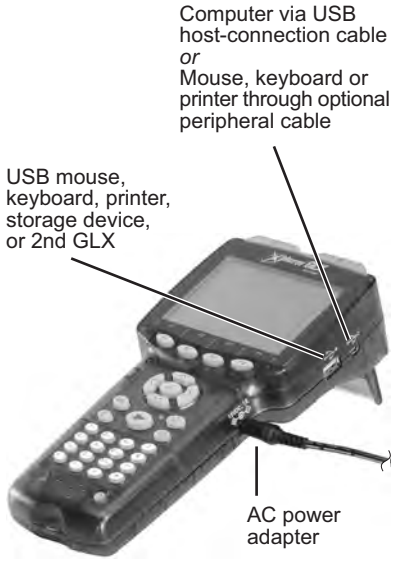
Sound Sensor To configure the GLX's microphone as a sound sensor, press (home) and (F4) together to enter the Sensors screen; then press (F3) to open the Microphone menu. From the menu, select Sound Sensor to record the sound waveforms, or select Sound Level to measure sound level in decibels. See "F3 Microphone" on page 58 for more information.

Computer If you will be using the GLX with a computer, use the included USB host-connection cable to connect the GLX to the USB port of the computer. Refer to page 99 for instructions on setting up the computer.

Mouse If you will be using an optional mouse (PS-2539), connect it to the USB port on the right side of the GLX.

A mouse can be convenient, but it is never required; anything that you can do with the mouse can also be done through the GLX's keypad. New users often find that operating the GLX is easier with a mouse. For experienced users, using the keypad rather than a mouse is usually faster.

Keyboard If you plan to do a lot of text entry, connect a USB keyboard (PS-2541) to the port on the right side of the GLX.



To connect a mouse and a keyboard simultaneously, use the optional PS-2536 Peripheral Cable.

Signal Output If you have headphones or a pair of amplified stereo speakers that you wish to use for sound generation, connect them to the signal output port. You also have the option of using the GLX's built-in speaker for sound output. See "Output" on page 39 for more information.

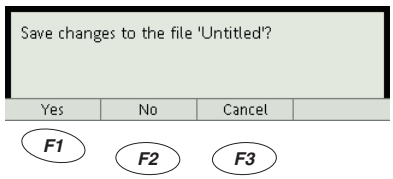
USB Storage Device If you have a USB storage device (such as a flash drive) you can connect it to the GLX's USB port for extra file-storage capacity and data backup. See page 83 for more information.

GLX-to-GLX Transfer If you have two GLXs that you would like to transfer files between, connect them using the included host-connection cable. See page 84 for more information.

Shutting Down

Manual Shut Down

To turn off the GLX, press and hold (power) for 1 second. The GLX will prompt you to save your data and experiment setup before it shuts down. Press (F1) to save your work, press (F2) to shut down without saving, or press (F3) to not shut down. See page 80 for instructions on opening the saved file.



If you hold the power button for 5 seconds, the GLX will shut down without saving your data.

The GLX cannot shut down while the battery is charging; if you try to turn it off, a message will appear informing you that charging is in progress. When the battery is fully charged, and the GLX has been idle for 60 minutes, it will shut down automatically (see below).

Auto Power Off

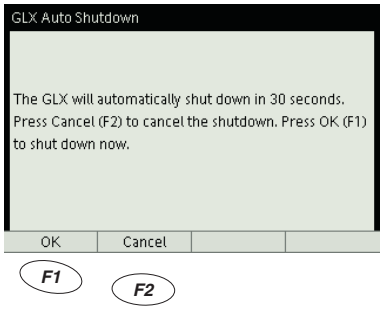
Timed Auto Power Off If it is running on battery power, the GLX will automatically save your data and shut down after a certain amount of continuous idle time (5 minutes by default).[3]

To set the idle time that must elapse before auto shut down on battery power, see "Auto Power Off" on page 85.

[3] **The GLX is considered idle when**
- the GLX is *not* collecting data,
- the Stopwatch is *not* running,
- the GLX is *not* connected to a computer running DataStudio, and
- the GLX is *not* receiving input through its keypad, a mouse, or a USB keyboard.

If the GLX is running on AC power *and* the battery is fully charged, it will automatically shut down after 60 minutes of idle time.

The GLX will warn you that it is about to shut down 30 seconds before it actually does. If you see the warning, press F1 to proceed with the shutdown, or press F2 to keep the GLX turned on.



Battery Auto Power Off The GLX will also save data and shut down automatically if the batteries drain to a critical level. Connect AC power before turning the GLX back on.

Auto Data Save Just before the GLX shuts down, it will save the open file (which includes all data, displays, calculations and set-up information). If you have named the file, it will be saved under that name. If you have not named the file, it will be saved with the filename "Untitled."

Resuming after Auto Power Off To resume your work after the GLX automatically shuts down, push and hold the power button (⏻) for about 1 second to turn it on. If the automatically saved file does not open automatically, go to the Data Files screen (see page 78) and open the file. (See page 80 for instructions on opening a file.)

If you have set the Startup Action of the GLX to "Open Last Experiment," the file will automatically open when you turn on the GLX. See page 86 for more information.

Sleep Between Samples If the GLX is running on battery power and collecting data at a rate of once every 30 s or slower, and it has been otherwise idle for the set auto-power-off time (see page 85), it will "sleep" between samples. When the GLX is sleeping, the screen and any connected sensors are turned off to save power, and the green LED on the front of the unit blinks once every two seconds. When it is time to collect a data point, the GLX wakes up briefly, records data, and goes back to sleep. Press any key to wake up the GLX.

The Record Button

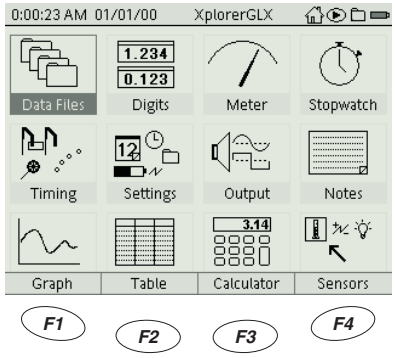
Default Recording Mode Whenever you have one or more sensors connected to the GLX, you can press ► to start data collection. In its default mode, the GLX will begin recording data continuously from all connected sensors. Press ► again to stop data collection. To start recording another data run, press ► yet again.

Sticky Start Use the Sticky Start feature to prevent data collection from being unintentionally stopped when you take the GLX on an amusement park ride. To start data collection with Sticky Start, press *and hold* ► for about 5 seconds. You will hear three beeps and see the Sticky Start icon (🔒) appear at the top of the screen. Data recording will continue after you release ►. To stop data

recording, you must press and hold ▶ until you hear three beeps again. Data recording will stop when you *release* ▶.

Alternative Recording Modes If you have put the GLX into Manual Sampling mode (see page 57), it will not start recording when you press ▶; rather it will stand by to record a data point whenever you press ⚐. If you have turned on the Trigger in the Graph display (see page 20), then the GLX will delay the start of recording after you press ▶ until the specified trigger condition is reached.

Home Screen



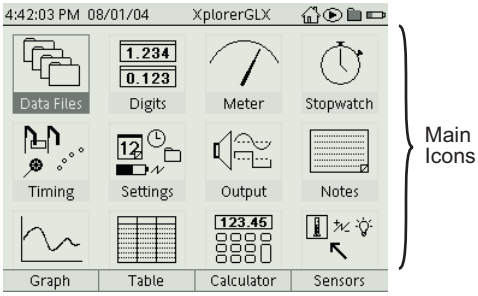
The Home Screen

The Home Screen is the center of the GLX environment. All other screens are just one step away from the Home Screen. From any other screen, you can always return to the Home Screen by pressing ⌂.

The Home Screen consists of three sections: the Main Icons, the Bottom Row, and the Top Bar.

Main Icons

The main icons on the Home Screen lead to the other screens of the GLX environment.



To open another screen via one of the main icons, use the up, down, left, and right arrow keys to highlight the desired icon, then press ✓.

> The highlight wraps around, so you can move it to any icon within three key presses. For instance, if the highlight is in the first column, and you want to move it to the fourth column, press the left arrow key once.

Alternatively, if you are using a mouse, simply click on the desired icon.

> You can also access the four icons in the bottom row using the function keys. See "Bottom Row" on page 10 for more information.

The icons and the screens they lead to are described briefly here, and in more detail elsewhere in the following chapters.

Data Files Once you have collected data or configured the GLX for an experiment, you can go to the Data Files screen to save your work. You can also open or delete saved files and manage the displays, sensors, calculations, and manually entered data sets that are part of a data file. See page 78 for more information.

Digits This screen is useful for displaying live data as they are collected from sensors and calculations. Up to six data sources can be displayed simultaneously. See page 37 for more information.

Meter This display simulates an analog meter with a needle that deflects in proportion to a measurement made by a sensor. See page 38 for more information.

Stopwatch With this screen, the GLX can be used like a regular stopwatch to time events. The stopwatch is started and stopped by the user through the GLX's keypad, so no sensors are necessary. See page 54 for more information.

Timing Use the Timing screen to configure photogates, Super Pulleys, and other switch-type or counting-type digital sensors. See page 62 for more information.

Settings Go to the Settings screen to change the GLX's name, time and date, and screen settings, set how long the GLX waits before automatically turning off, and control how the GLX behaves when you turn it on or connect a sensor. See page 85 for more information.

Output The Output screen contains the controls for the signal that the GLX generates and outputs through the built-in speaker, or through the signal output port to headphones or amplified speakers. See page 39 for more information.

Notes In the Notes screen, you can create, read, and edit pages of text notes to be saved along with an experiment configuration or collected data. See page 53 for more information.

Graph Use the Graph to plot and analyze data. In many cases, the Graph is the best way to view data as they are being collected. See page 13 for more information.

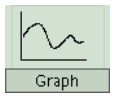
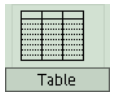
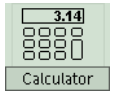


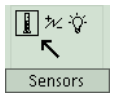
Table The Table displays data numerically in columns. It can be used for editing and entering data and for statistical analysis. See page 28 for more information.



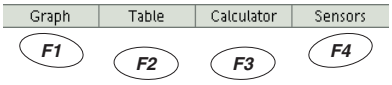
Calculator You can use the calculator like a regular calculator for finding the result of a simple expression and like a graphing calculator for plotting equations. The calculator can also perform operations on streams of data collected from sensors and on sets of manually entered data. See page 41 for more information.



Sensors Use the Sensors screen to customize the way sensors collect data. The screen shows which sensors are connected to the GLX and contains controls for how each sensor operates. See page 85 for more information.

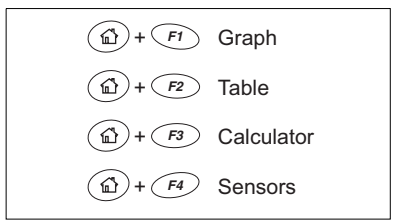


Bottom Row



Bottom Row

The icons in the bottom row of the Home Screen are selectable via the four function keys: F1, F2, F3, and F4. Graph, Table, Calculator, and Sensors are the most commonly used screens, and therefore the most easily accessible. To make the bottom row of the Home Screen appear temporarily from anywhere in the GLX environment, press *and hold* ⌂; while holding ⌂, press one of the function keys to open the corresponding screen.

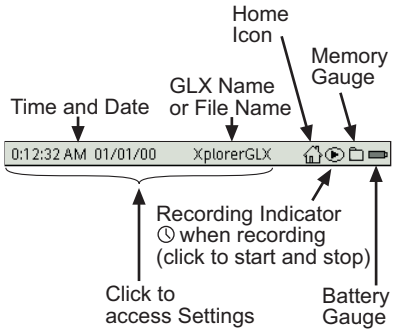


Shortcuts from anywhere in the GLX environment

In other screens, you will usually see four choices at the bottom of the screen that can be accessed with the function keys.

Top Bar

The Top Bar is the part of the Home Screen that is always visible from anywhere in the GLX environment. It shows the time and date and the name of the GLX or the name of the open file. It also indicates the recording status, battery level and memory usage.



Top Bar

Time and Date The time and date displayed in the Top Bar are set automatically when you connect the GLX to a computer running DataStudio (see page 99). You can also go to the Settings screen (see page 85) to set the time and date manually and change the format in which they are displayed.[4]

GLX Name By default, the name displayed in the Top Bar is "XplorerGLX." If you are using more than one GLX in your classroom or lab, you may wish to give each one a unique name. See "Settings Screen" on page 85 for instructions.

When a previously saved filed is open, the name of that file appears in place of the GLX Name. See page 78 for more information about saving and opening files.

Home Icon If you are using a mouse, you can click the Home Icon (⌂) in the Top Bar, instead of pressing ⌂ on the keypad, to return to the Home Screen from any other screen in the GLX environment.

Recording Status The Recording Status icon changes to indicate when the GLX is collecting data, and in what sampling mode it is operating (see page 57 for more information about the sampling modes). It also indicates when an audio note is being recorded or played (see "Data Annotation" on page 25).

If you are using a mouse, you can click the Recording Status icon, instead of pressing ▶ on the keypad, to start and stop data collection.

Memory Gauge The Memory Gauge indicates the GLX's available memory. As data are stored in random access memory (RAM), the icon becomes shaded from the bottom up. An entirely shaded icon means that there is little or no capacity remaining for recording data. See "Data Files Screen" on page 78 for instructions on deleting files or data runs to make more memory available.

If you are using a mouse, you can click the Memory Gauge to open the Data Files screen, start a new file, or save the file that you are working with. (Without a mouse, the Data Files screen, which includes the New File and Save File options, is accessed through the Home Screen; see page 78.)

Battery Gauge When the GLX is running on battery power, the Battery Gauge indicates the level of charge of the battery. It is fully charged when the entire gauge is shaded.

> Each GLX learns the particular charge and discharge characteristics of its battery as it is used. To make the gauge more accurate, allow the battery to fully charge, then fully discharge at least once.

The Battery Gauge also indicates when the GLX is connected to AC power and charging the battery.

[4]The time can be displayed in 12-hour or 24-hour format; the date can be displayed as month/day/year or day/month/year.

Recording Status Icons

- Not Collecting Data
- Sampling in Continuous Mode
- Sampling in Manual Mode
- Recording Audio Note
- Playing Audio Note

Memory Gauge Icons

- Most RAM free
- RAM about half free
- RAM almost full

Battery Gauge Icons

- Battery fully charged
- Battery nearly empty
- AC power connected; battery charging
- AC power connected; battery fully charged

Chapter 1: Displays

The GLX has four screens for displaying data: Graph, Table, Digits, and Meter. This chapter will describe the structure and use of each display.

Open any of the displays to monitor live data as it is collected. Open the Graph or Table to view previously recorded measurements or manually entered data.

Graph

The Graph plots data on a pair of axes. Use the Graph to view, compare, and analyze data sets.

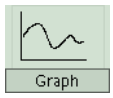
To Open the Graph

From the Home Screen, do one of the following:

F press F1, the function key below the Graph icon;

use the arrow keys to highlight the Graph icon, then press ✓; or

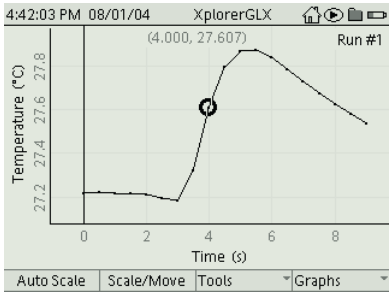
click the Graph icon.



The Graph icon on the Home Screen

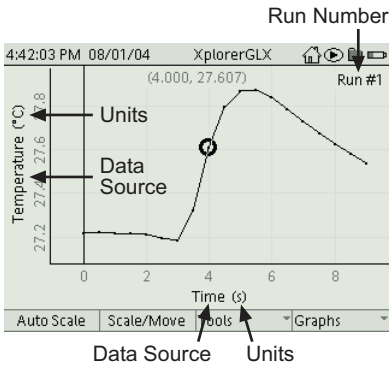
From *anywhere* in the GLX environment, you can always open the Graph with the shortcut ⌂ + F1.

In some cases, the Graph opens automatically when you connect a sensor.



The Graph Display

Active Fields



Active fields of the Graph

Active fields are the areas on the Graph (and other display screens) through which you control what data are shown. When you select an active field, a menu opens containing choices of data source, units, or run number. Follow the steps below to select an active field using the keypad.

1. Press ✓ to "light up" the active fields—shaded boxes appear around the active fields.

2. One of the shaded boxes is darker than the others, designating the highlighted field. Use the arrow keys to move the highlight to the field that you would like to select.

3. Press ✓ again to select the highlighted field, which causes a menu to open.

To select an option from the menu:

- use the up and down keys to highlight the desired menu option, then press ✓;

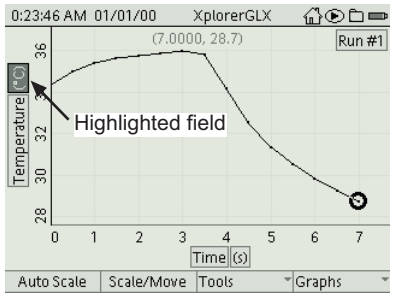
  or

- press the number on the keypad corresponding to the desired menu option.

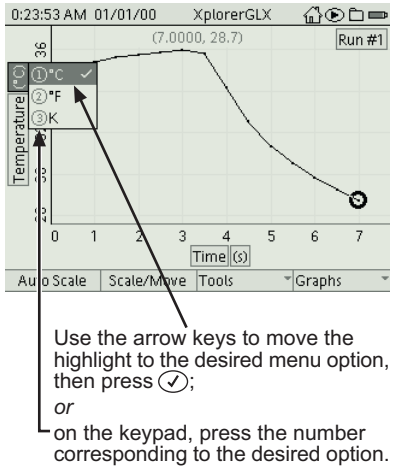
To turn off the highlight without selecting one of the fields, or to close a menu without selecting an option, press Esc.

If you are using a mouse, you can left-click an active field to select it and open the menu, then click one of the menu options. (It is not necessary to press ✓ first.)

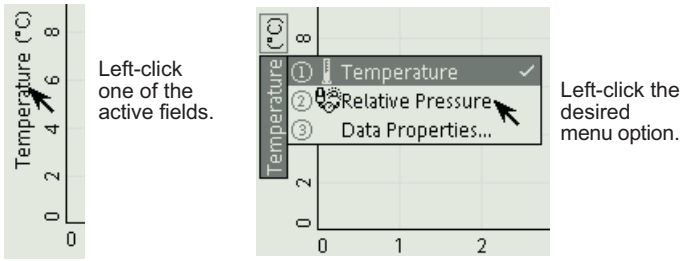
Selecting a field with the keypad



Press ✓ to light up the active fields. Use the arrows to move the highlight to the desired field and press ✓ to open the menu.



Use the arrow keys to move the highlight to the desired menu option, then press ✓;
or
on the keypad, press the number corresponding to the desired option.



Selecting a field with the mouse

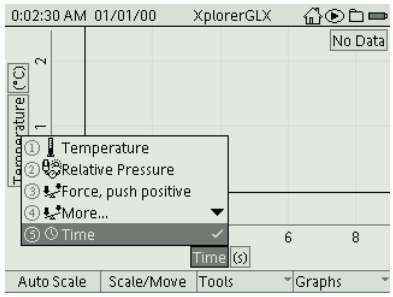
Choosing Data to Display

Data Source A graph is generated from two data sources: one on the vertical axis and one on the horizontal axis. The possible types of data source are

- a sensor measurement,
- time (horizontal axis only),
- a calculation,
- manually entered numeric data, and
- manually entered text data (horizontal axis only).[1]

[1]For more information on calculations, see page 41. For more information on manually entered data see page 32.

If you configure the Graph with data sources that already contain data, the data will appear immediately. If the selected data sources have not yet collected data, the Graph will initially be blank; when data collection starts, each data point will be plotted as it is acquired.



Data source menu for the horizontal axis

If there is at least one sensor connected to the GLX, the Graph will automatically set one of the sensor measurements as the vertical data source, with time as the horizontal data source. Select the vertical or horizontal data source field[2] to choose a different source.

When you chose a data source, it replaces the previously displayed one. See "Two Measurements" on page 23 and "Two Graphs" on page 24 for instructions on displaying two vertical data sources simultaneously.

If you do not see the sensor measurement that you want in the data source menu, select More to expand the menu.

For more information on selecting data from the Data Source menu when you are working with more than one sensor, or with a multiple-measurement sensor, see "Data Source Menus" on page 89.

Also from the Data Source menu, you can select Properties to edit the name and other properties of the currently displayed data set. See "Data Properties" on page 69 for more information.

Units Select the units field[2] to choose different units (if available) for the chosen data source.

Run Number Select the run number field[2] to choose a different data run. You can also choose to display no data.

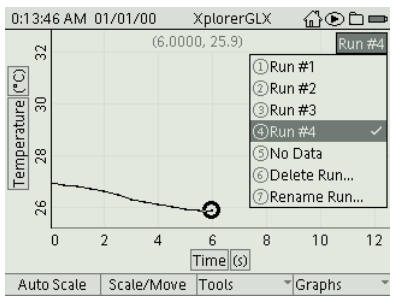
[2]**To select a data source, units, or run number field**

Keypad

1. Press ✓ to light up the active fields.
2. Use the arrow keys to move the highlight to the desired field.
3. Press ✓ again to open the menu.
4. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

1. Click the desired field to open the menu.
2. Click the desired menu option.

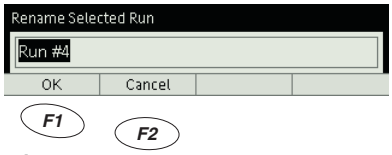


Run number menu

In normal mode, one data set is displayed at a time. See “Two Runs” on page 24 for instructions on displaying two runs simultaneously.

The next-to-last option in the run number menu is Delete Run, which deletes the currently displayed run. That run will be deleted from *all* measurements, not just the one displayed in the Graph.

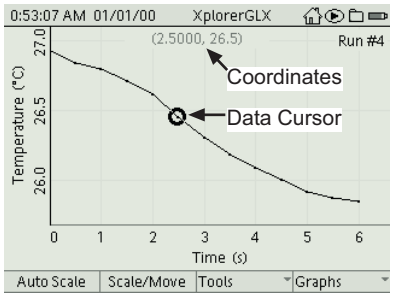
The last option in the run number menu is Rename Run. By default, data runs are names “Run #1,” “Run #2,” etc. When you select Rename Run, the GLX prompts you for a new run name. Enter the new name using multipress text entry (or an attached keyboard) and press F1 to accept the change (or press F2 to cancel the change). The new name will be applied to that run from *all* measurements, not just the one displayed in the Graph.



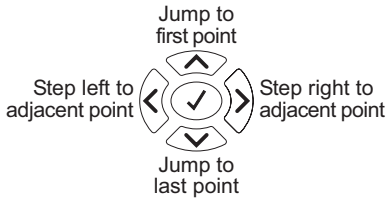
The GLX prompts you to enter a new data run name

For more information on multipress text entry, see page 90.

Data Cursor and Coordinates



The circle around one of the data points is the Data Cursor. Use the arrow keys to move the Data Cursor; the left and right arrow keys step the Data Cursor to adjacent data points, the up and down arrow keys make the cursor jump to the first and last visible data points. Press and hold the left and right arrow keys to move the cursor quickly.



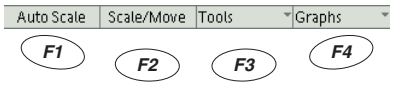
Use the arrow keys to move the Data Cursor

The coordinate pair near the top of the Graph indicates the “X” and “Y” values of the Data Cursor.

If you have a mouse, you can move the Data Cursor by dragging it: click on the Data Cursor, hold down the mouse button, and move the mouse left and right to move the Data Cursor along the data plot.

Graph Function Keys

In the Graph, the function keys are used to change the scale and to open the Tools and Graphs menus.



F1 Autoscale

Press F1 to make the scale of the Graph adjust automatically so that all data are visible.

F2 Scale/Move

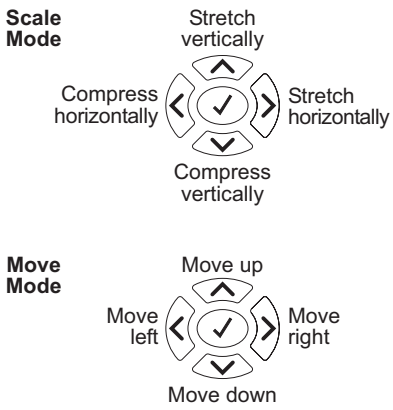
Pressing F2 cycles the graph through Scale mode (first press) and Move mode (second press).

In Scale mode, the left and right arrow keys compress and stretch the Graph horizontally; the up and down arrow keys stretch and compress the Graph vertically.

In Move mode, the arrow keys make the graph move left, right, up, and down.

To return to normal mode (indicated when the F2 function reads "Scale/Move"), press Esc. If the Graph is in Scale or Move mode and the arrow keys are not pressed for several seconds, the Graph will return to normal mode automatically.

See "Zoom" on page 21 for another way to rescale the Graph.

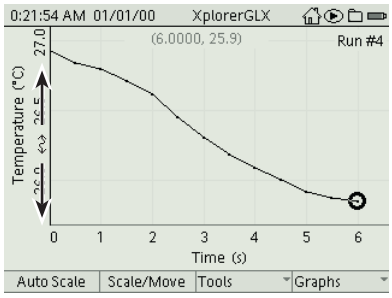


Arrow key functions in Move and Scale modes

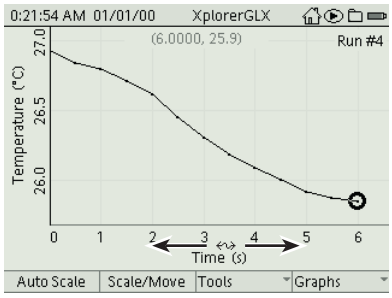
Scale and Move with a Mouse

If you have a mouse, you can scale and move the Graph by dragging it with the mouse cursor. (It is not necessary to press F2 first.)

To change the scale, click and drag on (or between) the numeric labels on the edges of the Graph to change the vertical and horizontal ranges.



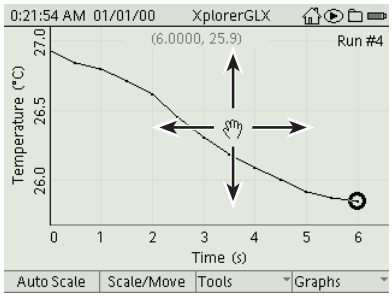
Vertical Scale



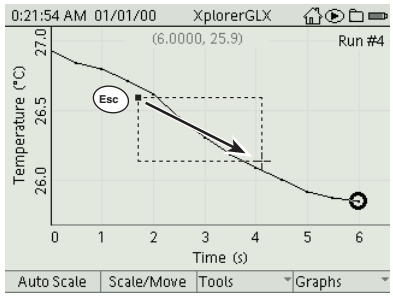
Horizontal Scale

To move the plot up, down, left, and right, click and drag anywhere in the "background" of the Graph.

To zoom in on part of the Graph, hold down Esc while you click and drag to draw a rectangle. The area enclosed by the rectangle will enlarge to fill the screen.



Move

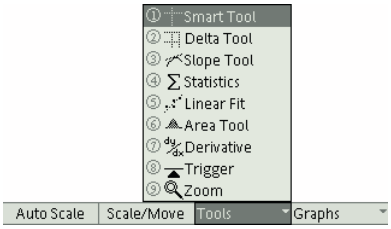


Zoom

F3 Tools Menu

Use the analysis tools contained in the Tools menu to obtain numerical information from the Graph (such as coordinates and statistics), to visualize different properties of the plotted data (such as slope and area), and to enlarge a selected area. This menu also contains an options to configure the Trigger (see page 20).

When you select a tool from the Tools menu,[3] a check mark (✓) appears next to it. To turn off a tool, select it from the menu again, which removes the check mark and returns the Graph to normal mode. If you have a tool turned on and you choose a different tool, the previous tool will automatically turn off.



The Tools menu

[3] **To select a tool from the Tools menu:**

Keypad

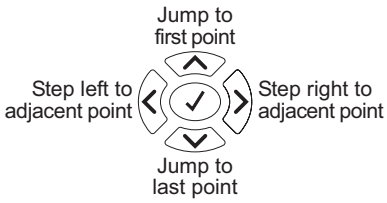
1. Press F3 to open the Tools menu.
2. Use the arrow keys to move the highlight to the desired tool and press ✓; *or* press the number on the keypad corresponding to the desired tool.

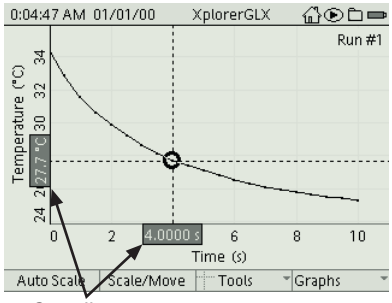
Mouse

1. Click "Tools" at the bottom of the screen to open the Tools menu.
2. Click the desired tool.

The options in the Tools menu are described below.

Smart Tool When the Smart Tool is selected from the Tools menu, a pair of crosshairs appears on the Graph with labels indicating its coordinates. Use the left and right arrow keys to move the Smart Tool to adjacent data points. Use the up and down arrow keys to send it to the first and last visible data points. Press and hold the left or right arrow key to move the Smart Tool quickly.

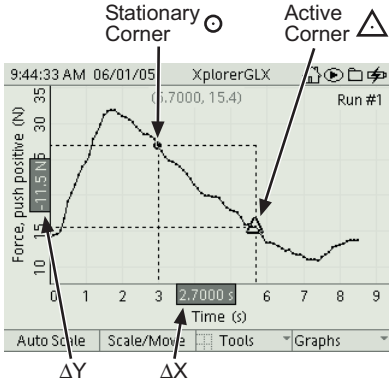




Smart Tool

If you have a mouse, you can move the Smart Tool by dragging the circle at the intersection of the cross hairs left and right.

Delta Tool When the Delta Tool is selected from the Tools menu, a dashed rectangle appears on the Graph. One corner is marked with a circle, the other is marked with a triangle. Labels on the edges of the Graph indicate the width (ΔX) and height (ΔY) of the rectangle, measured *from* the circle *to* the triangle.



Delta Tool

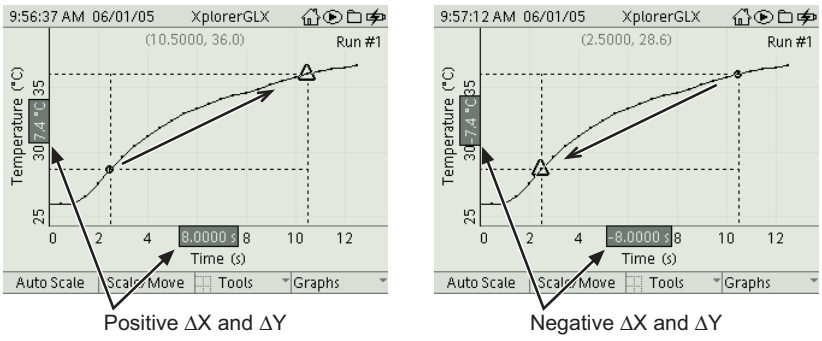
When you first turn on the Delta Tool, the circle and triangle appear at the same point. Press the left or right arrow a few times to separate them.

The left and right arrow keys move the triangle to adjacent data points; the up and down arrow keys send the triangle to the first and last visible data points. Press and hold the left or right arrow key to move the triangle quickly.

If you have a mouse, you can move the triangle by dragging it left or right.

The triangle designates the active corner of the Delta Tool, which is the corner that moves when you press the arrow keys or drag it with the mouse. To make the other corner active, hold Esc and press ⌫. The triangle and circle will swap places when you release both keys.

Note that when the cursors swap places, the signs of ΔX and ΔY change. These values are always measured from the circle to the triangle; ΔX is the triangle's X coordinate minus the circle's X coordinate, ΔY is the triangle's Y coordinate minus the circle's Y coordinate. You would most typically be interested in the values reported when the triangle is to the right of the circle.

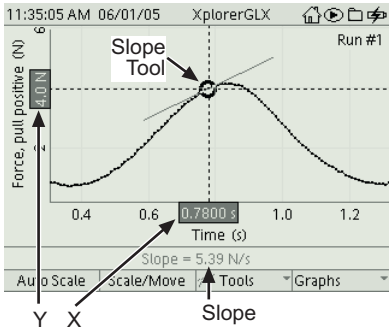


When the cursors swap places, the signs of ΔX and ΔY change

Slope Tool Select the Slope Tool from the Tools menu to measure the slope of a tangent line at one point on the data plot. A pair of crosshairs marks the point at which the slope is measured. Labels on the Graph's edges show the coordinates of the point, and the slope is displayed at the bottom of the screen.

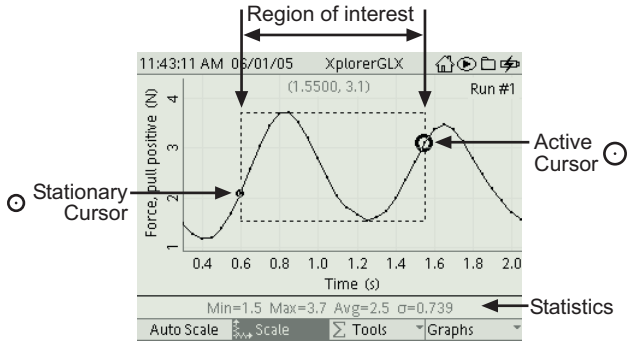
Use the left and right arrow keys to move the Slope Tool to adjacent points. Use the up and down arrow keys to send it to the first and last points. Press and hold the left or right arrow key to move the Slope Tool quickly.

If you have a mouse, you can move the Slope Tool by dragging the circle at the intersection of the cross hairs left and right.



Slope Tool

Statistics Select Statistics from the Tools menu to put the Graph into Statistics mode. The Graph displays the minimum, maximum, average, and standard deviation (σ) of the data inside the region of interest (ROI), which is indicated by a dashed box.



Statistics mode

Two cursors designate the left and right sides of the ROI. The larger cursor is the active one and can be moved with the arrow keys or mouse.[4] As the active cursor moves, one side of the box moves with it.

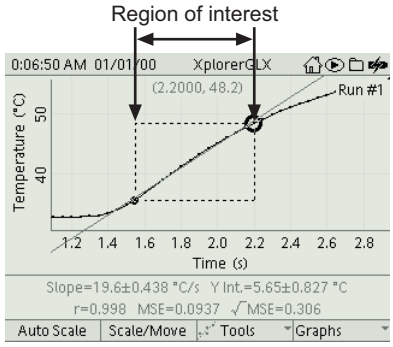
The smaller cursor indicates the side of the ROI that does not move.

To switch the active cursor to the other side of the box, hold Esc and press ⌫.

Linear Fit When Linear Fit is selected from the Tools menu, a best-fit line is applied to the data in the ROI. (See "Statistics" above for instructions on setting the ROI.)

The slope, the Y-intercept, the mean squared error (MSE), and the root mean squared error ($\sqrt{\text{MSE}}$) of the linear fit are displayed at the bottom of the screen along with the correlation coefficient (*r*) of the data in the ROI.

[4] See page 16 for detailed instructions on moving the cursor with the keypad or mouse.



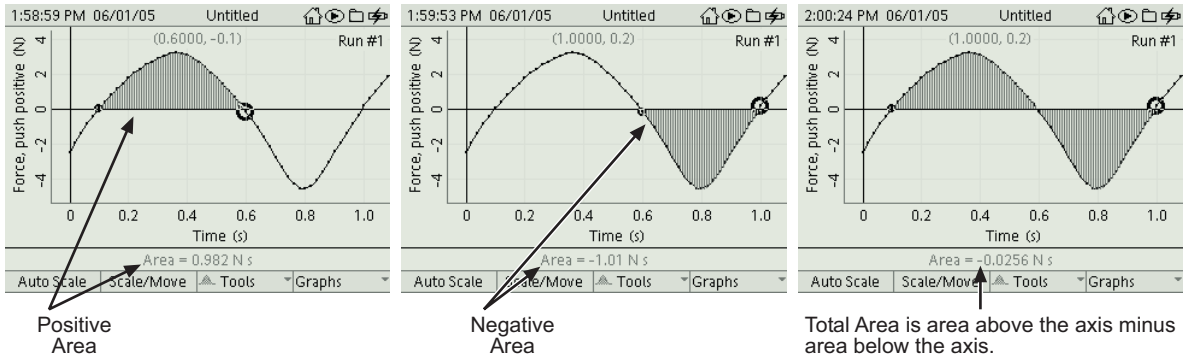
Linear Fit

When the Linear Fit is turned on, the special option Create Calculation from Linear Fit appears in the Tools menu (see page 22).

Linear Fit can be useful even when the graphed data are not linear (quadratic or exponential, for instance). See “Graph Linearization” on page 47.

Area Tool Select the Area Tool from the Tools menu to measure the area between the data plot and the X-axis in the ROI. (See “Statistics” above for instructions on setting the ROI.)

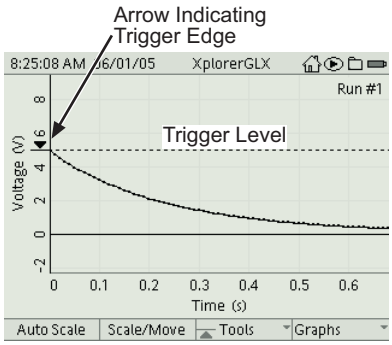
For data plotted below the X-axis, the area is measured as negative. The value of area displayed at the bottom of the screen is the total area above the X-axis minus the total area below the X-axis.



Area Tool

Derivative This tool overlays a graphical representation of the derivative (or rate of change) of the data. In some cases, the Graph may need to be rescaled in order to see the overlaid derivative. The Derivative Tool is designed for titration experiments in which it is necessary to identify a point in a data set at which the maximum rate of change occurs.

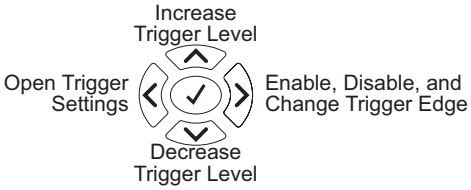
Trigger The Trigger is a tool that allows you to control how the GLX collects data. With the Trigger, you make the GLX delay data recording (after you press ▶) until a certain condition is met by the incoming data. The Trigger has two parameters: Trigger Edge, which can be rising or falling, and Trigger Level, which specifies the data value that must be crossed. For example, on a voltage versus time graph, if you set the Trigger Edge to rising and the Trigger Level to 5 volts, data recording will not start until the measured voltage rises above 5 volts.



Trigger

The Trigger can be used in normal graph mode to start continuous recording, or it can be used in Scope Mode (see page 22) to repeatedly trigger bursts of data collection. In both modes, the Graph must have time on the horizontal axis.

To turn on the Trigger, select it from the Tools menu.[5] A horizontal dashed line appears on the Graph indicating the Trigger Level. Press the up and down arrow keys to change the Trigger Level. Press the right arrow key to cycle through rising edge, falling edge, and disabled. (The Trigger is initially disabled, so you must press the right arrow key at least once to enable it.)

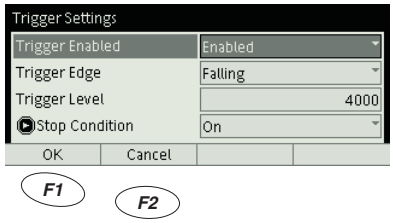


[5]The Trigger turns on automatically when you turn on Scope mode. See page 22.

The Trigger affects data recording even if you are not viewing the Graph. If you have set up two or more triggers on separate Graph pages,[6] data recording will start when the most recently set trigger condition is met.

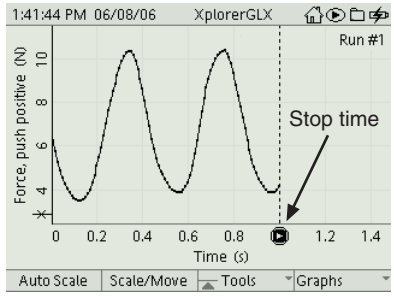
[6]For information about multiple Graph pages, see "New Graph Page" on page 24.

Trigger Settings When the Trigger is turned on, you can open the Trigger Settings dialog box by pressing the left arrow key (you can also select it from the Tools menu). In the dialog box, use the arrow keys to highlight Trigger Enabled and press ✓ to enable or disable the Trigger. To change the edge from rising to falling, or vice-versa, use the arrow keys to highlight Trigger Edge and press ✓. To set the level, use the arrow keys to highlight Trigger Level, press ✓, enter the desired value on the keypad, and press ✓ again.



Trigger Settings dialog box

You can also turn on the Stop Condition, which causes data collection to automatically stop at a specified time. To turn on the Stop Condition in the Trigger Settings dialog box, use the arrow keys to highlight Stop Condition and press ✓. When the Stop Condition is on, an icon ( ) and vertical dashed line appear on the Graph indicating the stop time. While viewing the Graph, hold down Esc and press the left and right arrow keys to adjust the stop time. For the Stop Condition to work, the Trigger must be turned on (but does need to be enabled).



Stop condition

When you have finished changing the settings in the Trigger Settings dialog box, press F1 to accept the changes, or press F2 to cancel them.

Zoom Use the Zoom Tool to enlarge an area that you define by drawing a rectangle. Select Zoom from the Tools menu; a zoom cursor ( ) appears. Move the cursor (using the arrow keys) to where you want one corner of the rectangle. Press ✓. Move the cursor to define the diagonally opposite corner of the rectangle. Press ✓ again. The area enclosed by the rectangle enlarges to fill the screen.

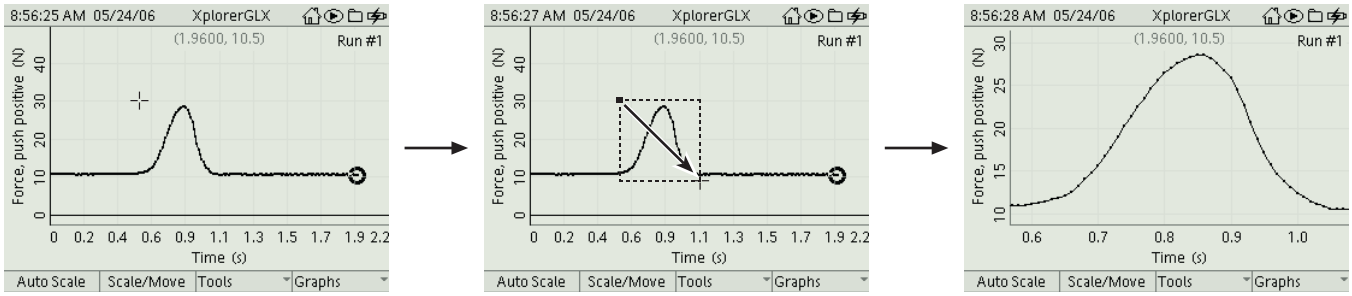
If you have a mouse, you do not have to open the Tools menu to zoom. Just hold down Esc while you click and drag on the Graph to draw the rectangle.[7]

[7]See also page 17 for other ways to scale the Graph with a mouse.

Position the cursor to define one corner. Press ✓.

Move the cursor to define the opposite corner. Press ✓.

Area enlarges.



Zoom Tool

Swap Cursors This option appears in the Tools menu when you are using the Delta Tool, Statistics, Linear Fit, or Area Tool. When you select Swap Cursors, the active and inactive cursors swap places, allowing you to move the previously stationary corner of the Delta Tool or side of the ROI.

To swap cursors without opening the menu: hold Esc, press ⌫, and release both keys.

Esc + ⌫

Swap Cursors Shortcut

Toggle Active Data This option appears in the Tools menu when the Graph is in one of the two-data set modes (see pages 23–24). Select it to switch focus from one data set to the other. The active data set is the one to which the Data Cursor

and other tools are applied. In cases where the two data sets are scaled separately, the active that is scaled.

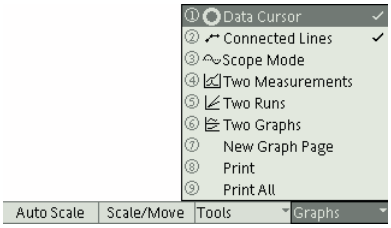
To toggle data without opening the menu: hold Esc, press ✓, and release both keys.

Esc + ✓
Toggle Data Shortcut

Create Calculation from Linear Fit This option appears in the Tools menu when the Linear Fit (see page 19) is turned on. Select this option to automatically create an equation in the calculator based on the slope and y-intercept of the currently display best-fit line. If the equation of the best fit line is $y = mx + b$, where m is the slope and b is the y-intercept, then the calculation will take the form $x = (1/m)y - b/m$. This calculation will appear in the Calculator and in data source menus with the name "Linear Fit Cal." For instructions on working with calculations, see page 41.

F4 Graphs Menu

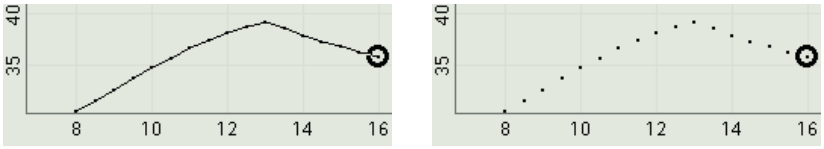
The Graphs menu contains options[8] to control the appearance of the Graph, make it emulate an oscilloscope, make it plot two data sets simultaneously, manage multiple pages, and print.



The Graphs menu

Data Cursor Select this option to turn on or off the Data Cursor and Coordinates displayed on the Graph. See page 16 for more information.

Connected Lines Select this option from the Graphs menu to turn on or off the lines connecting the data points.



Graph with connected lines (left) and without connected lines (right)

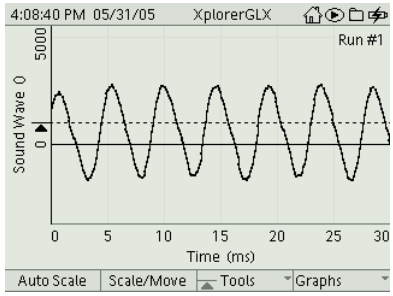
Scope Mode Select Scope mode from the Graphs menu to make the GLX emulate a digital storage oscilloscope. In this mode, the GLX collects and displays data in repeated bursts. The length of the burst and the sample rate are determined by the time scale of the Graph display. Scope mode can be used with any sensor to collect bursts of data; it is especially useful with the GLX's built-in sound sensor (see page 58) or voltage sensor.

When you turn on Scope mode, the Graph automatically sets its time range to 30 milliseconds and turns on the Trigger.[9] It also adjusts the sampling rate of the displayed sensor so that it will collect about 500 data points (or as many as possible) in each burst. If you change the Graph's time scale,[10] the GLX automatically adjusts the sampling rate.

[8] **To select an option from the Graphs menu**

Keypad
1. Press F4 to open the Graphs menu.
2. Use the arrow keys to move the highlight to the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click "Graphs" at the bottom of the screen to open the Graphs menu.
2. Click the desired menu option.



Scope mode

[9] The Trigger is initially disabled. See page 20 for instructions on enabling and setting the Trigger.

[10] See "F1 Autoscale" and "F2 Scale/Move" on page 16.

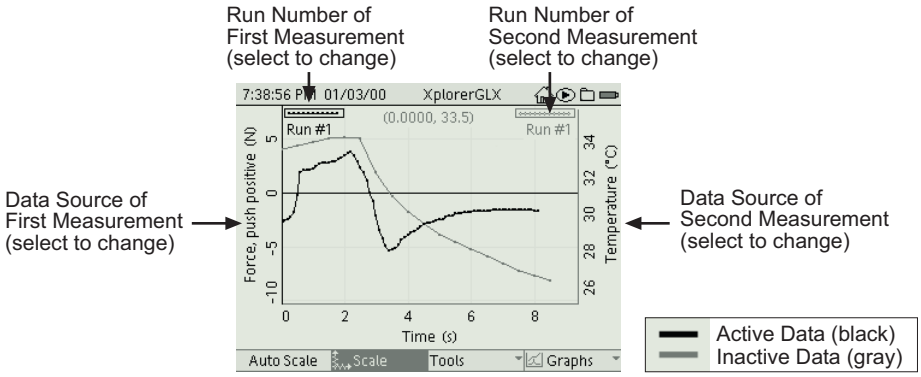
After you press ▶, the GLX begins collecting and displaying a series of data bursts (each burst is enough data fill the Graph from left to right). If you have enabled the Trigger, the GLX waits for the trigger condition to be met before collecting each burst.

While Scope-mode data collection is in progress, you can change the scale of the Graph (with F1 Autoscale, F2 Scale/Move, or the mouse) and you can change the Trigger settings with the arrow keys.

To stop data collection, press ▶ again. The GLX will save the last-collected data burst as Run #1 (or #2, #3, #4, etc.). You can also use the Trigger's Stop Condition (see page 21) to make the GLX stop automatically after collecting a single data burst.

You can use Scope Mode in conjunction with Two Measurements mode or Two Graphs mode (see below) to display two traces simultaneously.

Two Measurements Select this option from the Graphs menu to put the Graph into Two Measurements mode. In this mode, two measurements (or data sets) are graphed simultaneously.



Two Measurements mode

The data source and scale of the First Measurement are displayed on the left side, and the data source and scale of the Second Measurement is displayed on the right side. Select either the left or right data source field[11] to change the corresponding measurement.

The run number of the First Measurement is displayed in the upper left corner of the Graph, and the run number of the Second Measurement is displayed in the upper right corner. To change the run number of either measurement, select the corresponding run number field.[11]

One of the measurements is plotted in black, and the other one in gray. The measurement in black is the active data. To switch activity to the other measurement, hold Esc and press ✓.

The Data Cursor appears on the active data. If you select a tool from the Tools menu, it is applied to the active data set. If you press F2 to scale or move vertically, only the active data will change.[12] However, moving the Graph horizontally or changing the horizontal scale will affect both sets.

If you are using a mouse, you can switch activity to a measurement by clicking on the line above its run number. Vertically scale each measurement by dragging its numeric labels (on the left or right side of the Graph).

[11] **To select a data source field or run number field:**

Keypad

1. Press ✓ to light up the active fields.
2. Use the arrow keys to move the highlight to the desired field.
3. Press ✓ again to open the menu.
4. Use the arrow keys to move the highlight to the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

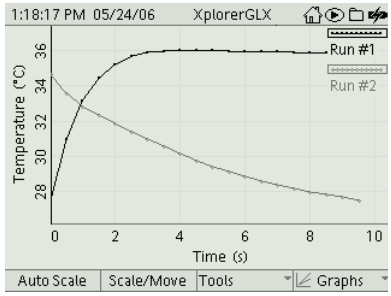
Mouse

1. Click the desired field to open the menu.
2. Click the desired menu option.

[12] The exception to this rule is when both data sets are of the same units (both temperature in °C, for instance); in that case, both data sets scale together.

Typically you would use Two Measurements mode to display data from two different sources, but you can also use it to display two runs from the same source. Select the same source from both data source fields, and different runs from each run number field. For another way to display two runs from the same source, see “Two Runs” below.

Two Runs Select Two Runs from the Graphs menu to display two data sets from a single data source.



Two Runs mode

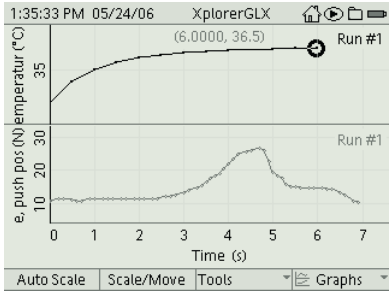
In this mode, a second run appears on the Graph. A second run number field appears in the upper right corner (below the first run number), which you can select to choose a different run.

One of the runs is plotted in black, and the other one in gray. The run in black is the active data. To switch activity to the other run, hold Esc and press ✓. The Data Cursor appears on the active data. If you select a tool from the Tools menu, it is applied to the active data set.

Both runs share a single pair of axes and they are scaled and moved together.

If you are using a mouse, you can switch activity to a run by clicking on the line above its run number.

Two Graphs Select Two Graphs from the Graphs menu to display two separate graphs simultaneously. This mode is similar to Two Measurements mode (see page 23), but each measurement is plotted on the top or bottom half of the screen, rather than overlapping.



Two Graphs mode

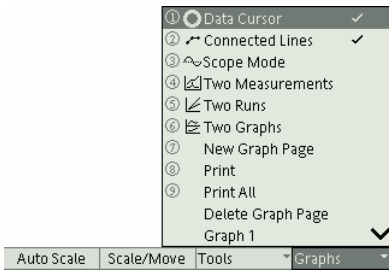
One of the measurements is plotted in black, and the other one in gray. The measurement in black is the active data. To switch activity to the other measurement, hold Esc and press ✓.

The Data Cursor appears on the active data. If you select a tool from the Tools menu, it is applied to the active data. If you press F2 to scale or move vertically, only the active data will change. However, moving the Graph horizontally or changing the horizontal scale will affect both sets.

If you are using a mouse, you can switch activity to a measurement by clicking on it.

New Graph Page The GLX supports an unlimited number of graph pages. Select New Graph Page from the Graphs menu to configure a new graph while preserving the previous one.

When two or more graph pages exist, each page appears in the Graphs menu. To make a page visible, select it from the menu.



The Graphs menu as it appears when multiple pages exist

If added graph pages make the Graphs menu too long to fit on the screen, an arrow or arrows (▼, ▲) will appear on the right side of the menu to indicate that some of the menu options are not visible.

Press the up or down arrow key multiple times to move the highlight beyond the visible portion of the menu. The menu will scroll to bring other options into view.

If you are using a mouse, you can click the arrows to scroll the menu.

Print If there is a printer connected to the GLX, select Print from the Graphs menu to print the currently displayed graph page.

Print All Select Print All to print all of the graph pages.

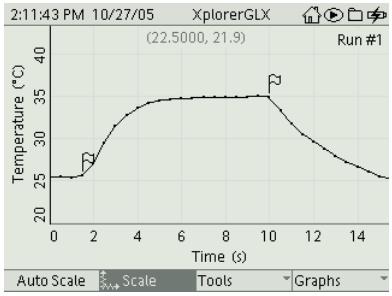
For more information, see "Printing" on page 91.

Delete Graph Page This option is available when two or more graph pages exist. When you select Delete Graph Page from the Graphs menu, the currently displayed page is deleted and the next page appears. (If there is no next page, the previous page appears.)

Data Annotation

The GLX's data-annotation capability allows you to attach notes to data points in the Graph display. You can add these notes while you are viewing the Graph either during or after data collection.[13] A note (represented by a flag icon: ⚐) can include a text message, an audio recording of your voice, or both; it can also be "empty" (not containing text or audio).

[13]In order to add a note *during* data collection, the GLX must be in Continuous Sampling mode (its default mode), rather than Manual Sampling mode. See page 57 for more information.



Data with notes

There are two ways to attach a note to a data point in the Graph display:

- Press ⚐ quickly to mark a data point with an icon (⚐) representing an empty note. You can later add text and audio to this note.
- Press *and hold* ⚐ and begin speaking to mark a point and immediately record an audio message. When you are finished speaking, release ⚐.[14]

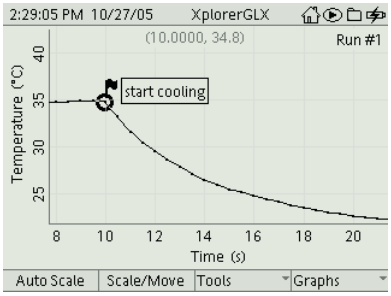
[14]The GLX cannot record audio for a data note when the microphone is configured as a sound sensor or sound level sensor. See page 58 for more information.

In both cases, the note is added at the location of the Data Cursor.[15]

See page 16 for instructions on moving the Data Cursor. If you are adding notes during data collection, it is often convenient to have the cursor tracking the data so that notes are always attached to the most recently collected point; press the down arrow key to make the cursor track the data.

[15]The Data cursor must be turned on (see page 22) in order to use data annotation.

After you have added a note, you can access its audio and text by positioning the Data Cursor on it.



A note with the Data Cursor positioned on it

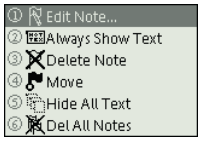
To make the Data Cursor jump directly to a note, hold Esc and press one of the arrow keys. Press Esc plus the left or right arrow key to make the cursor jump to the next visible note in either direction; press Esc plus the up or down arrow key to make the cursor jump to the first or last visible note. When the cursor lands on a note, the audio portion (if any) starts playing[16] and the text portion of the note (if any) appears.

[16] If you have not changed the default setting, the audio plays through the GLX's built-in speaker; otherwise it plays through the output device specified in the Audio Settings dialog box, which is accessed from the Settings screen. See page 87 for more information.

Annotation Menu

To change any of a note's attributes, position the Data Cursor on the note and press F; the Annotation menu will open.

If you have a mouse, you can open the menu by clicking the flag icon.



Annotation Menu

Select[17] any of the following menu options.

Edit Note Select this option to open the Note Editor dialog box. There you can read the text, listen to the audio, enter new text, change existing text, and record new audio. See "Note Editor Dialog Box" below for instructions.

Always Show Text This option is either turned on (with a check mark appearing next to it in the menu) or off (no check mark). When the option is on, the note's text is visible on the Graph even when the cursor is not on the note. To switch Always Show Text on or off, select it from the Annotation Menu.

Delete Note Select this option to delete the *entire* note, including the text and audio portions and the flag icon.

Move Select this option to move the note to a different data point. After you have selected Move, the flag icon becomes mobile; use the arrow keys (or mouse) to move the icon to a different data point and press ✓ to attach it to that point.

Hide All Text and Show All Text Select either of these options to hide or show the text of *all* notes in the displayed data run. These options are equivalent to turning on or off the Always Show Text option for every note.

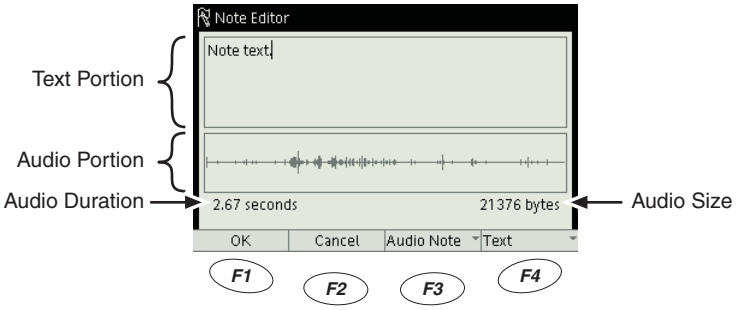
Delete All Notes Select this option to delete every note in the displayed data run.

[17] **To select and option from the Annotation menu**

Keypad
1. Position the Data Cursor on the data note.
2. Press F to open the menu.
3. Use the arrow keys to move the highlight to the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click the flag icon (⚐) to open the menu.
2. Click the desired menu option.

Note Editor Dialog Box

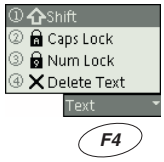


Note Editor Dialog Box

The Note Editor opens when you select Edit Note from the Annotation menu.

The text portion of the note appears in the upper half of the box. Use the GLX's keypad (or an attached USB keyboard) to enter new text or edit existing text.[18] Press F4 to open the Text menu, which contains options related to entering and editing text.

[18]See "Multipress Text Input Mode" on page 90.



Text Menu

To type a capital letter, select Shift or Caps Lock.[19] To take the keypad out of multipress text mode (to type only numerals), select Num Lock. To delete the *entire* text portion of the note, select Delete Text.

The audio portion of the note is graphically represented in the lower half of the Note Editor along with the audio recording duration and size. Press F3 to open the Audio Note menu, which contains options for recording and playing audio.[14]

[19]**To select an option from the Text or Audio Note menu**

Keypad

1. Press F3 or F4 to open the menu.
2. Use the arrow keys to move the highlight to the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

1. Click "Audio Note" or "Text" at the bottom of the screen.
2. Click the desired menu option.

Audio Note Menu

To record new audio, select Record Audio Note and begin speaking; press F3 to stop recording.[14] When you record new audio, the note's previous audio is overwritten. To play the audio portion of the note, select Play Audio Note from the Audio Note menu.[16] To delete the audio, select Delete Audio Note.

Two other menu options, Record Quality and Record Level, allow you to set the GLX's audio sample rate, bits per sample, and microphone volume *before* you record audio. The properties set using these options are identical to those in the Audio Settings dialog box (which is accessed from the Settings screen); see page 87 for details.

When you have finished changing the text and audio portions of the note, press F1 to accept changes and close the Note Editor, or press F2 to cancel changes.

Table

Use the Table to display data, edit or enter data manually, and display statistics on data sets. The Table can show up to four columns of numeric or text data.

To Open the Table

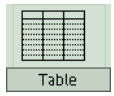
From the Home Screen, do one of the following:

F press F2, the function key below the Table icon;

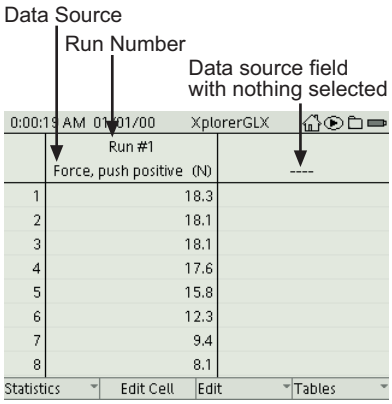
use the arrow keys to highlight the Table icon, then press ✓; or

click the Table icon.

From *anywhere* in the GLX environment, you can always get to the Table with the shortcut ⌂ + F2.



The Table icon on the Home Screen



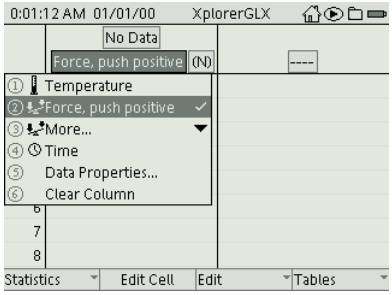
The Table Display

Choosing Data to Display

The Table can contain up to four columns.[20] Each column can be set to display data from one data source. If time is displayed, it occupies its own column. A column can also be empty (not set up for any data source).

The active fields described below are used to control what data appear in each column. (See page 14 for more information about active fields.)

Data Source Select the data source field[21] at the top of a column to choose a sensor measurement, calculation, manually entered data set, or time, or to clear the column. If no data source is assigned to a column, the data source field appears as a series of dashes (----).



Data Source menu

[20] See "F4 Tables" on page 31 for instructions on changing the number of displayed columns.

[21] **To select the data source, units, or run number field**

Keypad
1. Press ✓ to light up the active fields.
2. Use the arrow keys to move the highlight to the desired field.
3. Press ✓ again to open the menu.
4. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

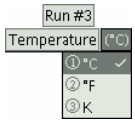
Mouse
1. Click the desired field to open the menu.
2. Click the desired menu option.

If the chosen data source does not contain data, the data source name will appear at the top of the column, but the cells of the column will remain empty until data collection starts.

Also from the data source menu, you can select Properties to edit the name and other properties of the currently displayed data set. See "Data Properties" on page 69 for more information.

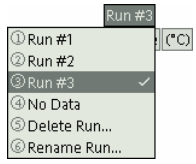
> For more information on selecting data from a data source menu when you are working with more than one sensor, or with a multiple-measurement sensor, see "Data Source Menus" on page 89.

Units Select the units field[21] to choose different units (if available) for the chosen data source.



Units menu

Run Number Select the run number field[21] to choose a different run, or select No Data to display nothing.



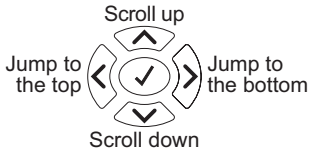
Run number menu

> By default, the Table is set to change the displayed run number in all columns whenever you change it in one column. Refer to "Lock Run Selection" on page 31 to change that setting.

The last two options in the run number menu are Delete Run and Rename Run. See "Run Number" on page 15 for more information.

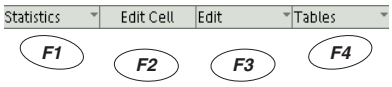
Table Scrolling

At any time, up to eight cells of data are visible in each column. Press the up or down arrow key to scroll the Table and make other rows of data visible. Press and *hold* the up or down arrow key to make the Table scroll continuously. Press the left arrow key to jump to the beginning of the table; press the right arrow key to jump to the end.



> The rules for scrolling are different when an editable column is visible. See page 35

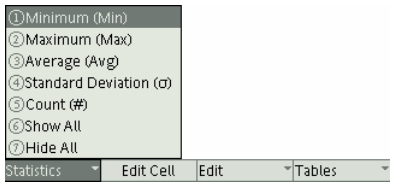
Table Function Keys



In the Table, the function keys are used to control the display of statistics, to edit data, and to set the number of columns.

F1 Statistics

From the Statistics menu, you can choose to display any of the following statistics for the displayed data sets:



Statistics menu

- **Minimum** (Min), the lowest value in the data set,
- **Maximum** (Max), the highest value in the data set,
- **Average** (Avg), the average of all values in the data set,
- **Standard Deviation** (σ), a measure of how much the data varies from the average, and
- **Count** (#), the number of values in the data set.

The chosen statistics will be displayed at the bottom of every column. To choose a statistic, select it from the menu.[22] To turn off a displayed statistic, select it again.

Select Show All or Hide All to turn on or off all of the statistics.

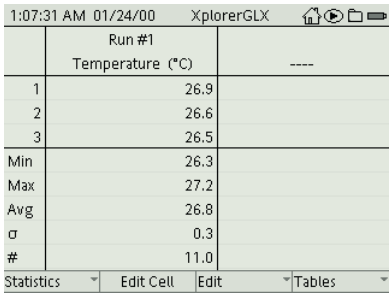


Table with statistics displayed

[22] **To select a statistic from the Statistics menu:**

Keypad

1. Press F1 to open the Statistics menu.
2. Use the arrow keys to move the highlight to the desired statistic and press ✓; *or* press the number on the keypad corresponding to the desired statistic.

Mouse

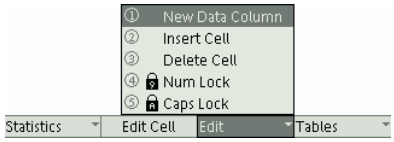
1. Click "Statistics" at the bottom of the screen to open the Statistics menu.
2. Click the desired statistic.

F2 Edit Cell

When you are navigating in an *editable* column, press F2 to edit the selected cell. See "Manually Entered Data" on page 32 for instructions on editing data.

F3 Edit

The options in the Edit menu are used when editing or entering data. See "Manually Entered Data" on page 32 for more information.



Edit menu

New Data Column Select New Data Column from the Edit menu to create an editable data set. See "Manually Entered Data" on page 32 for more information.

Insert Cell Insert Cell works only when the dashed Navigating Box is visible[23] (see page 34). When you select Insert Cell, a new cell is added directly above the Navigating Box. If the column contains numeric data, the new cell will contain the number 0. If the column contains text data, the new cell will be blank. Every cell below the new cell shifts down by one position.

Delete Cell Delete Cell works only when the dashed Navigating Box is visible[23] (see page 34). When you select Delete Cell, the cell that the Navigating Box is on is deleted. Every cell below the deleted cell shifts up by one position.

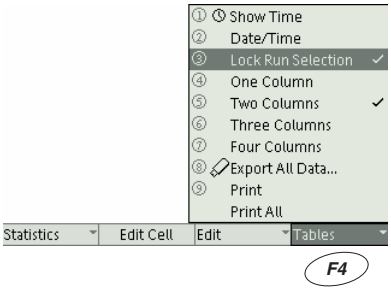
Num Lock Num Lock is only available in the Edit menu when an editable column is displayed. When Num Lock is turned on (which it is by default), a check mark (✓) appears next to it in the menu, and the keypad operates in numbers-only mode.

When Num Lock is turned off, the keypad can be used in multipress text input mode (see page 90) to enter numbers and letters. To turn Num Lock on or off, select it from the Edit menu.

Caps Lock Caps Lock is only available in the Edit menu when an editable column is displayed. When Caps Lock is turned on, a check mark (✓) appears next to it in the menu. When used in multipress text input mode, the keypad inputs capital letters.

[23] To make the Navigating Box appear in an editable column, press Esc.

F4 Tables



Tables Menu

From the Tables menu, you can select to display one, two, three, or four columns.[24] If you increase the number of columns, new columns are added to the right side (the GLX automatically selects data sources, if available, for new columns). If you decrease the number of columns, they will be removed from the right side (the data displayed in those columns disappears, but is not be permanently deleted).

[24] **To select an option from the Tables menu**

Keypad

1. Press F4 to open the Tables menu.
2. Use the arrow keys to move the highlight to the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

1. Click "Tables" at the bottom of the screen to open the Tables menu.
2. Click the desired menu option.

1:25:06 AM 01/24/00 XplorerGLX

	Run #1 Temperature (°C)
1	35.9
2	35.9
3	35.9
4	35.9
5	35.9
6	35.9
7	35.9
8	35.9

Statistics | Edit Cell | Edit | Tables

1:26:32 AM 01/24/00 XplorerGLX

	Run #1 Time (s)	Run #1 Temperature (°C)
1	0.0000	35.9
2	0.5000	35.9
3	1.0000	35.9
4	1.5000	35.9
5	2.0000	35.9
6	2.5000	35.9
7	3.0000	35.9
8	3.5000	35.9

Statistics | Edit Cell | Edit | Tables

1:26:58 AM 01/24/00 XplorerGLX

	Run #1 Time (s)	Run #1 Temperatur (°C)	Run #1 ative Press (kPa)
1	0.0000	35.9	0.0
2	0.5000	35.9	0.0
3	1.0000	35.9	0.0
4	1.5000	35.9	0.1
5	2.0000	35.9	0.0
6	2.5000	35.9	0.0
7	3.0000	35.9	0.1
8	3.5000	35.9	0.3

Statistics | Edit Cell | Edit | Tables

1:27:27 AM 01/24/00 XplorerGLX

	Run #1 Time (s)	Run #1 mperatı (°C)	Run #1 ve Pre (kPa)	Run #1 . push p((N)
1	0.0000	35.9	0.0	23.6
2	0.5000	35.9	0.0	24.8
3	1.0000	35.9	0.0	27.0
4	1.5000	35.9	0.1	29.2
5	2.0000	35.9	0.0	28.6
6	2.5000	35.9	0.0	28.6
7	3.0000	35.9	0.1	25.4
8	3.5000	35.9	0.3	22.4

Statistics | Edit Cell | Edit | Tables

Tables with one, two, three, and four columns

Other options in the Tables menu are described below.

Show Time Select Show Time to add a column of time data in the left-most position.[25] If there are four columns displayed when you select Show Time, the fourth column will be removed and the other three columns will shift to the right to make room for the time column on the left.

[25] To show time in a column other than the first one, select it from the data source menu at the top of the desired column. See "Data Source" on page 28 for more information.

Date/Time To turn on this option, select it from the Tables menu. With the option turned on, times displayed in the Table appear as the date and time of day at which each data point was recorded. With the Date/Time option turned off, time data appears as measured from the start of data collection.

The Date/Time format is set in the Settings screen. See page 85.

4:02:17 PM 10/27/05 XplorerGLX

	Time	Run #1 Temperature (°C)
1	10/27/05 3:56:14 PM	25.9
2	10/27/05 3:57:14 PM	23.7
3	10/27/05 3:58:14 PM	23.8
4	10/27/05 3:59:14 PM	23.8
5	10/27/05 4:00:14 PM	24.0
6	10/27/05 4:01:14 PM	24.0
7	10/27/05 4:02:14 PM	24.0
8		

Statistics | Edit Cell | Edit | Tables

Table with Date/Time option

Lock Run Selection When Lock Run Selection is on (which it is by default), all data columns will display the same run number, and changing the run number

of one column will cause all of them to change.[26] To turn Lock Run Selection off or on, select it from the Tables menu.

Export All Data If you have a USB storage device[27] (such as a USB flash drive), you can use this option to export data in tab-delimited text format. The GLX creates a text file on the storage device that you can open on a computer in a spreadsheet, mapping software, DataStudio, and other programs.

See page 83 for other ways to save and open data on a USB storage device.

Connect the storage device to the GLX's USB port and select Export All Data from the Tables menu. A dialog box appears showing which data sets will be exported. Highlight any of these data sets and press ✓ to exclude it. To select other data sources for exporting press F3 to add a single data source or press F4 to add all data sources that have been set to "visible" in the Sensors screen. Press F1 (OK) to create the export file on the USB storage device.[28]

Before exporting data for use with mapping software, display time in the first column and turn on the Date/Time option (see page 31).

To view the exported data, disconnect the storage device from the GLX and connect it to a computer. You will find the text file at the root level of the storage device. Its filename encodes the date and time at which the data was exported; for instance, if you exported data on October 28, 2005 at 11:22:53 AM, the filename will be "Export10282005112253.txt". You can open this file in a text editor, spreadsheet, or other program designed to import tab-delimited data.[29]

Print If there is a printer connected to the GLX, select Print to print one page of data. The GLX will print the data that are visible on the screen, plus as much additional data as will fit on one page.[30]

Print All Select Print All to print the entire contents of the displayed data sets, including data that are not currently visible on the screen (data that you would have to scroll up or down to see). If necessary, the GLX will print multiple pages.

[26] See "Run Number" on page 29 for instructions on changing the run number displayed in a column.

[27] The USB storage device must be formatted using the FAT16 or FAT32 file system. Most flash drives are formatted this way. Other mass-storage devices such as portable hard drives and audio players may also be compatible. You can use a USB card reader, however the card must be in the reader before you connect the reader to the GLX.

[28] If you export data while data collection is in progress, the text file will contain the data collected up to that point, and the GLX will continue to collect data.

[29] To import the file into DataStudio, open the File menu and select Import Data.

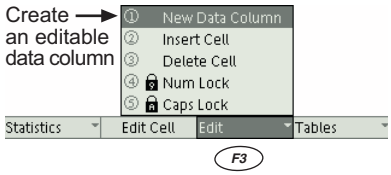
[30] For more information on printing, see "Printing" on page 91.

Manually Entered Data

In addition to collecting data from sensors, the GLX allows you to enter data in the Table display via the keypad or an attached keyboard. Any data that you have entered can later be edited.

Entering a New Data Set

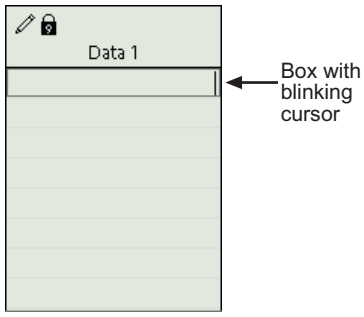
Creating a New Data Column Before you can enter data, an editable data column must exist. To create one, press F3 to open the Edit menu and select New Data Column.



The keypad shortcut for creating a new data column is F3, 1, pressed in sequence.

The new editable column takes the place of the first blank column in the Table. If there is no blank column, and there are three or fewer other columns, the new editable column is added on the right side of the table. If the Table is already displaying four columns, the new editable column replaces the fourth column.

Entering Numeric Data In a New Column In the new editable column, you will see a box around the first cell and a blinking cursor inside the cell.



1. Type a number on the keypad (or attached keyboard), then press ✓.

   When editing data in the Table, = has the same effect as ✓.

2. The box and cursor will step to the next cell in the column. Enter another value and repeat.

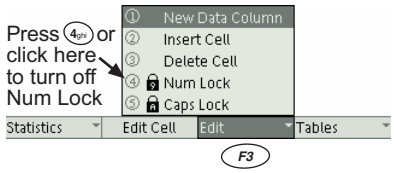
3. When you are finished, press Esc. (You must press ✓ to lock in the last value *before* you press Esc.)

   If you would like to change or add to the data after you have pressed Esc, refer to "Editing an Existing Data Set" on page 34.

Entering Text Data in a New Column In addition to numeric data, the Table allows you to create a column of text.

1. Create a new data column as described on page 32.

2. Press F3 to open the Edit menu. If Num Lock is turned on, select it to turn it off and enable multipress text input mode. (If you are using an attached keyboard, this step is unnecessary.)

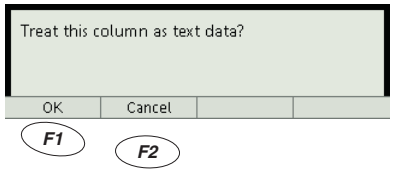


   For more information, see "Num Lock" on page 30 and "Multipress Text Input Mode" on page 90.

3. Type a non-numeric string of text and press ✓.

   The non-numeric text string can contain numerals, but it must have at least one letter or punctuation mark, so the GLX knows that it is supposed to be text. This limitation applies to only one cell in the column. After non-numeric text has been entered in one cell, the GLX will treat everything in that column as text, even if it looks like a number.

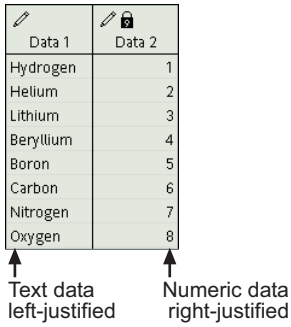
4. A dialog box will appear, reading: "Treat this column as text data?" Press F1 to select OK.



   The column is now configured to contain text data. If you enter a numeric value it will be treated as text only. You can recognize a text-only data set by its left-justification (contents appear on the left side of the column) as opposed to numeric data, which is always right-justified.

5. Continue entering text in subsequent cells. Press ✓ after you type in each cell to lock in that text string and step to the next cell. You can press ✓ on a blank cell to leave it empty.

6. When you are finished entering data, press Esc. (You must press ✓ to lock in the last value *before* you press Esc.)



   If you would like to change or add to the text data after you have pressed Esc, refer to "Editing an Existing Data Set" on page 34.

Naming Manually Entered Data and Adding Units

By default, new editable data sets are named “Data 1,” “Data 2,” etc., and they do not have defined units. To change the name and add units, open the data source menu and select Data Properties.[31]

For more information, see “Data Source” on page 28, and “Data Properties” on page 69.

Editing an Existing Data Set

The above section, “Entering a New Data Set” starting on page 32, describes how to create and enter data in a new column. This section describes how to change and add to a manually entered data set that has previously been created.

Whenever you have one or more editable columns displayed in the Table, one of the editable cells is surrounded by a box. The box is either an Editing Box (solid lines) or a Navigating Box (dashed lines).

Editing Box The Editing Box[32] is drawn with solid lines, and always contains a blinking cursor. It may be on a cell that already contains data, or it may be on an empty cell.

To move the Editing Box to a different cell, refer to “Navigating Box” below.

If the Editing Box is on an empty cell, anything that you type on the keypad (or attached keyboard) will appear in that cell.

When the Editing Box is on a cell that already contains data, what you type will either replace or amend the contents of the cell, depending on whether the contents are highlighted.

- If the cell contents are highlighted, they will be replaced by any number or text that you type. If you press ⌫, the entire contents of the cell will be deleted.
- If the cell contents are not highlighted, they will be amended at the location of the blinking cursor. If you press ⌫, the character to the left of the cursor will be deleted.

By default, when the Editing Box appears on a cell, the contents (if any) are highlighted. To remove the highlight, press the left or right arrow key, then use the left or right arrow key to move the blinking cursor to the position where you would like to make an edit.

After you have changed the cell contents, you must press ✓ to lock in the change. If you want to cancel the change, or leave the cell without entering data, press Esc instead of ✓.

If the contents of a cell are not highlighted, you can restore the highlight by pressing F2.

Navigating Box The Navigating Box[33] is drawn with dashed lines. Use the up and down arrow keys to move it within an editable column. Use the left and right arrow keys to move it to other editable columns.

[31] **To open the data source menu and select Data Properties**

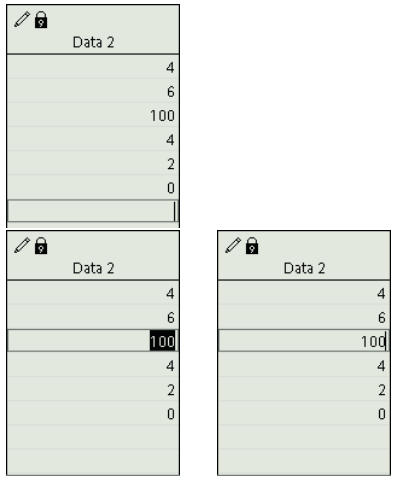
Keypad

1. If the blinking cursor is visible, press Esc.
2. Press ✓ to light up the active fields.
3. Use the arrow keys to move the highlight to the data source field.
4. Press ✓ to open the menu.
5. Use the arrow keys to highlight Data Properties and press ✓; *or* press the number on the keypad corresponding to Data Properties.

Mouse

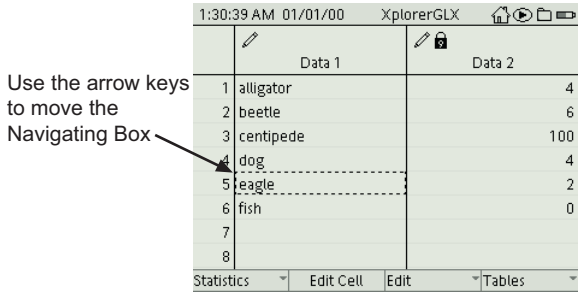
1. Click the data source field to open the menu.
2. Click Data Properties.

[32] If you do not see the Editing Box, press F2.



The existing contents will be replaced **The existing contents will be amended**

[33] If an editable column exists, but you do not see the Navigating Box, press Esc.



Position the Navigating Box on a cell where you would like to enter or edit data, then press F2 to make the Editing Box appear. To restore the Navigating Box, press Esc.

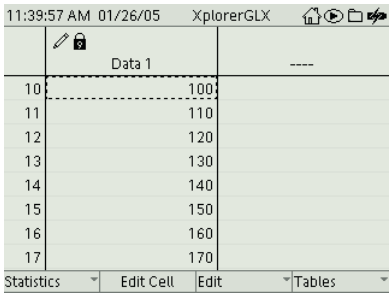
If you would like to add data to the bottom of a data set, position the Navigating Box on the first empty cell below the existing data and press F2.

Table Scrolling with Manually Entered Data

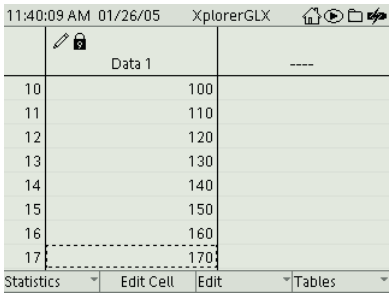
At any time, up to eight cells of data are visible in a manually entered data column. As with regular Table scrolling (see page 29), use the up or down arrow key to scroll the Table up or down and make other rows of data visible.

To scroll the Table when manually entered data column is displayed, the dashed Navigating Box must be visible.[34] To scroll up, press the up arrow key repeatedly (or press and hold it) to move the Navigating Box to the first visible cell, then continue to press (or hold) the key. To scroll down, press the down arrow key repeatedly (or press and hold it) to move the Navigating Box to the last visible cell, then continue to press (or hold) the key.

[34] If the Navigating Box is not visible, press Esc.

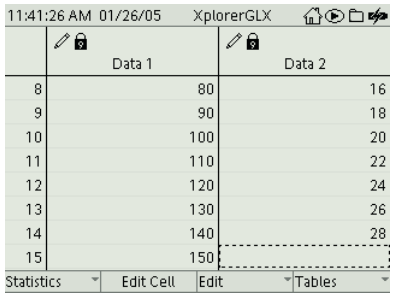


Press ^ to scroll up



Press v to scroll down

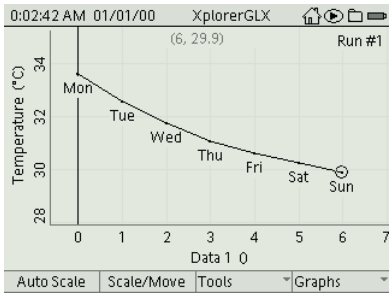
All columns scroll together. The Table will not scroll past the bottom of the column containing the Navigating Box. In the table picture below, the Navigating Box is at the end of the shorter data column. To scroll the Table down, press the left arrow key to place the Navigating Box on the longer manually entered column.



Graphing Manually Entered Data

Numeric Data After you have created an editable numeric data set in the Table, you can display it in the Graph. In the Graph, select the editable data from the horizontal or vertical data source menu (see page 15).

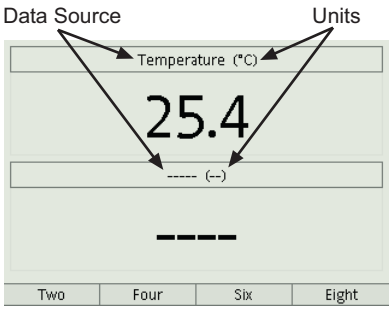
Text Data A text data set can be displayed on the horizontal axis of the Graph. First select a numeric data as the vertical data source, then select the text data as the horizontal data source (see page 15). The text from each cell of the Table appears on the Graph as a label next to the corresponding data point.



Graph displaying manually entered text data on the horizontal axis

Digits Display

Use the Digits display to show data from up to eight data sources. This display monitors and shows live data even when the GLX is not recording.



Digits display

To Open the Digits Display

From the Home Screen, do one of the following:

use the arrow keys to highlight the Digits icon, then press ✓; or

click the Digits icon.

The Digits icon on the Home Screen

Choosing Data to Display

Data Source Select the data source field[35] at the top of each section to select a data source. A data source would usually be a sensor measurement or a calculation based on a sensor measurement.

Sensor measurements or calculations based on sensor measurements can vary while data collection is in progress. If you select a static data source (such as manually entered data), the Digits display will show only the last data point.

For more information on selecting data from a data source menu, see "Data Source Menus" on page 89.

Also select the data source field to access the Data Properties of the displayed data. See "Data Properties" on page 69 for more information.

Units Select the units field[35] at the top of each display to select different units for the selected data source (if available).

[35] **To select a data source field**

Keypad

1. Press ✓ to light up the active fields.
2. Use the arrow keys to move the highlight to the data source or units field.
3. Press ✓ again to open the menu.
4. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

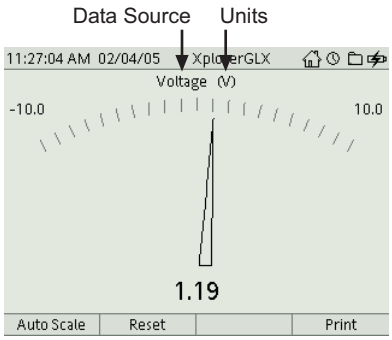
1. Click the data source or units field to open the menu.
2. Click the desired menu option.

Digits Function Keys

Press F1, F2, F3, or F4 to divide the display into two, four, six, or eight segments. The GLX automatically selects data sources, if available, for new segments.

Meter

The Meter display simulates an analog meter with a needle that deflects in proportion to a sensor measurement or sensor-based calculation. This display monitors and shows live data even when the GLX is not recording.



Meter display

To Open the Meter Display

From the Home Screen, do one of the following:

use the arrow keys to highlight the Meter icon, then press ✓; or

click the Meter icon.

The Meter icon on the Home Screen

Choosing Data to Display

Data Source Select the data source field[36] at the top of the Meter display to select a data source. A data source would usually be a sensor measurement or a calculation based on a sensor measurement.

Sensor measurements or calculations based on sensor measurements can vary while data collection is in progress. If you select a static data source (such as manually entered data), the Meter display will show only the last data point.

For more information on selecting data from the a data source menu, see “Data Source Menus” on page 89.

Units Select the units field[36] at the top of the display to select different units for the selected data source (if available).

[36] **To select a data source or units field**

Keypad

1. Press ✓ to light up the active fields.
2. Use the arrow keys to move the highlight to the desired field.
3. Press ✓ again to open the menu.
4. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

1. Click the desired field to open the menu.
2. Click the desired menu option.

Auto Scale and Reset

Press F1 to automatically scale the Meter. If the GLX is recording data, the lower and upper limits of the meter will be reset to equal the lowest and highest values measured thus far in the current or most recent data run. Press F2 to restore the default scale.

Print

Press F4 to print the Meter. See page 91 for more information.

Chapter 2: Utility Screens

This chapter describes the Output screen, Calculator, Notes screen, and Stopwatch.

Output

The Output screen is the control panel for generating sound through the GLX's built-in speaker or through headphones or amplified stereo speakers connected to the signal output port.

To Open the Output Screen

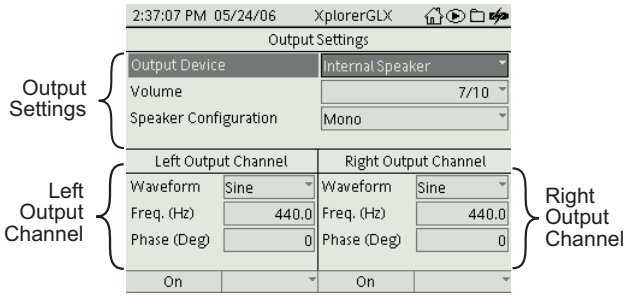
From the Home Screen do one of the following:

use the arrow keys to highlight the Output icon, then press ✓; or

click the Output icon.

The Output icon on the Home Screen

Navigating in the Output Screen



The Output screen is divided into three parts: Output Settings, Left Output Channel, and Right Output Channel. There are three controls within each part, for a total of nine controls. One of the controls is always highlighted. Use the arrow keys to move the highlight. Press ✓ to select the highlighted control. If a menu opens, use the up and down arrow keys to highlight the desired setting and press ✓. If a cursor appears, type the desired value and press ✓. The Volume, Frequency, and Phase controls can also be set using + and −.

If you are using a mouse, click the control that you would like to set; then click the desired menu option, or type the desired value.

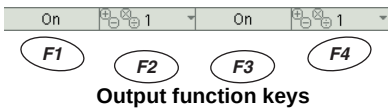
Output Function Keys

F1 and F3 On/Off

Press F1 to turn the left channel on or off, press F3 to turn the right channel on or off.

F2 and F4

When the Frequency control for the left or right channel is highlighted, press F2 or F4 to set the step size for that channel. From the menu that opens, select one of the step sizes or select Custom Step to enter any value. The step size determines the amount by which the frequency changes when you press +, −, x, or / (see "Frequency" below).



Output function keys

Output Settings[1]

[1]The output settings in the Output screen can also be changed in the Audio Settings dialog box, accessed from the Settings screen (see page 87). When you change the settings in one location, they are automatically updated in the other location.

Output Device

Highlight the Output control and press ✓ to select the output device that you are using.

Headphones Select this option to play sound through headphones connected to the signal output port on the left side of the GLX.

Internal Speaker If there is nothing connected to the signal output port, select Internal Speaker to play sound through the GLX's built-in speaker.

External Speaker Select this option to play sound through a pair of amplified stereo speakers connected to the signal output port.

Power Amplifier Selecting this option puts the Output screen into a special mode for the optional GLX Power Amplifier.

Volume

The Volume setting determines the overall loudness of the output sound. Highlight the Volume control and press + or − to change it incrementally; or press ✓ to select the desired volume from a menu.

Speaker Config

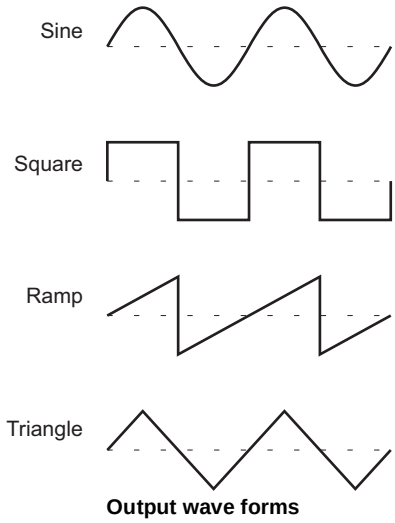
When Output Device is set to Headphones or External Speaker, the two options for Speaker Config are Stereo and Mono. When Output device is set to Internal Speaker, Mono is the only option. In Mono configuration, the signals from both channels are combined within the GLX; both external speakers or both sides of the headphones play the same combined signal. In Stereo configuration, the Left Output Channel plays through the left speaker or the left side of the headphones, and the Right Output Channel plays through the right speaker or the right side of the headphones.[2]

[2]If you are using stereo headphones to demonstrate beats or destructive interference, set Speaker Config to Mono so that each ear can hear both tones.

Left and Right Output Channels

Wave

Highlight the left or right Wave control and press ✓ to set the wave form of each output channel. The options are Sine, Square, Ramp, and Triangle.



Output wave forms

Frequency

Highlight the left or right Frequency control and press + or − to change the frequency up or down by the value specified above F2 or F4; press X or / to multiply or divide the frequency by that value. To enter the frequency directly, press ✓. The frequency can be set between 240 and 5000 Hz for the internal speaker, or between 60 and 5000 Hz for external speakers and headphones.

Phase

Highlight the left or right Phase control and use + or − to adjust the phase up or down, or press ✓ and enter the desired phase. The phase of each channel can be set between -360° and 360°.

Calculator

You can use the GLX Calculator like a regular calculator for finding the result of a simple expression, like a graphing calculator for plotting equations, and for performing operations, in real time, on streams of data collected from sensors and on sets of manually entered data.

To Open the Calculator

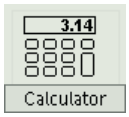
From the Home Screen, do one of the following:

(F) press (F3), the function key below the Calculator icon;

use the arrow keys to highlight the Calculator icon, then press (✓); or

click the Calculator icon.

From *anywhere* in the GLX environment, you can always get to the Calculator with the shortcut (⌂) + (F3).



The Calculator icon on the Home Screen

Types of Calculations

The Calculator supports four types of calculations: basic, algebraic, graphing, and sensor-based. The following examples will demonstrate the four types.

example

Basic Calculations

Basic calculations involve only numerals (no constants or variables). Open the Calculator and try this:

- On the first blank line, type:

  1 + 1 (✓)

  The Calculator responds by adding an equal sign and the result. It also displays the result at the bottom of the screen. Notice that the cursor has moved to the next line.

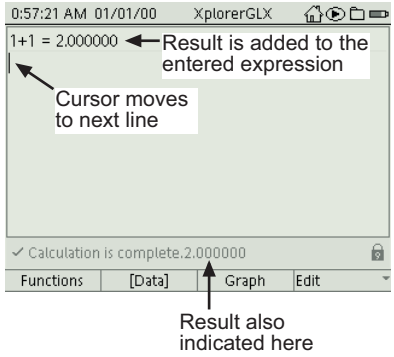
- On the next line type:

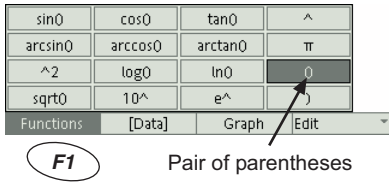
  9 * (8 + 3) (=)

  To type the multiplication symbol (the asterisk), press (X).

  For the parentheses, press (F1) once to open the first Functions menu[3]; use the arrows to highlight the pair of parentheses, then press (✓).

  Note that (=) has the same effect as (✓).





First Functions menu

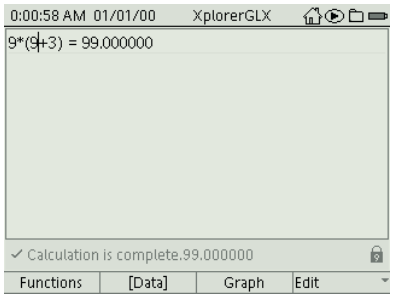
[3]For more information on the Functions menus, see page 48.

- Press the up arrow key to put the cursor back on the above expression and modify it to read:

  9 * (9 + 3)

  When you type something into the middle of an existing expression, the new characters are inserted without overwriting anything; press ⌫ to delete the characters that you don't want.

  Note that the correct result does not appear until you have moved the cursor to a different line by pressing = or ✓, or the up or down arrow key.



This expression has just been modified, but the user has not yet pressed = or ✓ so it appears to show an incorrect result.

example

Algebraic Calculations

Algebraic calculations involve symbols (letters or words) standing for constants. When you enter an algebraic expression, the GLX fills in the result if it knows the value of every symbol used in the expression. If it does not know the value of a symbol, it will prompt you to enter it.

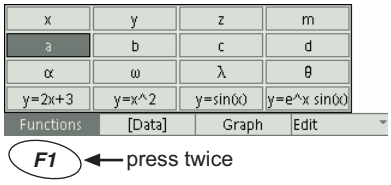
If you are entering an equation to be graphed, leave one symbol undefined. See "Graphing Equations" on page 44 for more information.

Try these examples:

- Type:

  a + 3 ✓

  For the *a* symbol, press F1 twice to open the second Functions menu. Use the arrow keys to highlight a, then press ✓.



Second Functions menu

For more information on the Functions menus, see page 48.

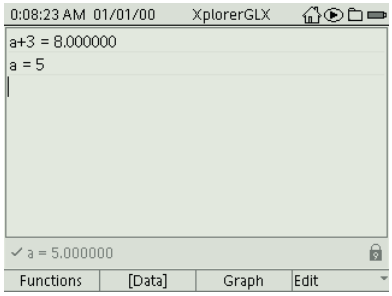
  The Calculator does not know the value of *a*, so it prompts you with:

  a =

  Type:

  5 ✓

  The Calculator fills in the result of the original expression.



The Calculator fills in the result of *a*+3 when the value of *a* is entered.

- Try entering a new value for *a* on the next line:[4]

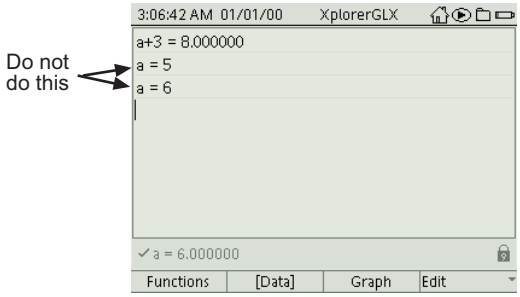
  a = 6 ✓

  Note that the original expression still reads

  a + 3 = 8

[4]For the *a* symbol, press F2 twice and select it from the second Functions menu.

When there is more than one definition for the same symbol, the calculator uses the first definition. *To avoid confusion, do not define a symbol more than once.* If you want to change the value of a symbol, use the arrow keys to go back to the original definition and change it.



- When you are prompted for the value of a symbol, you can enter another expression rather than a simple number. Type:[5]

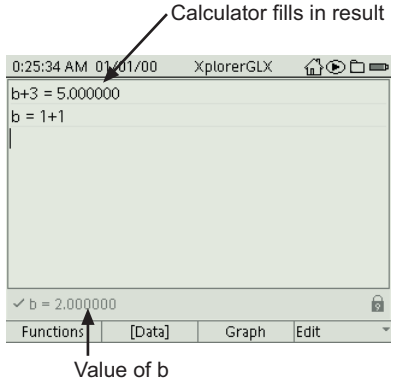
  b + 3 ✓

  When prompted for the value of *b*, enter:

  1 + 1 ✓

  The Calculator displays the value of *b* at the bottom of the screen and fills in the result of *b* + 3 on the line above.

[5]For the *b* symbol, press F2 twice and select it from the second Functions menu.



- Rather than a simple expression, you can enter a complete equation for the Calculator to evaluate. Enter:[6]

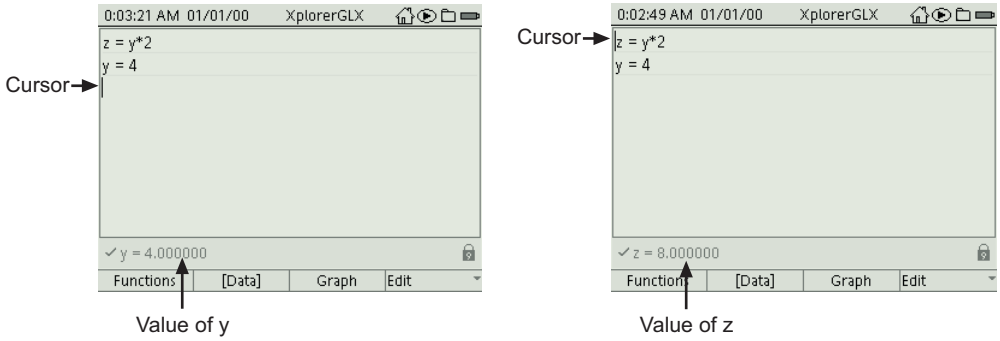
  z = y * 2 ✓

  When prompted for the value of *y*, enter:

  4 ✓

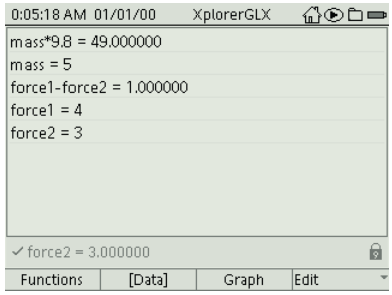
  The Calculator indicates the value of *y* at the bottom of the screen. To see the value of *z* at the bottom of the screen, use the up arrow key to put the cursor on the definition of *z*.

[6]For the *z* or *y* symbol, press F2 twice and select it from the second Functions menu.



Reposition the cursor to see the value of z

- A symbol does not have to be a single letter. The Calculator will recognize any text string (without spaces) as a symbol, including text strings that contain numerals. (To type text on the keypad, see “Num Lock” on page 50.)



Examples of text strings used as symbols in algebraic calculations

example

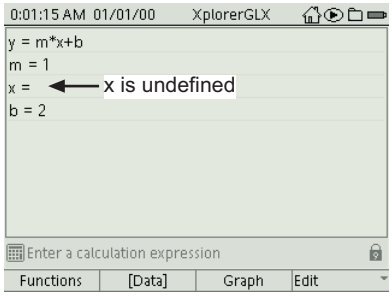
Graphing Equations

If you enter an equation that contains one undefined variable to the right of the equal sign, the GLX can graph it.

- Type:[7]

  y = m * x + b ✓

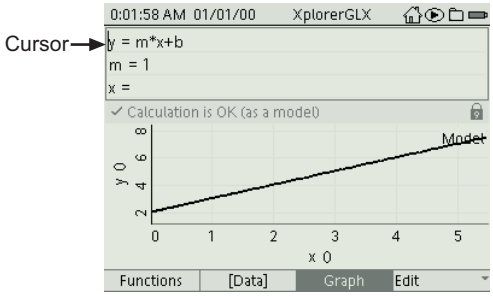
- When prompted, assign numeric values for *m* and *b*, but not for *x*.



Enter values for *m* and *b*, but not *x*

- Press the up arrow key to place the cursor on y = m * x + b and press F3. The equation is plotted in a preview graph in the lower half of the screen.

  The preview graph will always show the equation that the cursor is on. (Move the cursor down to *m* and see what happens.)



F3

The preview graph shows the equation that the cursor is on

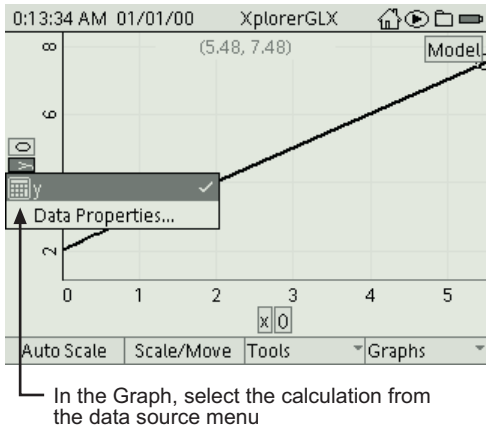
  Press F3 again to turn off the preview graph.

- The preview graph is a simplified version of the Graph screen, without all of the scaling and analysis features.[8] For the normal full-screen Graph, press ⌂ + F1, then select the calculation (y) from the data source menu of the vertical axis.

[7] For the *y, m, x,* or *b* symbol, press F2 twice and select it from the second Functions menu.

[8] If you are using a mouse, you can scale the preview graph by direct manipulation (see page 17).

See "Data Source" on page 15 for more information about selecting data in the Graph.

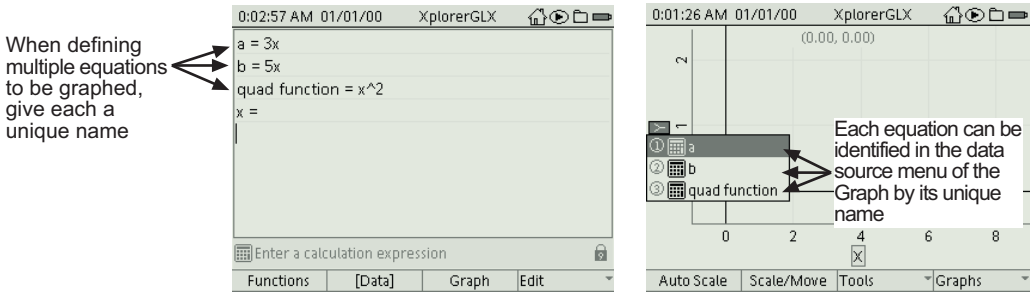


- You don't have to use *x* as the undefined variable; whichever symbol you leave undefined on the right side of the equation will be plotted on the horizontal axis. However, the label on the horizontal axis will always read "x," even if the variable used in the calculation is not *x*.

Do not leave more than one symbol on the right side of the equation undefined. If you do, the graph will use both of them as model ranges with confusing results.

- The text on the left side of the equation does not have to be *y*. The text to the left of the equal sign is the name of that calculation, and will appear as the vertical axis label on the Graph. It can consist of any combination of letters, numerals, and spaces.

  If you are defining more than one equation to be graphed, use different text on the left side of each equation so that you can distinguish between them in the data source menu of the Graph.



example

Sensor-based Calculations

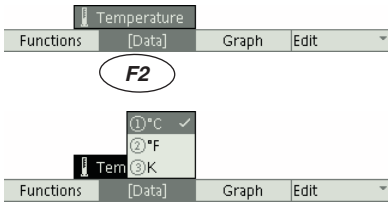
You can create a calculation to automatically transform any data collected by a sensor.

- Connect a temperature probe to one of the ports on the left side of the GLX. Press ► to collect data for a few seconds. Press ► again to stop.

- Open the calculator. On the first blank line, enter:[9]

  d = [Temperature (°C)] - 20

  Instead of typing "[Temperature (°C)]", select it from the [Data] menu.[10]



Open the [Data] menu; select Temperature and °C

- Press the up arrow key to place the cursor on the calculation. Press F3 to view the calculation on the preview graph. Note how the calculated data differs from the original temperature data.

- Press ⌂ + F1 to open the full-screen Graph. Press ✓ *twice* to open the vertical data source menu and choose the calculation (see right).

See "Data Source" on page 15 for more information about selecting data in the Graph.

- Press ▶ to begin collecting data again. Note that the calculation is performed in real time on the new data.

- Calculations have no units by default. To assign units to a calculation, select Data Properties from the data source menu in the Graph (see "Data Properties" on page 69).

- In addition to sensor-collected data, calculations can operate on other data sources, such as manually entered data sets, other calculations, and time. To insert any data source into a calculation, press F2 and select it from the [Data] menu.

Uses of Sensor-based Calculations

Shift Data Vertically In the example above, the sensor-based calculation subtracts 20 °C from the measured temperature. This calculation might be used in an experiment where the difference between the measured temperature and room temperature is of interest (a study of Newton's law of cooling, for instance). The calculation in the example shifts the temperature graph down by 20 °C.

Time-shift Data When a data plot appears on the Graph with Time on the horizontal axis, the plot can be shifted right or left with a time-based calculation.

For example, the graph shown at the right is from an experiment in which a temperature probe was dipped into warm water, then removed, wiped dry, and allowed to cool. The relevant data start after the probe was dried, about 14 seconds from the start of data collection. To make the analysis simpler, the graph needs to be shifted left so that the relevant data start at time zero. To do so, create the calculation below. (To insert [Time (s)], press F2 and select it from the [Data] menu.)

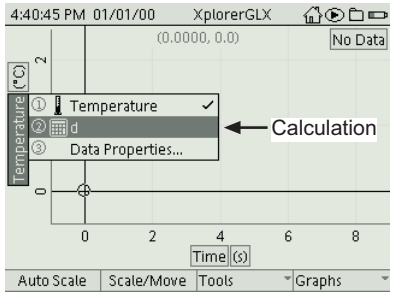
[Time (s)] - 14

[9] For the *d* symbol, press F1 twice and select it from the second Functions menu.

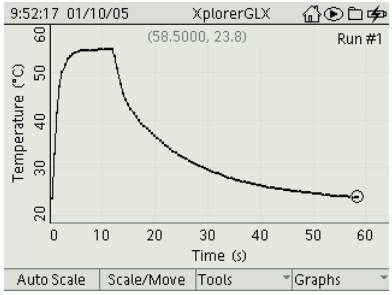
[10] **To select Temperature from the [Data] menu**

Keypad
1. Press F2 to open the [Data] menu.
2. Use the up or down arrow key to highlight Temperature and press ✓; *or* press the number on the keypad corresponding to Temperature.
3. The units menu will open. Use the up or down arrow key to highlight °C and press ✓; *or* press the number on the keypad corresponding to °C.

Mouse
1. Click [Data] to open the menu.
2. Click Temperature.
3. The units menu will open. Click °C.

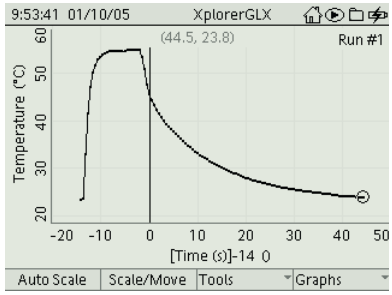


In the Graph, choose the calculation from the data source menu



This data plot needs to be time-shifted

Plot the calculation on the horizontal axis in place of Time to create the graph shown below. (See page 28 for instructions on selecting data for the horizontal axis.)



This data plot has been time-shifted by -14 s

Convert Units of Measure Most of the sensors used with the GLX are programmed with SI units (or the International System of Units) and, in some cases, other common units. If you wish to make a measurement using units that are not programmed into the sensor, create a calculation to convert the measured data.[11]

For example, if you are using a Motion Sensor, which measures position in meters, and you want to convert the measurement to centimeters, create the calculation below. (To enter text, see "Num Lock" on page 50.)

```
position in cm = [Position(m)]*100
```

Calculate an Experimental Value In some experiments, it is possible to calculate an experimental value based on a sensor measurement. For example, in an experiment where a Motion Sensor measures the acceleration of an object, you can use the Calculator to calculate the net force:

```
force = mass * [Acceleration (m/s/s)]
```

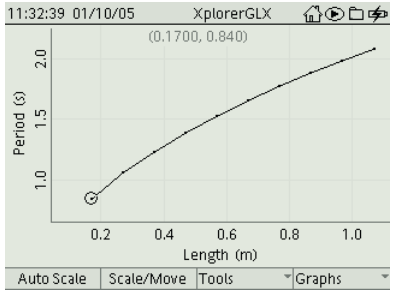
The Calculator will prompt you for the value of mass.

Compare Measurements from Two Sensors When collecting data with two sensors, a calculation can be used to compare the separate measurements. For example, if you are using two temperature probes, named "Temperature" and "Temperature2," and you want to know the temperature difference between them, create the calculation:

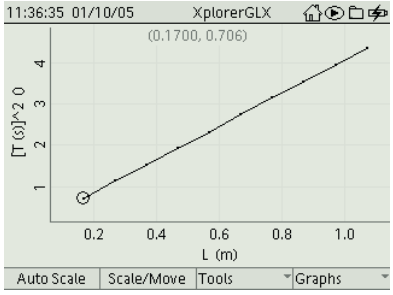
```
[Temperature (°C)] - [Temperature2 (°C)]
```

Graph Linearization In some cases, such as the examples below, you may want to linearize data so that you can use the Linear Fit tool in the Graph display (see "Linear Fit" on page 19). To do so, use the Calculator to calculate the square, square root, natural log, etc., of the measured data. (See "F1 Functions" on page 48 for more information on these and other functions.)

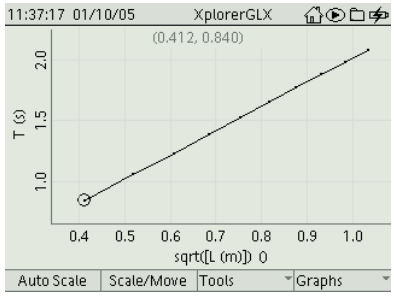
- The graph to the right shows period (T) versus length (L) data from a simple pendulum. The graph can be linearized by plotting T^2 versus L. The slope of the graph (shown below on the left) is $4\pi^2/g$, where g is the free-fall acceleration. Alternatively, the graph can be linearized by plotting T versus $\sqrt{L}$. On the graph (shown below right), the slope is $2\pi/\sqrt{g}$.



Period vs. Length for a simple pendulum



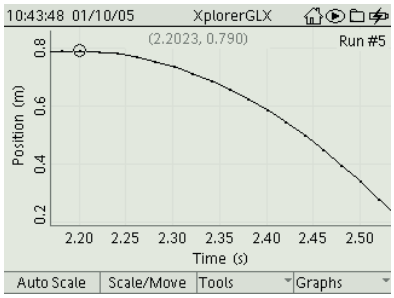
T^2 vs. L for a simple pendulum



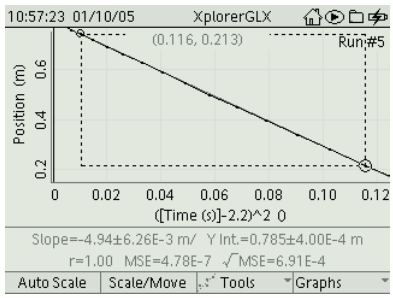
T vs. $\sqrt{L}$ for a simple pendulum

[11] For certain measurements (temperature, for instance), it is not necessary to calculate a units conversion because the sensor is programmed with other common units of measure (°C, °F, and K), which can be selected from the units field of any display. See pages 15 and 29.

- The position versus time graph of an object in free fall (below right) exhibits a typical quadratic relationship. The object was dropped from a height of 0.79 m, with the release occurring 2.2 s after the start of data collection. The graph can be linearized (as shown below right) by replacing Time on the horizontal axis with the calculation ([Time (s)]-2.2)^2. The slope of the best-fit line is $a/2$, where a is the acceleration of the object.

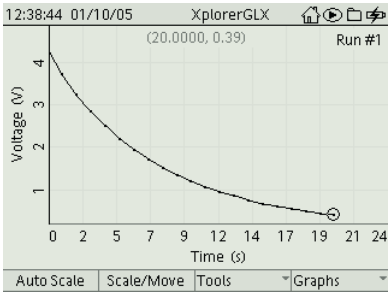


Position vs. Time of an object in free fall

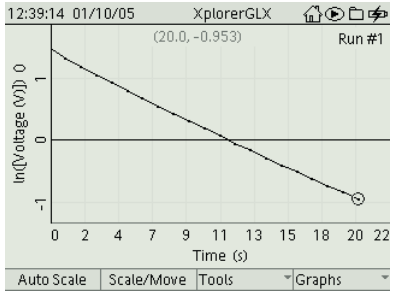


Linearized free-fall data

- Voltage versus time graph for a discharging capacitor is shown below on the left. The graph the natural log of voltage versus time is a linear (below right). The slope of the line is $-1/RC$, where C is the capacitance and R is the resistance through which the capacitor discharges.



Voltage versus Time data for a capacitor

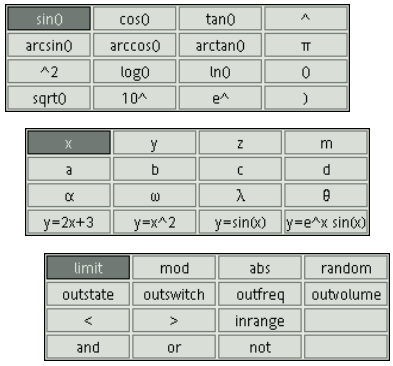


Linearized data for a discharging capacitor

Calculator Function Keys

F1 Functions

Press F1 (or click Functions) repeatedly to access the three Functions menus. These menus contain the following items.



The first and second Functions menus

- **Functions:** *sin, cos, tan, arcsin, arccos, arctan,* ^2, *log, ln, sqrt,* 10^, *e*^
- **Operators:** ^ (the exponent operator)
- **Constants**: π
- **Commonly used symbols**: *x, y, z, m, a, b, c, d,* α, ω λ, θ
- **Sample expressions:** $y = 2x + 3$, $y = x^2$, $y = \sin(x)$, $y = e^x \sin(x)$
- **Parentheses:** a pair of parentheses and a single right parenthesis
- **Special Functions:** *limit, mod, abs, random*
- **Output-control Functions:** *outstate, outswitch, outfreq, outvolume*
- **Logic Operators and Functions:** <, >, *inrange, and, or, not*

Special functions, output-control functions, and logic operators and functions are typically used to control the GLX's digital and audio output. See "Output-control Calculations" on page 50 for detailed explanations of these functions and operators.

Inserting a Function When you select an item from one of the Functions menus, it is inserted at the cursor location.[12] If the item includes a pair of parentheses, the cursor will be positioned between them.

[12] **To select an item from the Functions menus**

Keypad

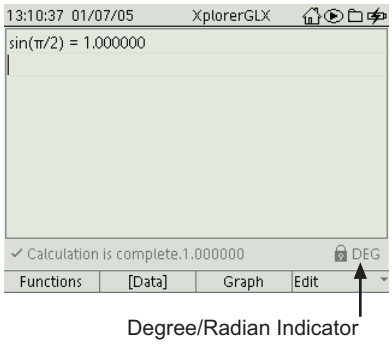
1. Press F1 once to open the first menu, or twice to open the second menu.
2. Use the arrow keys to highlight the desired item and press ✓.

Mouse

1. Click Functions once to open the first menu, or twice to open the second menu.
2. Click the desired item.

Degrees/Radians A calculation containing a trigonometric function can be set to operate in degrees or radians. This setting is applied to each calculation separately. The lower right corner of the Calculator indicates whether the calculation that the cursor is on is set for degrees or radians.

To switch the setting, press F4 to open the Edit menu and select (or deselect) Radians. After you have switched the setting for a calculation, you must press ✓ or = to make the GLX reevaluate the calculation.



Predefined Constants The symbol π is a predefined constant. The Calculator will recognize its value as 3.141592 when it is used as part of an expression or on the right side of an equation.

The symbol *e* is a predefined constant equal to 2.718282. The capital letter *E* can be used interchangeably with *e*. Typically *e* is used with the exponent operator (^) to form *e*^, the exponential function.[13]

[13] When using the constant *e*, be careful not to enter it in a way that the GLX will mistake for scientific notation. See page 91 for more information.

F2 [Data]

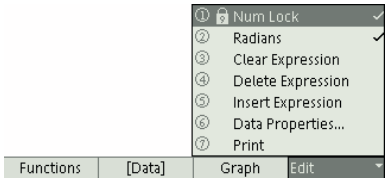
Press F2 (or click [Data]) to select a data source to insert into an equation. See "Sensor-based Calculations" on page 45 for more information.

The [Data] menu contains sensor measurements, manually entered data, calculations, and time.

F3 Graph

Press F3 or (click Graph) to plot the equation that the cursor is on in the preview graph on the lower half of the screen. See "Graphing Equations" on page 44 for more information.

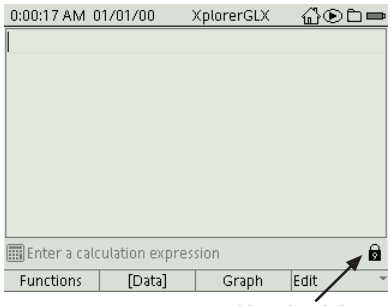
F4 Edit Menu



Edit menu

Press F4 (or click Edit) to open the Edit menu, which contains the options described below.

Num Lock When Num Lock is on (which it is by default), an icon (🔒) appears in the lower right corner of the screen.



Num Lock Icon

To turn Num Lock on or off, select Num Lock from the Edit menu.[14]

With Num Lock on, you can type only numerals (not letters or punctuation marks) with the keypad. Multiple presses of a key will not cycle through multiple characters. (That way you can type "100," for instance, without having to wait between zeros.) The single exception is the letter *E*, which you can always type by pressing decimal point key (.EE) twice.

With Num Lock off, the keypad operates in multipress text input mode (see page 90), allowing you to enter letters and punctuation marks.

It is often unnecessary to turn off Num Lock because commonly used letters and other symbols can be selected from the Functions menus, and the names of data sources can be selected from the [Data] menu.

Radians Select or deselect this option to switch the highlighted calculation to radians or degrees. See "Degrees/Radians" on page 49.

Clear Expression This option removes the expression that the cursor is on and leaves a blank line.

Delete Expression This option removes the expression that the cursor is on and shifts up everything below it to fill in the blank line.

Insert Expression This option shifts the expression that the cursor is on (and everything below it) down by one line to create a blank line at the cursor location.

Data Properties Select this option to open the Data Properties dialog box for the highlighted calculation. See page 69 for more information.

Print If there is a printer connected to the GLX, select Print to print the Calculator screen.[15]

[14] **To select an option from the Edit menu**

Keypad
1. Press F4 to open the Edit menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click Edit to open the menu.
2. Click the desired menu option.

[15] For more information on printing, see "Printing" on page 91.

Output-control Calculations

The functions and operators described below can be selected from the third Functions menu.[16] With them, you can write expressions in the Calculator that control the GLX's audio outputs, and the outputs of connected Digital Adapters.

[16] See "F1 Functions" on page 48.

Special Functions

These special functions do not directly control output, but can be useful in combination with the output-control functions.

limit(min, max, x) The *limit* function is used keep a varying value within a specified range. The function has three arguments: *min*, *max,* and *x*.

- If $x < min$, then $limit(min, max, x) = min$.
- If $x > max$, then $limit(min, max, x) = max$.
- If $min \leq x \leq max$, then $limit(min, max, x) = x$.

mod(numerator, denominator) The *mod* function is equal to the remainder when *numerator* is divided by *denominator*. The arguments *numerator* and *denominator* can be any number (not just whole numbers). If *denominator* = 0, then mod(*numerator, denominator*) = 0.

abs(x) The *abs* function is equal to the absolute value of its argument.

random() The *random* function equals a randomly generated number between 0 and 1. Each time the function is evaluated, a new random value is generated. Note that the *random* function appears with a pair of parentheses after it, but it cannot have anything between the parentheses.

Output-control Functions

The output-control functions set the output of the GLX's audio channels and connected Digital Adapters. The output-control functions work only when data collection is in process. Each function must be used as part of a sensor-based calculation (the calculation must include data from a sensor or time). Any property of the audio output that is not specified in the Calculator will be determined by the setting in the Output screen (see page 39). In the Functions menu, the names of these functions are abbreviated to *outstate, outswitch, outfreq,* and *outvolume*.

outputstate(GLXPort, AdapterChannel, state) Use the *outputstate* function to switch on or off a Digital Relay connected through a Digital Adapter.[17]

The first argument of the function, *GLXPort*, can equal 1, 2, 3, or 4; it identifies the port that the Digital Adapter is connected to. The second argument, *AdapterChannel*, can equal 1 or 2 and identifies which channel of the adapter the Digital Relay is connected to. The third argument, *state*, can equal any number and determines whether the relay is OFF or ON.

- If *state* = 0, then the relay is OFF.
- If *state* ≠ 0, then the relay is ON.

outputswitch(Channel, state) Use the *outputswitch* function to turn on or off the left or right audio output channel.[18] The first argument, *Channel*, can equal 1 (for left) or 2 (for right) and identifies which audio channel is to be controlled. The second argument, *state*, can equal any number and determines whether the audio output is OFF or ON.

- If *state* = 0, then the audio output is OFF.
- If *state* ≠ 0, then the digital output is ON.

[17] The Digital Relay is PASCO part CI-6462. The Digital Adapter is PASCO part PS-2159.

See "Relay Control" on page 67 for instructions on connecting and configuring the adapter.

[18] Whether the output is played through the output port (to a pair of headphones or amplified speakers) or through the GLX's built-in speaker depends on the Output setting in the Output screen (see page 40).

outputfreq(Channel, frequency) Use the *outputfreq* function to set the frequency of the audio output signal.[18] The first argument, *Channel*, can equal 1 (for left) or 2 (for right) and identifies which channel is to be controlled. The second argument, *frequency*, sets the frequency, in Hz, of the output signal. The frequency can be set between 250 and 5000 Hz for the built-in speaker, or between 60 and 5000 Hz for headphones or external speakers.

outputvolume(volume) Use this function to set the loudness of the output signals.[18] The argument of the function can be set between 0 (for no output) and 10 (for the loudest possible output). The function controls both audio channels together.

Logic Operators and Functions

A logic function has two possible values: 0 and 1. A logic operator (< or >) is used to build an expression that can have a value of 0 or 1.

Less Than and Greater Than If an expression such as $a < b$ is true, then it equals 1. If the expression is false, then it equals 0.

inrange(min, max, x) This function has three arguments: the first two, *min* and *max*, define the upper and lower limit of a range, and the third, *x*, is an input value to be compared with that range. If $min \leq x \leq max$, then the function equals 1. If $x < min$, or $x > max$, then the function equals 0.

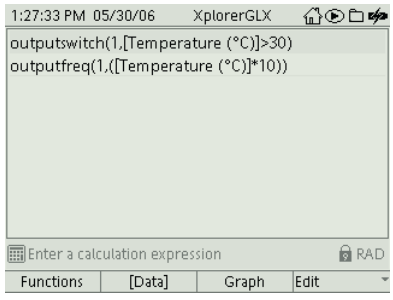
and(a, b) This function equals 0 if either of the arguments equals 0; otherwise the function equals 1.

or(a, b) This function equals 0 if both of the arguments equal 0; otherwise the function equals 1.

not(x) This function equals 1 if the argument equals 0; otherwise the function equals 1.

Audio Temperature Indicator

In this example, the GLX is programed to emit a sound when the temperature exceeds 30 °C. The frequency of the sound increases as the temperature increases.



Audio Temperature Indicator Example

Connect a temperature sensor to the GLX. In the Calculator, enter these two expressions:

```
outputswitch(1,[Temperature (°C)]>30)

outputfreq(1,[Temperature (°C)]*10)
```

Select the *outputswitch* and *outputfreq* functions from the F1 Functions menu. Select the [Temperature (°C)] measurement from the F2 [Data] menu.

Press ▶ to start data collection. Place the temperature sensor in warm water. Then allow it to cool again. When the temperature reaches 30 °C, the GLX emits a tone at 300 Hz. As the temperature rises, the frequency of the tone rises.

Notes Screen

Use the Notes screen to record experiment instructions, information about the sensors and displays that you have set up, notes on recorded data, or any other text information.

To Open the Notes screen

From the Home Screen, do one of the following:

use the arrow keys to highlight the Notes icon, then press ✓; or

click the Notes icon.

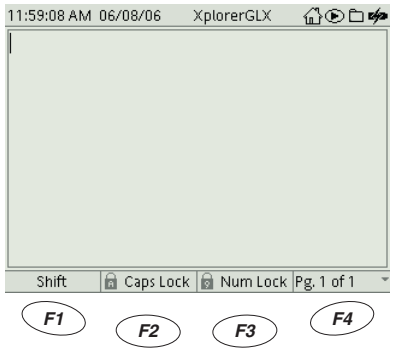
The Notes icon on the Home Screen

Entering, Reading, and Printing Text Notes

Enter text via the GLX keypad or a connected USB keyboard.

See "Multipress Text Input Mode" on page 90 or "Using a USB Keyboard" on page 90.

To input a single capital letter, first press F1 to turn on Shift. To input all capital letters, turn on Caps Lock by pressing F2. To disable multipress text input mode (for typing just numbers), turn on Num Lock by pressing F3.



The GLX can store multiple notes pages. To start a new page, press F4 to open the Notes menu and select New Page.[19]

If more than one page exists, you can also press F4 to select a previously created page for viewing and editing, or to delete the currently displayed page. The page number of the visible page and the total number of pages are indicated in the lower right corner of the screen.

To print the currently displayed page on a connected printer, press F4 and select Print. To print all notes pages, select Print All.

For more information, see "Printing" on page 91.

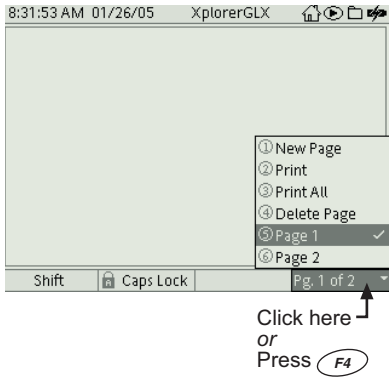
[19] **To select an option from the Notes menu**

Keypad

1. Press F4 to open the Notes menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse

1. Click the page number in the lower right corner to open the Notes menu.
2. Click the desired menu option.



The Notes menu

Stopwatch

With the Stopwatch screen, you can use the GLX like a conventional stopwatch.

To Open the Stopwatch

From the Home Screen, do one of the following:

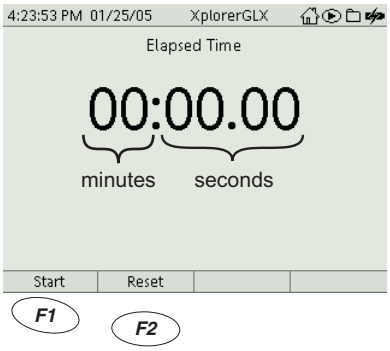
use the arrow keys to highlight the Stopwatch icon, then press ✓; or

click the Stopwatch icon.

The Stopwatch icon on the Home Screen

Timing with the Stopwatch

The numbers displayed on the stopwatch indicate elapsed time in minutes and seconds.



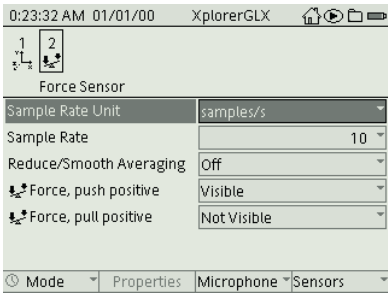
Press F1 to start timing. Press F1 again to stop timing.

When timing is stopped, press F2 to set the displayed elapsed time back to 00:00.00

Chapter 3: Settings and Files

Sensors Screen

In many cases, the sensor set-up process requires nothing more than simply plugging in a sensor. However, if you would like to change any of the sensor settings, or configure a sensor that you have not physically plugged in, or change the mode of data collection, go to the Sensors screen. Also use the Sensors Screen to configure the GLX's microphone as a sound sensor.



Sensors screen

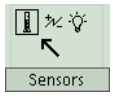
To Open the Sensors Screen

From the Home Screen, do one of the following:

F press F4, the function key below the Sensors icon;

use the arrow keys to highlight the Sensors icon and press ✓; or

click the Sensors icon.



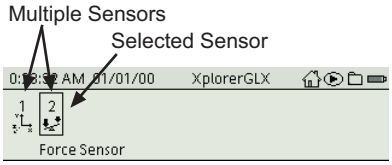
The Sensors icon on the Home Screen

From *anywhere* in the GLX environment, you can always open the Sensors Screen with the shortcut ⌂ + F4.

Working with Multiple Sensors

An icon for each sensor connected to the GLX appears at the top of the screen.[1] A box around one of the icons indicates the selected sensor. Use the left and right arrow keys (or mouse) to select the sensor that you want to set up. The settings for the selected sensor appear in the lower part of the screen.

[1] In some cases, an icon for a sensor that is not physically connected to the GLX appears in the Sensor screen. Such icons are designated with ⚠.



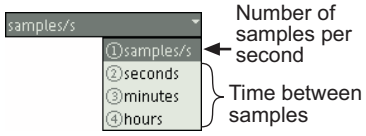
Top portion of the Sensors screen; this GLX is connected to an acceleration sensor and a force sensor

Sensor Settings

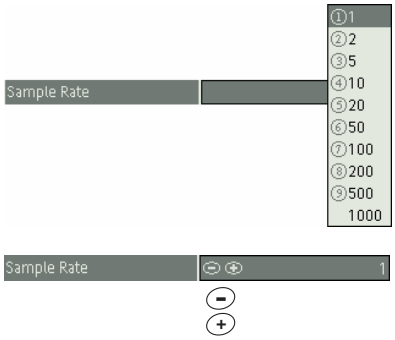
To change any of the settings, use the arrow keys to highlight the settings and press ✓.

If you are using a mouse, click the desired setting.

Sample Rate Unit Select Sample Rate Unit[2] to choose how the sampling rate will be measured. The choices are samples per second; or seconds, minutes, or hours (time between samples).



Sample Rate Select Sample Rate[3] to set the sensor's rate of data collection (measured in the units selected above).

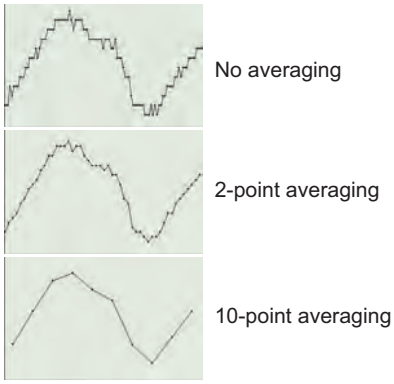


Open the Sampling Rate menu or change the sampling rate with ⊕ and ⊖

Reduce/Smooth Averaging This feature is a type of oversampling. You can use it to:

- reduce what would be a large data set to a manageable size,
- smooth noisy data,
- improve the effective resolution of a sensor.

Select Reduce/Smooth Averaging and choose the number of points to be averaged.[4] The number of points represents the factor by which the effective sampling rate, data set size and noise level are reduced.



[2] To select Sample Rate Unit

Keypad
1. Use the arrow keys to highlight Sample Rate Unit
2. Press ✓ to open the menu.
3. Use the arrow keys to highlight the desired units and press ✓; *or* press the number on the keypad corresponding to the desired units.

Mouse
1. Click Sample Rate Unit to open the menu.
2. Click the desired units.

[3] To select Sample rate

Keypad
1. Use the arrow keys to highlight Sample Rate.
2. Press ✓ to open the menu.
3. Use the arrow keys to highlight the desired rate and press ✓; *or* press the number on the keypad corresponding to the desired rate.

or

1. Use the arrow keys to highlight Sample Rate.
2. Press ⊕ or ⊖ to increase or decrease the value.

Mouse
1. Click box to the right of Sample Rate to open the menu.
2. Click the desired rate.

[4] To select Reduce/Smooth Averaging

Keypad
1. Use the arrow keys to highlight Reduce/Smooth Averaging.
2. Press ✓ to open the menu.
3. Use the arrow keys to highlight the desired number of points and press ✓; *or* press the number on the keypad corresponding to the desired number of points.

Mouse
1. Click the box to the right of Reduce/Smooth Averaging to open the menu.
2. Click the desired number of points.

Zero Automatically On Start This setting appears for sensors that support zeroing (such as acceleration, rotary motion, and drop counter sensors). The three choices are "On," "Off," and "Zero Now." When "On" is selected (which it is by default), the sensor measurement is adjusted with each new data run to make the first sample zero. When "Off" is selected, the measurement is not automatically zeroed. When you select "Zero Now," the measurement is adjusted to make present value zero, but it will not be re-zeroed at the start of data collection.

Measurements Each of the sensor's measurements have a "Visible" or "Not Visible" tag. Visible measurements appear in the data source menus of the display screens. Select a measurement to change its setting from "Visible" to "Not Visible," or vice-versa.[5]

A measurement set to "Not Visible" does not appear in the displays' data source menus; however, it is still accessible by selecting "More" from the menu. See "Expanding the Data Source Menu" on page 89.

[5] **To change the visibility of a measurement**

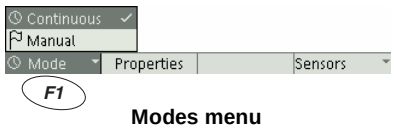
Keypad
1. Use the arrow keys to highlight the measurement.
2. Press ✓.

Mouse
Click on the word "Visible."

Sensors Function Keys

F1 Mode

The Mode menu contains options for how the GLX collects data. When you select a sampling mode[6], that mode is applied to all sensors.



Modes menu

Continuous Sampling Continuous Sampling is the default and most commonly used mode. In this mode, when you press ▶, the GLX starts to collect and record data from every sensor at a constant rate. Data collection stops when you press ▶ again.

The rate of data collection is determined separately for each sensor. See "Sample Rate" on page 56 for more information.

Manual Sampling Select Manual Sampling from the Mode menu to record a series of single manually triggered samples. See page 60 for instructions on setting up and using manual sampling.

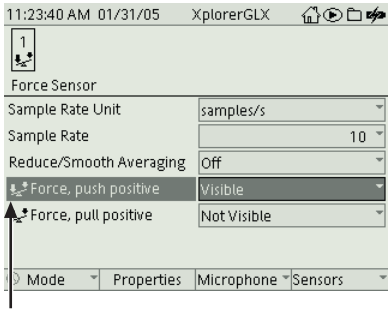
[6] **To select a sampling mode**

Keypad
1. Press F1 to open the Mode menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click Mode to open the menu.
2. Click the desired menu option.

F2 Data Properties

To open the Data Properties dialog box for a sensor measurement, *first* use the arrow keys to highlight the measurement, then press F2. See page 69 for a description of the Data Properties dialog box.



To open the Properties dialog box, highlight a measurement *before* you press F2

F3 Microphone

The Microphone menu contains options for setting how the GLX uses its built-in microphone. The selected option is indicated by a check mark (✓) appearing next to it in the menu.[7]

Sound Sensor When Sound Sensor is selected, the GLX's microphone becomes a sensor that collects data showing the waveform of sound. The sound sensor appears in the upper part of the Sensors screen, just like any other sensor.

Like other sensors, the Sound Sensor settings include Sample Rate Unit, Sample Rate, and Reduce/Smooth Averaging; however you typically would not change any of these settings because the sample rate is automatically set by the Graph in Scope Mode.

The Sensitivity setting sets the gain of the Sound Sensor.[8] For very loud sounds set the Sensitivity lower; for softer sounds, set it higher. To make the Sound Sensor automatically adjust its sensitivity based on the loudness of the sounds that it detects, set the Sensitivity to Automatic.

The Sound Sensor is most commonly used with the Graph display in Scope mode. Press ⌂ and F1 together to go to the Graph display. Then press F4 to open the Graphs menu, and press 3 wxyz to select Scope mode. Press ▶. Whistle or hum; you will see sound wave in the Graph. (See page 22 for more information on Scope mode.)

Sound Level When Sound Level is selected, the GLX's microphone measures the loudness of sound in decibels (on the dBA scale).

The Sound Level sensor operates at a much lower sampling rate than the Sound Sensor. Like most other sensors, you would normally use the Sound Level sensor in continuous or manual sampling mode (see page 57), not in Scope mode.

Audio Notes With this default setting, the microphone is configured to record the audio portion of data notes (see "Data Annotation" on page 25). If you have previously recorded sound-sensor or sound level data, selecting Audio Notes is equivalent to unplugging the Sound or Sound Level sensor. The GLX will preserve any sound data sets that have been recorded, but it will not collect new data from the microphone.

[7] **To select an option from the Microphone menu**

Keypad
1. Press F3 to open the menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired option.

Mouse
1. Click Microphone to open the menu.
2. Click the desired option.

[8] **To change the Sensitivity**

Keypad
1. Use the arrow keys to highlight Sensitivity.
2. Press ✓ to open the menu.
3. Use the arrow keys to highlight the desired setting and press ✓; *or* press the number on the keypad corresponding to the desired setting.

or

1. Use the arrow keys to highlight Sensitivity.
2. Press + or − to increase or decrease the value.

Mouse
1. Click box to the right of Sensitivity to open the menu.
2. Click the desired setting.

F4 Sensors

The Sensors menu contains the following options for adding, removing, and calibrating sensors.[9]

Add Select this option to set up a sensor without physically connecting it. A menu containing all PASPORT sensors will open. Use the arrow keys to highlight the desired sensor and press ✓.

Remove Use this option to delete the selected sensor without disconnecting it from the GLX. All data collected by that sensor will be deleted.

> If there are multiple sensors, select the sensor that you want to delete before selecting the Remove option. See "Working with Multiple Sensors" on page 55.

It is *not* necessary to select Remove from the Sensors menu in order to disconnect a sensor; you can simply unplug it.

When you physically unplug a sensor (after recording data), the icon for the sensor remains in the upper part of the Sensors screen with ⚠ above it. All data recorded from that sensor, and the sensor's settings (such as sampling rate) are preserved in the GLX. If that sensor is ever reconnected, it will be installed in its old place with the same settings. If you would like to remove the archived data and settings, select the icon of the unplugged sensor[10], then select Remove from the Sensors menu.

Calibrate Select Calibrate from the Sensors menu to open the Calibration dialog box. See page 71 for a description of the dialog box and instructions on calibrating a sensor.

[9] **To select an option from the Sensors menu**

Keypad
1. Press F4 to open the menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired option.

Mouse
1. Click Sensors to open the menu.
2. Click the desired option.

[10] **To select a sensor icon**

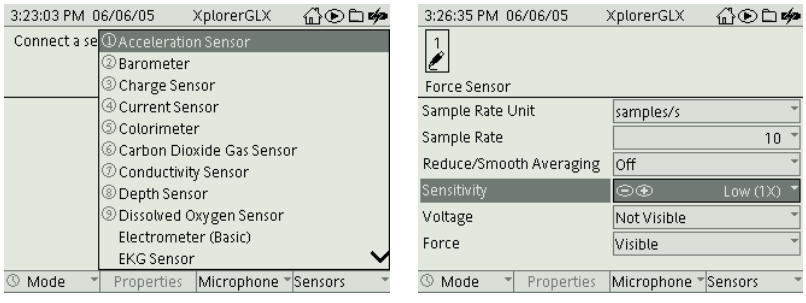
Keypad
Press the left or right arrow key to move the box to the icon in the upper portion of the Sensors screen.

Mouse
Click the icon in the upper portion of the Sensors screen.

Analog Adapter with a *ScienceWorkshop* Sensor Set-up

You can connect an analog *ScienceWorkshop* sensor to the GLX via an Analog Adapter (PS-2158). When you connect the Analog Adapter to the GLX, a special menu listing all *ScienceWorkshop* sensors appears. From this menu, select the sensor that you have connected (or will connect) to the adapter.[11] After you have selected it, the sensor appears in the top portion of the Sensors screen, just like a PASPORT sensor.

In addition to the regular sensor settings (see page 56), a Sensitivity setting appears in the Sensor screen. This setting controls the gain of the Analog Adapter and can be set to Low (1X), Medium (10X), or High (100X). The gain is the factor by which the resolution of the sensor is improved, and by which the range is decreased.



***ScienceWorkshop* Sensors menu (left) and Sensors screen with a *ScienceWorkshop* sensor (right)**

[11] **To select a sensor form the *ScienceWorkshop* Sensors menu**

Keypad
1. Connect an Analog Adapter to the GLX to launch the menu.
2. Use the arrow keys to highlight the desired sensor. Arrows (▼, ▲) appear on the menu to indicate that some sensors are not visible. Press the up or down arrow key multiple times to move the highlight beyond the visible portion of the menu. The menu will scroll to bring other sensors into view. To skip directly to the last sensor on the menu, move the highlight to the first sensor, then press the up arrow key.
3. Press ✓.

Mouse
1. Click the up or down arrow on the menu (▼, ▲) to bring the desired sensor into view.
2. Click the desired sensor.

Manual Sampling Mode

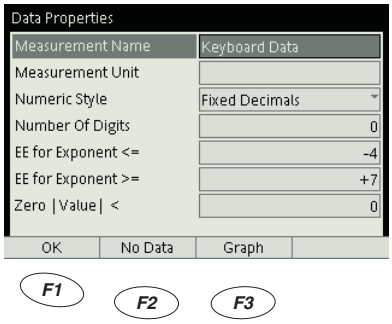
In Manual Sampling mode, the GLX records a single sample from each measurement only when you trigger it by pressing . Follow these steps to set up Manual Sampling mode and record data.

Set Up

1. Press + F4 to go to the Sensors screen.
2. Press F1 to open the Mode menu.
3. Use the arrow keys to highlight Manual and press .

   The Data Properties dialog box appears. This box specifies the name and units of the (optional) manually entered data. By default, the name is "Keyboard Data" and the units are unnamed.
4. If you plan to manually enter data to go with each sample, enter the name and units of this data in the Data Properties box. (See page 69 for instructions on using the Data Properties box.)
5. Do one of the following:

   - Press F1 (OK) to enter Manual Sampling mode with the manually entered data option.
   - Press F2 (No Data) to enter Manual Sampling mode without the option of manually entering data.
   - Press F3 (Graph) to enter Manual Sampling mode with a Graph display automatically set up to display a sensor measurement on the vertical axis and manually entered data on the horizontal axis.



Sampling

1. Press . The GLX starts measuring, but not recording. A blinking flag icon ( ) appears in the upper right-hand corner of the screen.
2. When you are ready to take a data point, press . The GLX instantly records a single sample from each measurement.
3. If you have selected the manually entered data option, the GLX prompts you to enter data. Type in the data (either numeric or text[12]) and press F1 (OK).
4. Repeat steps 2 and 3 to record additional samples.
5. When you have finished recording *all* samples, press .

[12]To type text data, press F3 to disable Num Lock. The first time the GLX detects non-numeric data, it will ask you to confirm that the data should be treated as text.

Cell-selective Sampling

You can collect data in manual sampling mode while viewing any display; however, using the Table display allows additional flexibility. After setting up the GLX in manual sampling mode as described above, follow these steps to record data into specific table cells.

1. Press + F2 to open the Table display.

2. Press ▶. The GLX starts measuring, but not recording. A blinking flag icon (⚑) appears in the upper right-hand corner. Another flag icon appears at the left side of the first table row.

3. Press the right arrow key. Notice that the flag icon moves to first cell of one column. If there is another column displaying collected data (not manually entered) press the right arrow again to move the icon to that column. This icon indicates which cell will collect data when you press ⚑. If the icon is at the left end of the row, all cells in that row will collect data.

4. Use the arrow keys to select which cell or cells in the first row you wish to collect data.

5. Press ⚑.

6. If you have selected the manually entered data option, the GLX prompts you to enter data. Type in the data and press F1 (OK).

7. To collect more data, use the arrow keys to position the flag icon on the single cell or row where you want to collect data. If the selected cells already contain data, that data will be overwritten.

8. Press ⚑.

9. Repeat steps 7 and 8 to record additional samples.

10. When you have finished recording *all* samples, press ▶.

	Run #1 Position (m)	Run #1 Force, push positive (N)
1	0.240	1.5
2		
3		
4		

All cells in selected row will collect data

	Run #1 Position (m)	Run #1 Force, push positive (N)
1	0.240	
2		
3		
4		

Only selected cell will collect data

	Run #1 Position (m)	Run #1 Force, push positive (N)
1		1.5
2		
3		
4		

Only selected cell will collect data

	Run #1 Position (m)	Run #1 Force, push positive (N)
1	0.253	1.5
2	2.197	4.0
3	0.689	4.0
4		

Previously recorded data in selected row will be overwritten

Why Use Cell-selective Sampling?

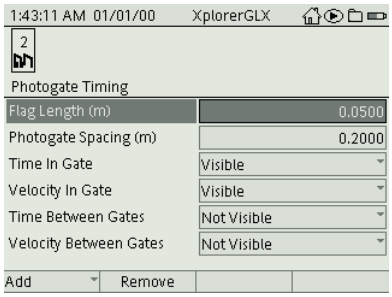
Redo a Sample Cell-selective sampling is useful for redoing data points. For instance, suppose that you are measuring the pH of several different solutions. You place the pH probe in a solution and press ⚑ to record a sample. You then realize that you made a mistake—you forgot to wait for the measurement to stabilize. To correct the mistake, press the up arrow to return the flag icon to the first row. Press ⚑ again to overwrite the data on that row with a new sample.

You can redo any sample even if you have recorded subsequent samples; use the arrow keys to return the flag icon to any previously recorded row or cell and press ⚑. Remember to move the icon back to an empty row if you want to take a new sample without overwriting an old one.

Alternate Between Sensors If you have two or more sensors connected to the GLX, you may want to record single samples from each sensor separately. To do this you would select a single cell (instead of a whole row) for each sample. For example, you have several solutions and you would like to measure the pH and conductivity of each. Place the pH probe in the first solution. Press the right arrow key to select a single cell in the pH column. Press ⚑ to record only in that cell. Remove the pH probe from the solution and place the conductivity probe in the same solution. Use the arrow keys to select the cell in the conductivity column (in the same row). Press ⚑ to record into that cell. Repeat this process for all other solutions. In this way you will record pH-conductivity data pairs without having to make pH and conductivity measurements simultaneously.

Timing Screen

Use the Timing screen to set up measurements made with photogates, Smart Pulleys and other switch- or counting-type sensors.



The Timing Screen

To Open the Timing Screen

The Timing screen usually launches automatically when you connect a switch- or counting-type digital sensor to the GLX through a Photogate Port or a Digital Adapter.[13]

[13]Photogate Port is PASCO part PS-2123A. Digital Adapter is PASCO part PS-2159.

If a timer for a sensor has already been set up, the Timing screen will not automatically launch when that sensor is plugged in. To manually open the Timing screen from the Home Screen, do one of the following:

 use the arrow keys to highlight the Timing icon and press ✓; or

 click the Timing icon.

The Timing icon on the Home Screen

Theory of Timing

Certain digital sensors connected to the GLX through a Digital Adapter or Photogate Port operate differently from most other sensors. Rather than collecting data at a constant rate, they send a signal to the GLX only when an event happens. For instance:

- when a photogate switches from being blocked to unblocked, or vice-versa;
- when the spoke of a pulley enters or exits a photogate; or
- when a nuclear sensor detects a particle.

The GLX can be configured to measure the time span of a particular sequence of events. Examples of sequences include:

- blocked-unblocked, or “time-in-gate;”
- blocked-blocked, or “time-between-gates;” and
- blocked-blocked-blocked, used to measure the period of a pendulum.

The “blocked” event occurs when a photogate switches from being unblocked to blocked. The “unblocked” event occurs when a photogate switches from being blocked to unblocked.

Whenever the specified sequence occurs, the GLX records the time span of the sequence as a data point. It also records the time at which the sequence occurred,

measured from the start of data collection to the *midpoint* of the sequence. From these measurements and user-entered (or default) constants, the GLX derives other measurements such as position, velocity, and acceleration. The configuration of what sequences the GLX measures and what secondary measurements it derives is called a timer.[14]

[14]One exception, the "General Counting" timer, measures the number of events that occur within a specified period. See page 66 for details.

The GLX is programmed with nine timers. The timer that you choose depends on the sensor (or combination of sensors) that you are using and the type of measurement that you would like to make. The following example details the procedure for selecting and setting up the "Photogate Timing" timer. The general procedure for other timers is similar, and the specifics of each timer are described on pages 64 through 67.

example

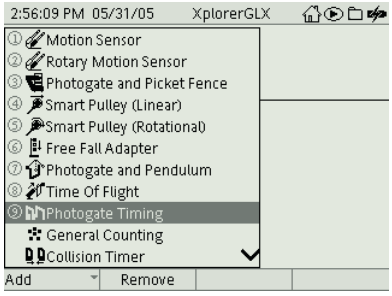
Setting Up the "Photogate Timing" Timer

In this example, we will connect and set up a single photogate to measure the velocity of an object of known width.

1. Connect a Photogate Port or Digital Adapter and a single photogate to the GLX.

   If the Timing Screen does not open automatically, go to the Home Screen, use the arrow keys to highlight the Timing icon, and press ✓. Then press F1 to open the Add menu.

2. You will see the Add menu, which contains the timer options. For this example, select Photogate Timing.[15]



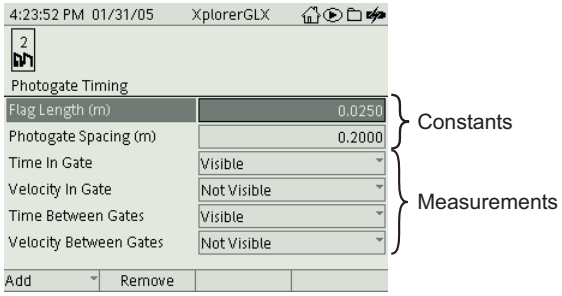
[15]**To select a timer from the Add menu**

Keypad
1. Press F1 to open the Add menu.
2. Use the up and down arrow keys to highlight the desired timer and press ✓; *or* press the number on the keypad corresponding to the desired timer.

Mouse
1. Click Add to open the menu.
2. Click the desired timer.

   Once you have chosen a timer, there are two types of things to set:

   - measurements, which can be set as "visible" or "not visible," and
   - constants, which, in this case, are Flag Length and Photogate Spacing.



3. In this example there is only one photogate, so set Time Between Gates and Velocity Between Gates to "Not Visible."[16]

[16]**To change the visibility of a measurement:**

Keypad
1. Use the arrow keys to highlight the measurement.
2. Press ✓.

Mouse
Click the word "Visible."

4. Set Time in Gate and Velocity in Gate to “Visible.”

5. Pretend that you have a cart with a 5 cm flag on it; set the Flag Length constant to 0.05 m. (Highlight Flag Length and press ✓, then type 0.05.)

6. In this case, photogate spacing is irrelevant, so leave the Photogate Spacing field blank.

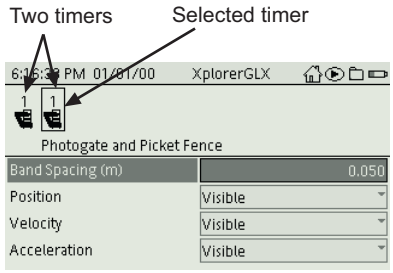
Viewing and Collecting Data from a Timing Sensor

After you have set up a timer, its measurements are available from the data source menus of the Graph (see page 15), Table (page 28) and other displays.

To start collecting data, press ▶.

Working with Multiple Timers

If there is more than one timer, an icon for each timer appears at the top of the screen. To set up each one, select it with the left and right arrow keys or with the mouse.

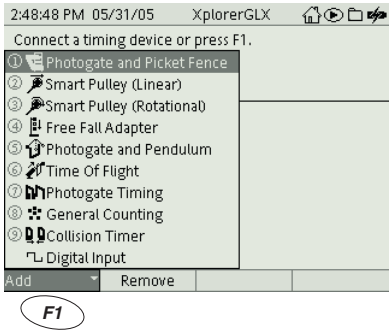


Note that in certain cases, a single timer operates with multiple sensors, so having more than one sensor does not necessarily mean that you will have (or need) more than one timer.

Timing Screen Function Keys

F1 Add

The Add menu usually launches automatically when you connect a photogate or other timing sensor. If you wish to set up a timer for a sensor that you have not yet connected, or for a sensor that is already connected, open the Timing screen and press F1. From the Add menu, select one of the following timers.[17]



If you are using a Digital Adapter, the Add menu may include Motion Sensor, Rotary Motion Sensor, and Relay Control. See page 67 for information on these special options.

Photogate and Picket Fence Select this timer for a single photogate used with a picket fence or photogate tape. The constant, Band Spacing, is the distance (in meters) between the centers of the dark bands on the picket fence or photogate tape.

The measurements are Position, Velocity, and Acceleration. Each time the photogate is interrupted by a band of the picket fence, the timer registers a change in

[17] **To select a timing option from the Add menu**

Keypad
1. Press F1 to open the Add menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click Add to open the menu.
2. Click the desired option.

Position equal to the Band Spacing. Velocity and Acceleration are calculated based on the time intervals between the changes in Position.

Picket fences include PASCO parts ME-9377A and ME-9804. Photogate tape is included with parts ME-6664 and ME-6666.

Smart Pulley (Linear) Use this timer for measuring linear motion with a Smart Pulley (or a combination of photogate and pulley). The constant, Spoke Arc Length, equals the circumference of the pulley (in meters) divided by the number of spokes.[18]

[18]The default value, 0.0150 m, is the spoke arc length of the inside groove of the PASCO Super Pulley (part ME-9450) and similar 10-spoke pulleys.

The measurements are Position, Velocity, and Acceleration. Each time the photogate is interrupted by a spoke, the timer registers a change in Position equal to the Spoke Arc Length. Velocity and Acceleration are calculated based on the time intervals between the changes in Position.

Smart Pulley (Rotational) Use this timer for measuring rotational motion with a Smart Pulley (or a combination of photogate and pulley). The constant, Spoke Angle Spacing, equals 360° divided by the number of spokes.

The measurements are (angular) Position, (angular) Velocity and (angular) Acceleration. Each time the photogate is interrupted by a spoke, the timer registers a change in angular Position equal to the Spoke Angle Spacing. Angular Velocity and angular Acceleration are calculated based on the time intervals between the changes in angle.

Free Fall Adapter Use this timer with PASCO part ME-9207B. The constant, Height Of Fall, is the distance (in meters) from the release mechanism to the receptor pad.

The measurements are Time Of Fall and Acceleration.

- Time Of Fall is the time interval starting when the ball is released and ending when it hits the receptor pad.
- Acceleration is calculated using the formula:

$$a = \frac{2x}{t^2}$$

Where a is Acceleration, x is Height Of Fall, and t is Time Of Fall.

Photogate and Pendulum The constant for this timer is Pendulum Width[19], which is the width of the pendulum bob (or whatever part passes through the photogate).

[19]It is necessary to enter Pendulum Width only if you are interested in the velocity of the pendulum bob.

The measurements are Period and Velocity.

- Period is the time the pendulum takes to complete one cycle of oscillation. A period data point is recorded every other time the photogate is blocked.
- Velocity is the Pendulum Width divided by the time-in-gate. A velocity data point is recorded every time the pendulum passes through the photogate. For more accurate velocity measurements, use a cylindrical (rather than spherical) pendulum bob.

Time of Flight Use this timer with a projectile launcher, two photogates, and a Time-of-Flight Accessory.[20] The constant, Photogate Spacing, is the distance (in meters) between the centers of the photogates.

The measurements are Initial Velocity and Time Of Flight.

- Initial Velocity is the Photogate Spacing divided by the time-between-gates.
- Time Of Flight is the elapsed time starting when the projectile blocks the first photogate and ending when it hits the Time-of-Flight Accessory.

Photogate Timing Use this timer for general measurements made with one or two photogates.[21] The constants are Flag Length and Photogate Spacing.

- Flag Length is the length (in meters) of the object that passes through the photogates.
- Photogate Spacing is the distance (in meters) between the centers of the photogates. This constant is not relevant if you are using only one photogate.

There are four measurements: Time In Gate, Velocity In Gate, Time Between Gates, and Velocity Between Gates.

- Time In Gate is the time that the flag spends inside either gate each time it passes through. A data point is recorded every time either photogate detects a blocked-unblocked sequence.
- Velocity In Gate equals Flag Length divided by Time In Gate.
- Time Between Gates is the time elapsed between successive interruptions of either gate. A data point is recorded every time one of the photogates is blocked (except the first time).
- Velocity Between Gates equals Photogate Spacing divided by Time Between Gates.

General Counting Use this timer with nuclear sensors, drop counters, and other counting-type digital sensors. The constant, Count Time Interval, is the period over which the timer counts pulses for each data point. It is also the time between successive data points.

The measurement, Pulse Count, is the number of pulses (nuclear events or drops) detected during the Count Time Interval. Pulse Count data points are recorded at a constant rate, one data point at the conclusion of every Count Time Interval.

Collision Timer Use this timer to measure the velocities of two carts before and after they collide. The constant is Flag Length, which is the length (in meters) of the objects that pass through the photogates. The flags attached to both carts must be the same length.

The measurements, Velocity 1 and Velocity 2, are the velocities measured by each photogate. Velocity 1 is Flag Length divided by the time-in-gate of the first photogate. Velocity 2 is Flag Length divided by the time-in-gate of the second photogate.

Arrange the photogates so that the collision occurs between the photogates.

[20] The Time-of-Flight Accessory is PASCO part ME-6810. Projectile Launchers include ME-6800 and ME-6801. A Photogate Bracket, part ME-6821, is necessary to attach the photogates to the launcher.

[21] Photogate Timing works best for measuring the velocity of a single object that blocks only one photogate at a time. To measure the separate velocities of two objects, use Collision Timer.

If both carts are traveling in the same direction before the collision, one photogate will measure the initial velocity of both carts. Similarly, if both carts are traveling in the same direction after the collision, one photogate will measure both final velocities.

If one of the carts is stationary before the collision, its initial position will be between the photogates, and its initial velocity will not be measured. If one of the carts is stationary after the collision, its final velocity will not be measured.

Digital Input Select the Digital Input timer[22] to record the state changes of a photogate or other switch-type sensor.

This timer measures the sensor's Logic State, which has only two possible values: 0 and 1. A Logic State value of 0 corresponds to a sensor output voltage of 0 V, and a value of 1 corresponds to an output voltage of 5 V.

In the case of a photogate, if the most recently recorded Logic State value is 0, then the photogate is blocked; if the most recent value is 1, then the photogate is unblocked. A data point is recorded each time the sensor changes states; thus when the photogate switches from being unblocked to blocked, the timer records 0, and when the photogate switches from blocked to unblocked, the timer records 1.

Typically, the interesting data recorded by the Digital Input timer is not the 0-or-1 Logic State value, but rather the time-stamps recorded with those values. To see the time data, view Time in one column of the Table display and Logic State in another column.[23]

[22] If the Add menu is too long to fit on the screen, arrows (▼, ▲) appear on the menu to indicate that some of the menu options are not visible.

Press the up or down arrow key multiple times to move the highlight beyond the visible portion of the menu. The menu will scroll to bring other options into view.

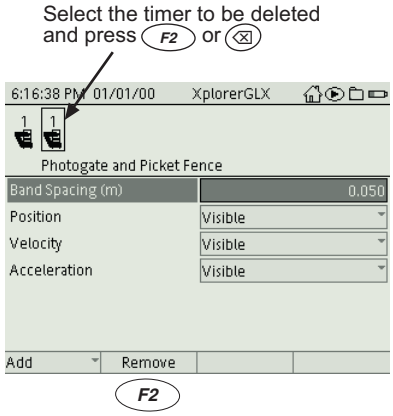
If you are using a mouse, you can click the arrows to scroll the menu.

[23] See page 28 for instructions on choosing data to display in the Table.

F2 Remove

To remove a timer, press F2 or ⌫. If you have more than one timer set up, first use the left and right arrow keys (or mouse) to select the timer that you want to remove in the upper part of the screen, then press F2 or ⌫.

If there are data collected by that timer, they will be permanently deleted. (The GLX will ask you for confirmation before it deletes the timer.)



Digital Adapter Options

In addition to switch-type sensors, the Digital Adapter (PS-2159) allows the GLX to be used with a *ScienceWorkshop* Motion Sensor, a *ScienceWorkshop* Rotary Motion Sensor, or a Digital Relay.

To set up the GLX for one of these devices, connect the Digital Adapter to the GLX and connect the sensor or relay to the adapter (in either order). The Add menu will open automatically with Motion Sensor, Rotary Motion Sensor, and Relay Control among the options. (These options do not appear if you press F1 to open the menu.)

***ScienceWorkshop* Motion Sensor or Rotary Motion Sensor** To use one of these sensors[24] with a Digital Adapter, connect the yellow and black plugs of the sensor to ports 1 and 2 (respectively) of the adapter and connect the adapter to the GLX. The Add menu will open automatically; select Motion Sensor or Rotary Motion Sensor. To set the sample rate and other sensor properties, go the Sensors screen (see page 55).

[24] The *ScienceWorkshop* Motion Sensor is PASCO part CI-6742. The *ScienceWorkshop* Rotary Motion Sensor is PASCO part CI-6538.

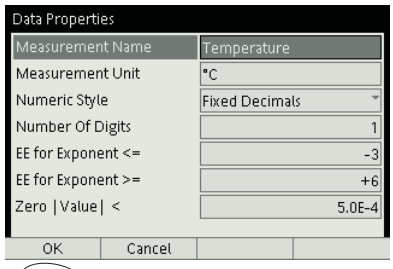
Relay Control To set up the GLX for control of a Digital Relay[25] through a Digital Adapter, connect the relay to the adapter and connect the adapter to the

[25] The Digital Relay is PASCO part CI-6462.

GLX. The Add menu will open automatically; select Relay Control.[22] *Both* ports of the adapter will be configured for Relay Control (though they are controlled separately), so you can connect a second relay to the adapter with no additional set-up required. You can connect up to four Digital Adapters, each with two ports, for up to eight separately controlled output channels. See page 51 for information about controlling digital output through the Calculator.

To use a Digital Relay and a digital sensor simultaneously, connect them to separate adapters.

Data Properties



Data Properties dialog box

Every data set and data source in the GLX has data properties, which control how the data are displayed in the Graph, Table, and other screens.

To Open the Data Properties Dialog Box

To access and edit the properties of a data source, set up the Graph or Table to display the data source, then open the data source menu and select Properties.[26] The Data Properties dialog box will open.

You can also access the data properties of a sensor measurement from the Sensors screen. In the Sensors screen, press F2. (See page 55 for more information.)

When you are finished viewing or editing the data properties, press F1 (OK) to close the dialog box and return to the previous screen, or press F2 to cancel any changes.

[26] For instructions on displaying data in the Graph and selecting items from the data source menu, see pages 13 and 15. For instructions on displaying data in the Table and selecting items from the data source menu, see pages 28 and 28.

Navigating in the Data Properties Dialog Box

Measurement Name The Measurement Name is the label that designates a data source on a graph axis or at the top of a table column. You may want to edit the Measurement Name to add more information about that measurement (change "Temperature" to "Water Temperature," for instance) or to shorten it (change "Force" to "F," for instance).

To edit the Measurement Name, use the up and down arrows keys to highlight it and press ✓ (or click it if you are using a mouse). Type the new name on the keypad and press ✓ (or press Esc to cancel).

See "Multipress Text Input Mode" on page 90 for instructions on using the keypad to enter text.

Measurement Unit The Measurement Unit is the name of units that are displayed on a graph axis or at the top of a table column.

You many want to edit the Measurement Unit to add units to a calculation or manually entered data set, or to abbreviate or spell out the units of a sensor measurement. For instance, you might change "m" to "meters."

To edit the Measurement Unit, use the up and down arrows keys to highlight it and press ✓ (or click it if you are using a mouse). Type the new unit name on the keypad and press ✓ (or press Esc to cancel).

See “Multipress Text Input Mode” on page 90 for instructions on using the keypad to enter text.

Note that changing the *name of the units* will have no effect on the actual data. For instance, if you change the name of the Temperature units from “°C” to “°F,” the numeric values of displayed temperature will *not* change. To change the actual unit of measure, select the units field in the Graph (see page 15), Table (page 29), or other display; or create a calculation (see page 47).

Numeric Style and Number of Digits Select Numeric Style[27] and Number of Digits[28] to set how numbers are displayed in the Table and Digits displays.

The meaning of Number of Digits depends on the selected Numeric Style, as described below.

- **Fixed Decimals:** in this style, the Number of Digits determines how many digits are displayed to the right of the decimal point.
- **Significant Figures:** the Number of Digits determines the number of significant figures that are displayed.
- **Scientific Notation:** all numbers are displayed with a single digit to the left of the decimal point, and the other digits to the right, followed by symbol E and an exponent. (The E means “times 10 raised to the power of….”) The Number of Digits is the total number of digits displayed on both sides of the decimal point (not including the exponent).
- **Engineering Notation:** This style is similar to scientific notation, but there are three digits to the left of the decimal place and Number of Digits determines the number of digits to the right of the decimal place.
- **NSEW 000°00.000:** Use this style for longitude or latitude data collected with a GPS sensor. The data will be displayed in degrees and minutes.

EE for Exponent <= This data property determines the smallest number that will be displayed without using exponential notation. A value of -3, for instance, means that anything less than or equal to 10^{-2} will be displayed in exponential notation.

EE for Exponent >= This data property determines the largest number that will be displayed without using exponential notation. A value of 6, for instance, means that anything greater than or equal to 10^{6} will be displayed in exponential notation.

Zero |Value| < This data property is the smallest absolute value that will be displayed. Any number with a smaller absolute value will be displayed as 0.

[27] **To select a Numeric Style**

Keypad
1. Use the arrow keys to highlight Numeric Style.
2. Press ✓ to open the menu.
3. Use the arrow keys to highlight the desired style and press ✓; *or* press the number on the keypad corresponding to the desired style.

Mouse
1. Click Numeric Style to open the menu.
2. Click the desired style.

[28] **To select the Number of Digits**

Keypad
1. Use the arrow keys to highlight Number of Digits.
2. Press + or − increase or decrease the value.

Mouse
1. Click Number of Digits to highlight it.
2. Press + or − increase or decrease the value.

Calibration

Some of the sensors that you use with the GLX can be calibrated in the Calibration dialog box, which is accessible through the Sensors screen. Calibration can make a measurement more accurate or adjust multiple measurements so that they agree with each other.

Sensors designed for calibration include the temperature probes included with the GLX. Certain other PASPORT sensors are also calibratable. To find out if a sensor can be calibrated, check its documentation, or connect it to the GLX and look for it in the Sensor field of the Calibration dialog box.

To Open the Calibration Dialog Box

From the Sensors Screen[29] follow these steps.

[29]See "Sensors Screen" on page 55.

1. Press F4 to open the Sensor Menu.
2. Use the arrow keys to highlight Calibrate and press ✓; or press the number on the keypad corresponding to Calibrate.

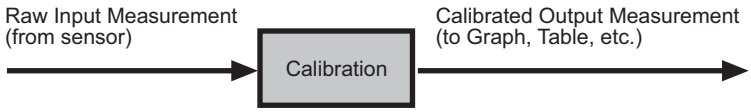
The Calibration dialog box will not open during data collection.

Theory of Calibration

To skip to the practical instructions on calibrating a sensor, see "Navigating in the Calibration Dialog Box" on page 73 and "Calibration Procedures" on page 75.

One of the functions of the GLX is to take the stream of raw data from a sensor and transform it into the calibrated data that you see in the Graph, Table, and other displays. If you do not calibrate a sensor yourself, the GLX uses a default calibration that is loaded when the sensor is connected.

You can think of the GLX as containing a device that takes in raw data and outputs calibrated data.



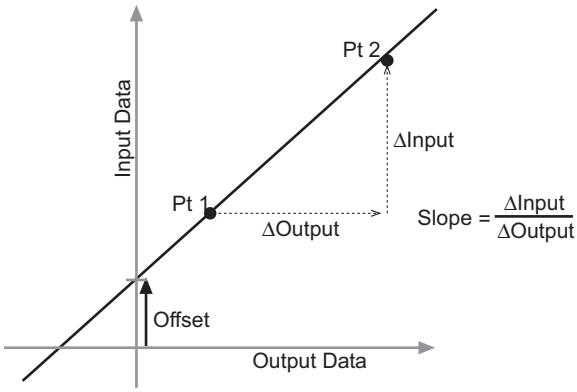
When you perform a calibration, the GLX redefines the linear equation that transforms the raw input into the calibrated output. The linear function is of the form:

$$\text{Raw Input} = \text{Slope} \times \text{Calibrated Output} + \text{Offset}$$

Or:

$$\text{Calibrated Output} = (\text{Raw Input} - \text{Offset}) / \text{Slope}$$

This function can be graphically represented as a line.

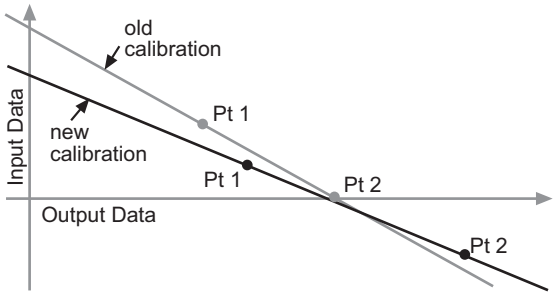


Two points, Pt 1 and Pt 2, define the line. In the two-point calibration procedure, each point is reset by associating a known standard value (for instance, the pH of a buffer solution) with a raw input measurement that the sensor sends to the GLX when it is in that standard. In a one-point calibration, only one of the points is reset by the user.

Types of Calibration

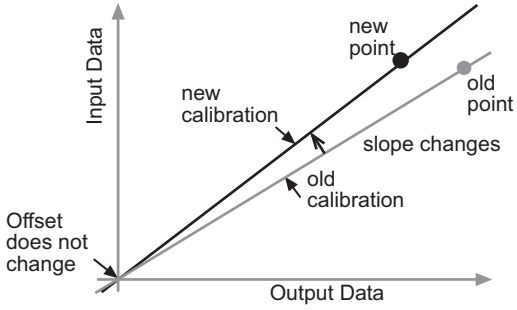
There are three types of calibration: two-point, one-point slope, and one-point offset. Any of these calibrations can be performed on a single sensor, or simultaneously on multiple similar sensors; however, for any given sensor, the GLX will automatically select the most typical calibration type as the default setting.

Two-Point In a two-point calibration, you reset two points to define a new line. This type of calibration affects both the slope and the offset. For step-by-step instructions on the two-point calibration procedure, see page 75.



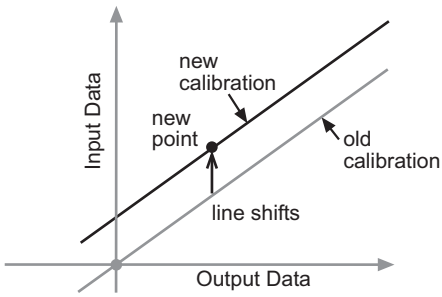
Two-point calibration; two points are set to redefine the line

One-Point Slope In a one-point slope calibration, you reset only one point. The slope of the line changes so that the line intersects the new point, while the offset (or Y-intercept) does not change. For step-by-step instructions on the one-point slope calibration procedure, see page 76.



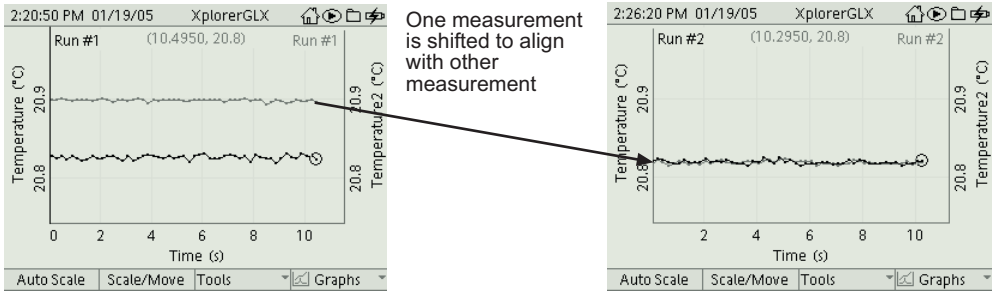
One-point slope calibration; the line changes its slope to intersect the new point

One-Point Offset In a one-point offset calibration, you reset only one point. The line shifts so that it intersects the new point, but its slope does not change.



One-point slope calibration; the line shifts to intersect the new point

Offset calibration is usually used to make one sensor agree with another sensor. The graph below on the left shows the measurements from two temperature probes in the same container of water. Due to normal variation among probes, the second probe consistently reads about 0.08 °C higher than the first probe. Normally this difference would be insignificant; however, an offset calibration can be used to bring the sensors into closer alignment. See "One-Point Offset Calibration or Multiple-Measurement Alignment Procedure" on page 77 for step-by-step instructions.



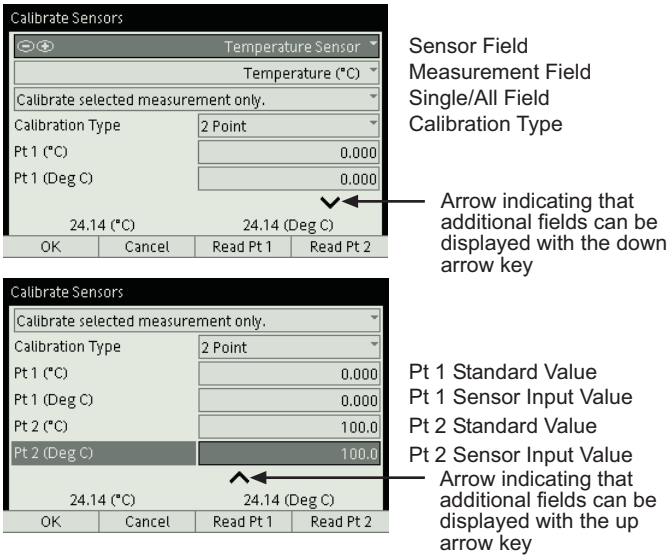
Before offset calibration **After offset calibration**

Navigating in the Calibration Dialog Box

For step-by-step instructions on the calibration procedure, see page 75.

The Calibration dialog box contains a list of fields that are used to select the measurement (or measurements) to be calibrated, and to enter the parameters of the calibration. One of the fields is always highlighted. Use the up and down arrow keys to move the highlight to a different field.

You will sometimes see an up or down arrow (^ or v) near the bottom of the dialog box indicating that more fields are available, but not currently visible. When you see the up arrow displayed on the screen, you can press the up arrow key on the keypad multiple times to make more fields visible. When you see the down arrow displayed on the screen, you can press the down arrow key to make more fields visible.



The top and bottom portions of the Calibration dialog box

Sensor Field Highlight this field and press + or − to cycle through the calibratable sensors connected to the GLX.

Measurement Field Highlight this field and press + or − to cycle through the calibratable measurements of the selected sensor.

Single/All Field Highlight the Single/All Field and press ✓ to switch between "Calibrate selected measurement only" and "Calibrate all similar measurements."[30]

[30]See "One-Point Offset Calibration or Multiple-Measurement Alignment Procedure" on page 77 for more information.

Calibration Type In most cases, it is not necessary to access this field because the GLX automatically selects the most typical calibration type for the selected measurement.

To override the automatic selection, highlight Calibration Type and press ✓ to open the menu. Highlight the desired calibration type and press ✓, or press the number on the keypad corresponding to the desired type. The options are 2 Point, 1 Point Slope, and 1 Point Offset.

Pt 1 Standard Value Highlight this field and press ✓. Enter a value and press ✓.

Pt 1 Sensor Input Value It is usually not necessary to access this field because its value is entered automatically when you press F3.

To enter a value manually, highlight the field and press ✓. Enter a value and press ✓.

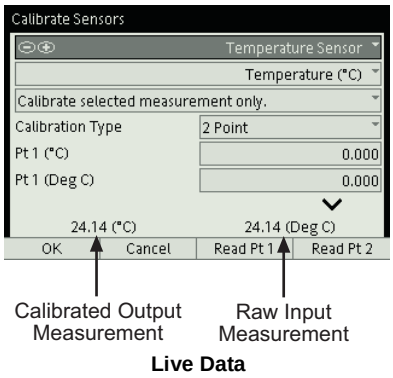
Pt 2 Standard Value Highlight this field and press ✓. Enter the value of the standard and press ✓.

Pt 2 Sensor Input Value It is usually not necessary to access this field because its value is entered automatically when you press F4.

To enter a value manually, highlight the field and press ✓. Enter the value of the standard and press ✓.

Because they are not needed, the fields for Pt 1 are hidden when the 1 Point Slope calibration type is selected, and the fields for Pt 2 are hidden when the 1 Point Offset calibration type is selected.

Calibrated Output and Raw Input Two live values are displayed at the bottom of the Calibration dialog box: the Calibrated Output Measurement and the Raw Input Measurement. The Raw Input Measurement is the data transferred from the sensor to the GLX. The Calibrated Output Measurement is the value resulting from the currently defined calibration. The Calibrated Output Measurement is displayed in the Graph, Table, and other displays.



Live Data

Note About Raw Input Measurement

The value and units of the raw input measurement data can be confusing because they do not necessarily have an obvious meaning. Depending on which sensor you are using, the raw input may represent the default calibration, the voltage produced by an electrode in the sensor, or the digital output of the sensor's analog-to-digital converter.

Keep in mind that it does not matter what the value is, or what its units are. It is only important that the raw sensor input varies in direct proportion to the quantity being measured.

Calibration Procedures

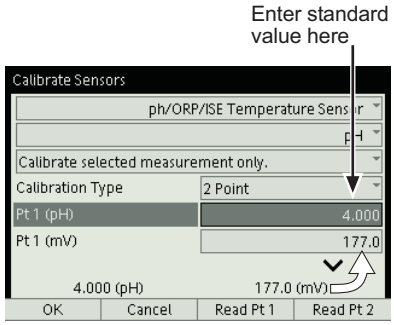
If you don't know whether a two-point or one-point slope calibration is best suited for a particular sensor, follow steps 1–3 of either procedure and observe the Calibration Type that is automatically selected.

Two-Point Calibration Procedure

A two-point calibration requires two known standards. For instance, if you are calibrating a pH sensor, you might use two buffer solutions: one of pH 4 and the other of pH 7.

The fields of the Calibration dialog box are identified on page 74.

1. From the Sensor field, select the desired sensor.
2. From the Measurement field, select the desired measurement.
3. Set the Single/All field to "Calibrate selected measurement only."
4. From the Calibration Type menu, select 2 Point, if it is not already selected.
5. Place the probe in the first known standard.
6. Enter the value of the standard in the Standard Value field for Pt 1.
7. Observe the Raw Input Measurement displayed near the bottom right corner of the screen and wait until it has stabilized.



8. Press F3 to read the sensor input value of Pt 1.

   Note that the Raw Input Measurement has been automatically entered into the Pt 1 Sensor Input Value field, and the standard value is now displayed as the Calibrated Output Measurement.

9. Place the probe in the second known standard.

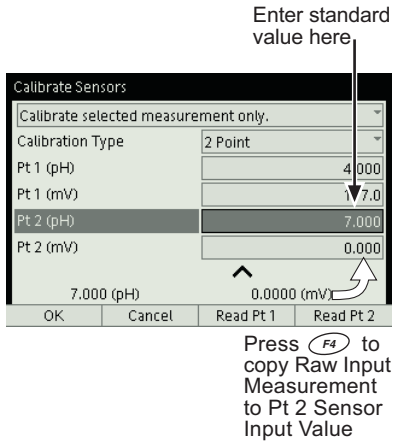
10. Enter the value of the standard in the Standard Value field for Pt 2.

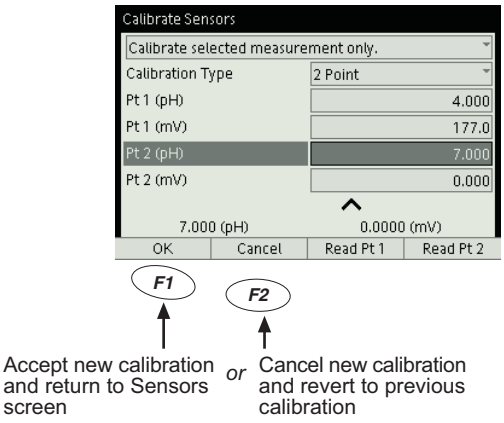
11. Observe the Raw Input Measurement displayed near the bottom right corner of the screen and wait until it has stabilized.

12. Press F4 to read the sensor input value of Pt 2.

    Note that the Raw Input Measurement has been automatically entered into the Pt 2 Sensor Input Value field, and the standard value is now displayed as the Calibrated Output Measurement.

13. Press F1 to accept the new calibration and return to the Sensors screen, or press F2 to cancel the new calibration and revert to the previous or default calibration.





One-Point Slope Calibration Procedure

A one-point slope calibration requires one known standard. For instance, if you are calibrating a dissolved oxygen sensor, you might use 100% saturated water, for which you can look up the oxygen concentration based on temperature and pressure.

The fields of the Calibration dialog box are identified on page 74.

1. From the Sensor field, select the desired sensor.

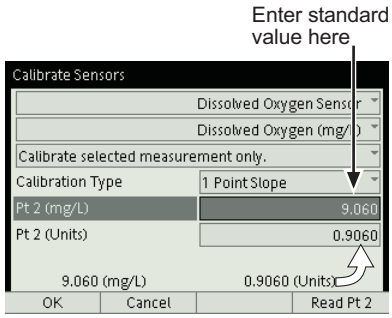
2. From the Measurement field, select the desired measurement.

3. Set the Single/All field to “Calibrate selected measurement only.”

4. From the Calibration Type menu, select 1 Point Slope, if it is not already selected.

5. Place the probe in the known standard.

6. Enter the value of the standard in the Standard Value field for Pt 2.



Press F4 to copy Raw Input Measurement to Pt 2 Sensor Input Value

7. Observe the Raw Input Measurement displayed near the bottom right corner of the screen and wait until it has stabilized.

8. Press F4 to read the sensor input value.

   Note that the Raw Input Measurement has been automatically entered into the Pt 2 Sensor Input Value field, and the standard value is now displayed as the Calibrated Output Measurement.

9. Press F1 to accept the new calibration and return to the Sensors screen, or press F2 to cancel the new calibration and revert to the previous or default calibration.

One-Point Offset Calibration or Multiple-Measurement Alignment Procedure

If you are making two or more simultaneous measurements of the same type, it is sometimes desirable to slightly adjust the calibrations so that all of the measurements agree. For instance, if you are using several temperature probes, you may find that they have slightly different readings when immersed in the same container of liquid; a multiple-measurement alignment will make all of the probes read the same temperature.

This procedure is a one-point offset calibration performed on two or more similar measurements simultaneously.

The fields of the Calibration dialog box are identified on page 74.

1. From the Sensor field, select the desired sensor.

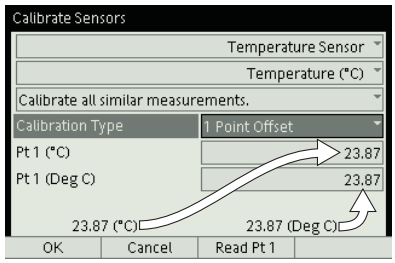
2. From the Measurement field, select the desired measurement.[31]

3. Set the Single/All field to "Calibrate all similar measurements."

4. From the Calibration Type menu, select 1 Point Offset.

5. Place all the probes so that they are all measuring the same thing. It is not necessary to know the value of what they are measuring at this point. (For instance, place all the temperature probes into the same container of water.)

6. Press F3. Note that the Calibrated Output Measurement has been automatically entered into the Pt 1 Standard Value field, and the Raw Input Measurement has been automatically entered into the Pt 1 Sensor Input Value field.



Press F3 to copy Calibrated Output Measurement to Pt 1 Standard value; *and* Raw Input Measurement to Pt 1 Sensor Input Value

7. Press F1 to accept the new calibration and return to the Sensors screen, or press F2 to cancel the new calibration and revert to the previous or default calibration.

To confirm that the measurements are aligned, open the Digits display and view two or more of the measurements simultaneously while recording data. They should be identical or very close.

For information on the Digits display, see page 37.

[31] In this case, the calibration of the selected measurement will *not* change. Rather, the calibrations of all other similar measurements will be changed to match the selected measurement.

Data Files Screen

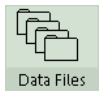
Collected data, calculations, notes, display configurations, and sensor settings are all stored in the GLX's memory. You can save data in a file during or after an experiment, or save a file without data to use as the starting point of an experiment. Use the Data Files screen to view, create, copy, move, and delete these files and their components. In this screen you can also transfer files to and from a second GLX or a flash drive connected to the USB port.

To Open the Data Files Screen

From the Home Screen, do one of the following:

use the arrow keys to highlight the Data Files icon, then press ✓; or

click the Data Files icon.

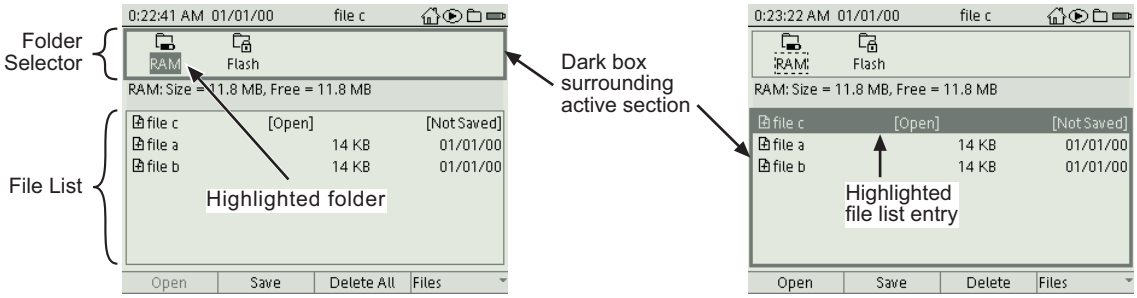


The Data Files icon on the Home Screen

Navigating in the Data Files Screen

The Data Files screen is divided into two sections: the Folder Selector and the File List. The Folder Selector is used to select one of the GLX's two data-storage locations. The File List displays the files stored in the selected folder.

At any time, the focus is either on the Folder Selector or the File List, indicated by a dark box surrounding that section. The focused section also has one of its items highlighted.

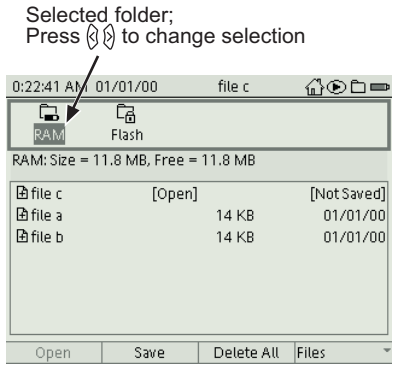


Folder Selector active **File List active**

Press the down arrow key to move the focus from the Folder Selector to the File List section. Press the up arrow key (when the highlight is on the top entry of the File List) to move the focus from the File List to the Folder Selector.

If the File List is empty, the focus cannot be moved to it.

Navigating in the Folder Selector



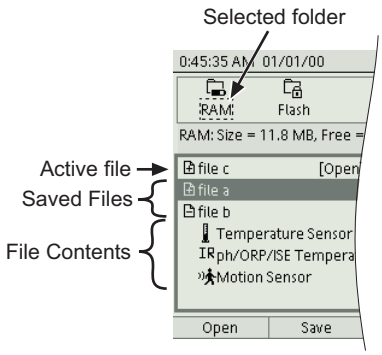
There are two folders in the Folder Selector: RAM and Flash. When the Folder Selector has the focus, the selected folder is highlighted. Press the left and right arrow keys to switch between RAM and Flash. The size and free capacity of the selected folder are indicated below the Folder Selector. The files in the selected folder are displayed in the File List section.

Press the down arrow key to move the focus to the File List of the selected folder. When the focus is not on the Folder Selector, the selected folder is indicated by a dashed box.

For more information on the RAM and Flash data-storage locations, see page 82.

Navigating in the File List

When the focus is on the File List, a highlight appears on one of the entries. Press the up and down arrow keys to move the highlight.



The entries in the File List consist of:

The Active File This is the open file that you are currently working with. It always appears as the first entry in the RAM file list. Any data that is recorded becomes part of the active file.

The active file may be saved or unsaved (see "F2 Save" on page 80). If you have collected data or you have changed any settings since the last time you saved the active file, the saved version of the active file may not match the current state of the GLX.

Saved Files These are files that are stored but not necessarily open. The file list indicates the size of each file and the date on which it was last saved. When you open a saved file (see "F1 Open" on page 80), it becomes the active file.

File Contents By default, the file contents are hidden. To view the contents of a file, highlight the file and press the right arrow key. To hide the contents, press the left arrow key. The icon to the left of the file indicates whether a file can be expanded or contracted.


File can be expanded to show its contents


File can be contracted to hide its contents

Highlight a file and press ◁ or ▷ to hide or show its contents

The file contents include the following types of components, which can be recognized by their icons.

- **Sensors and timers.** Every sensor or timer that appears in the Sensors screen of the file receives a separate entry in the file list. (See "Sensors Screen" on page 55.)


Examples of sensor and timer icons

- **Data runs.** If the file contains data collected from sensors, each data run appears as a file list entry with the time at which data collection started. A data run represents all of the data recorded from all of the connected sensors within a single period of data collection. By default, data runs are named Run #1, Run #2, etc., but they can be renamed (see "Rename" on page 81).


Data run icon

- **Manually entered data.** Each column of data that has been entered in the Table appears as a separate entry. (See "Manually Entered Data" on page 32.)


Manually entered data icon

- **Calculations.** Every equation or expression entered in the Calculator appears as a separate entry. (See "Calculator" on page 41.)


Calculation icon

- **Displays.** If the Graph or Table in the file has been altered from its default settings, it appears in the file list. If multiple graph pages exist, each page appears separately. (See "Graph" on page 13 and "Table" on page 28.)


Graph icon


Table icon

- **Notes.** If one or more Notes pages exist in the file, they are represented by a single entry. (See "Notes Screen" on page 53.)


Notes icon

The GLX saves all the components of a file, but not all of them appear in the File List. The hidden components include the Digits display configuration, Output settings, and data properties.

Mouse Navigation

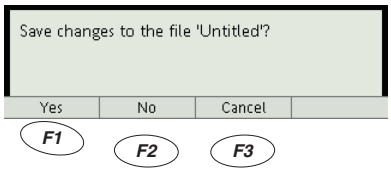
If you are using a mouse, click RAM or Flash to view the File List for each folder. Click the file or file component to highlight it. Click the icon to the left of a file to show or hide the file contents.

Data Files Function Keys

F1 Open

To open a saved file, highlight it in the File List and press F1 (or click Open).

If changes have been made to the current active file since it was last saved, a dialog box will ask if you want to save the file. Select Yes (F1) to save the active file before the new file is opened. Select No (F2) to open the new file without saving the active file; any changes you have made to the active file since it was last saved will be lost. Select cancel (F3) to keep the active file open and not open a new file.



To make the active file revert to its last-saved state, highlight it and press F1 (Open). When the dialog box asks if you want to save changes, select No (F2).

F2 Save

Press F2 (or click Save) to save the active file. If a previous version of the file had been saved in RAM, it will be overwritten. If the active file had originally been opened from the Flash folder, a new copy will be saved in the RAM folder.

F3 Delete

To delete a file, highlight it in the File List and press F3 (or click Delete). A dialog box will ask for confirmation before the file is deleted; select OK (F1) or Cancel (F2).

> You can use ⌫ instead of F3 to delete a single file.

If you delete the active file, it will be unloaded from the GLX and the last copy saved in RAM will be deleted.

To delete a data run or manually entered data set from the active file, highlight it and press F3 (or click Delete). To delete an individual data run or data set from a saved file, the file must first be opened.

When the Folder Selector is active, the F3 option is Delete All. Highlight the RAM or Flash folder and press F3 (or click Delete All) to delete the entire contents of that folder.

F4 Files

Press F4 (or click Files) to open the Files menu. The contents of this menu change depending on what item is highlighted in the File List or Folder Selector. Possible menu options are described below.

New File This option is always available from the Files menu. Select it to unload the current active file and create a new active file.[32]

[32] **To select an option from the Files menu**

Keypad
1. Press F4 to open the Files menu.
2. Use the arrow keys to highlight the desired menu option and press ✓; *or* press the number on the keypad corresponding to the desired menu option.

Mouse
1. Click Files to open the Files menu.
2. Click the desired menu option.

If changes have been made to the current active file since it was last saved, a dialog box will ask if you want to save the file. Select Yes (F1) to save the current active file before it is unloaded. Select No (F2) to unload the file without saving it; any changes you have made since it was last saved will be lost. Select cancel (F3) to keep the current active file open and not create a new file.

Save As This option appears in the Files menu when the active file is highlighted. Select Save As to save the active file with a new name.

Enter the new file name on the keypad (see "Multipress Text Input Mode" on page 90) and press ✓.

Move File Move File appears in the Files menu when a saved file (other than the active file) is highlighted. Use this option to move the highlighted file from the RAM folder to the Flash folder, or vice versa.

When you select Move File, an icon appears in the Folder Selector section of the screen. Press the left or right arrow key to place the icon next to RAM or Flash and press ✓. The file will be moved to that folder.

You cannot move the active file, because that file must remain in the RAM folder. To place the active file in the Flash folder, press F2 to save it, then use Copy File (see below) from the Files menu.

Move All Files This option appears in the Files menu when the Folder Selector has the focus and the selected folder contains saved files other than the active file. Move All Files is similar to Move File, but it moves every saved file in the selected folder, except the active file, to the folder that you choose.

Copy File This option appears in the Files menu when any saved file is highlighted. Copy File is similar to Move File, but, instead of moving the file, a copy of the file is placed in the folder that you choose.

If Copy File is used on the active file, the last saved state of the active file will be copied. Any changes that have been made to the active file since you last saved it will not be part of the copied file.

If you place the copied file in a different folder, it will have the same name as the original. If you place it in the same folder, the words "Copy of" will be added to the original name.

Copy All Files This option appears in the Files menu when the Folder Selector has the focus. Copy All Files is similar to Copy File, but it copies every saved file in the selected folder to the folder that you choose.

Rename This option is available when a file in the RAM folder or a data run in the active file is highlighted. Follow these steps to change the name of a file or data run.

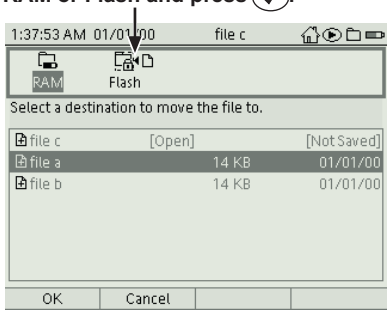
1. Highlight the file or data run.

2. Select rename from the Files menu.

3. Enter the new file name on the keypad (see "Multipress Text Input Mode" on page 90) and press ✓ (or press Esc to cancel the name change).

You can rename a file or run without opening the Files menu. Highlight the file or run and press ✓. Type the new name and press ✓.

Press ◊ and ◊ to place the icon next to RAM or Flash and press ✓.



Move or Copy File

RAM and Flash

The GLX has two types of memory for file storage: RAM and Flash, represented by two folders in the Data Files screen. By default, files are saved in the RAM folder. Whether it is most appropriate to store a file in RAM or Flash depends on how you intend to use the file.

Files in the RAM folder are saved in the GLX's random access memory. With a capacity of about 12 MB, the RAM folder is large enough to store many files, including ones containing large data sets. Files can be saved to RAM quickly and easily.

Files copied to the Flash folder are stored in a special type of programmable read-only memory. Use the Flash folder to store files that you do not want to be easily altered, such as configuration files for experiments or sample data files. When you open a file from the Flash folder and save it again, it does not overwrite the original file; rather, it saves a copy in the RAM folder. This property prevents users from accidentally saving collected data over a file designed to be used as an experiment set-up file.

Files saved in either RAM or Flash will remain saved even if the GLX's battery runs too low for normal operation. When the battery drains to a critical level, the GLX shuts down, reserving enough energy to maintain the RAM memory until it can be connected to AC power. However, if you store the GLX for several days without power connected after the battery has drained to the critical level, it is possible for the battery to run so low that RAM is erased.

Flash memory does not require any power to store data permanently. You can leave the GLX unpowered for any amount of time without losing files saved in the Flash folder.[33]

[33]See page 94 for more information about battery power and data storage.

File Size Limits

In order to reserve enough free RAM capacity to save a data file, the GLX limits a single file to 4 MB. If that size limit is reached, data collection will automatically stop. To collect data after the file-size limit has been reached, delete existing data or start a new file. Data collection will also stop if the size of the data file exceeds the free space remaining in RAM. Since a 4-MB file typically contains over 100000 data points (depending on the sensors used), most users will not be affected by these limits.

Using the GLX with a USB Storage Device

If you have a USB storage device[34] (such as a USB flash drive), you can use it to add storage capacity to your GLX, back up data, and transfer data to another GLX or a computer.

> See also "Export All Data" on page 32 for instructions on exporting data as a tab-delimited text file to USB storage.

Connect a storage device to the larger USB socket (labeled with ⇠•) on the side of the GLX.

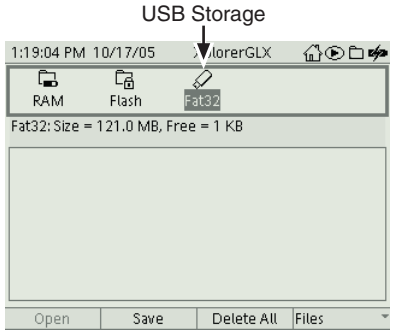
[34]The USB storage device must be formatted using the FAT16 or FAT32 file system. Most flash drives are formatted this way. Other mass-storage devices such as portable hard drives and audio players may also be compatible. You can use a USB card reader, however the card must be in the reader before you connect the reader to the GLX.

File Transfer

When a USB storage device is connected to the GLX, a third icon appears in the Folder Selector of the Data Files screen.

This icon represents the USB storage "folder." Use this folder like the standard RAM and Flash folders to open, delete, move, copy, and rename files (see pages 80–81). You cannot open a file directly from USB storage; you must first move the file to the GLX's RAM or Flash folder. After you have saved files on the storage device, you can unplug it and connect it to any other GLX to open the files.

If you connect the storage device to a computer, you will find the files on the device's root level. See page 101 for instructions on opening these files in DataStudio, or page 104 for instructions on opening them in the GLX Simulator. You can also copy GLX files[35] from the computer to the storage device, and later open these files on a GLX. When you copy or save a GLX file from your computer to the storage device, you can put it at the root level or in a folder; when the device is connected to a GLX, the GLX searches through the entire device and displays all GLX files in the Data Files screen.



A third folder appears when a USB storage device is connected

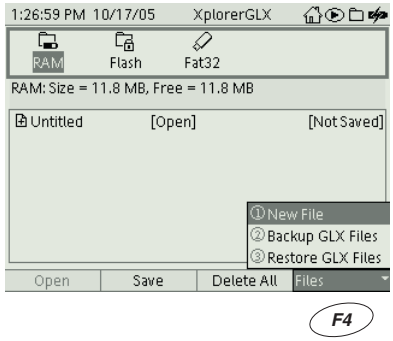
[35]GLX files on your computer may have been transferred there from another GLX (see page 100) or created using the GLX simulator (see page 103).

Backup and Restore GLX Files

To back up the GLX, go to the Data Files screen and press F4 to open the Files menu; select Backup GLX Files. All data files in the Ram and Flash folders and all settings are copied to the flash drive. To restore these files and settings, press F4 to open the Files menu and select Restore GLX Files. Once a GLX has been backed up onto a storage device, you can restore the files and settings onto any other GLX.

The back-up and restore operations may erase and overwrite files and settings on the GLX or flash drive. When you back up a GLX, any previous GLX back-up data on the flash drive is overwritten. When you restore backed-up data, all previous files and settings on the GLX are overwritten.

Data that you have stored using the GLX backup operation can only be accessed using the restore operation. If you want to save multiple files that can be accessed individually, use the Move All Files or Copy All Files options from the Files menu (see page page 81).

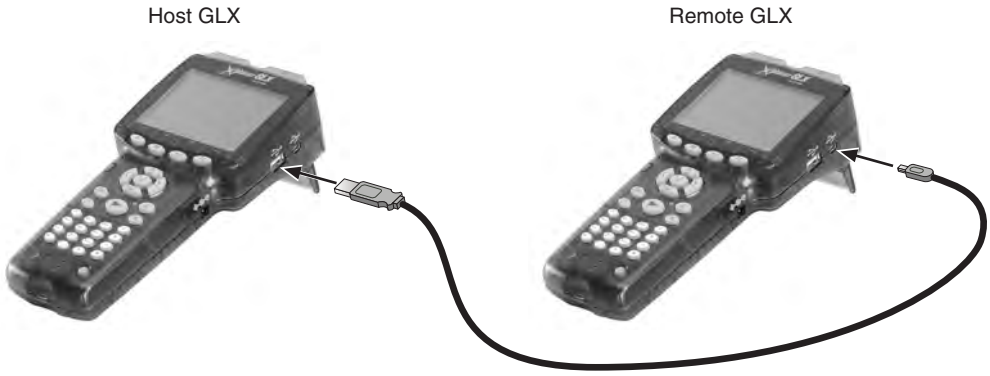


Backup and Restore options in the Files menu

> If you connect the flash drive to a computer after you have backed up a GLX, you will find a folder named *GLXBackup*, which contains the back-up data. This folder and the files in it are intended only for access by the GLX when it performs the restore operation.

GLX-to-GLX File Transfer

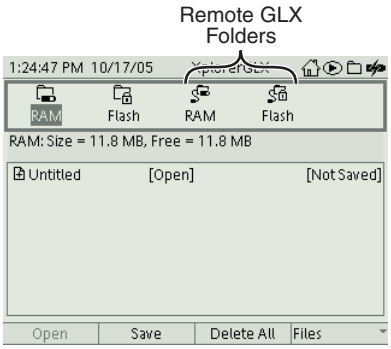
To transfer files directly between two GLXs, connect the larger USB port of one GLX to the smaller USB port of the other GLX using the included USB host-connection cable.



Use the host-connection cable to connect two GLXs

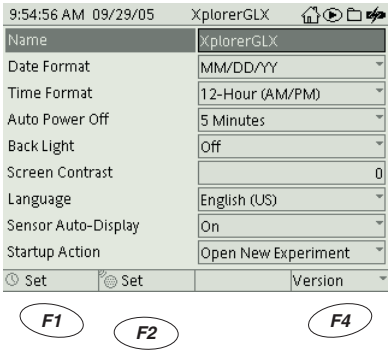
The GLX connected by the larger USB port is the *host unit*, and the one connected by the smaller port is the *remote unit*. All GLX-to-GLX file-transfer operations are controlled in the Settings screen of the *host* unit.

When a remote GLX is connected, two additional folders appear in the Settings screen of the host GLX, which represent the RAM and Flash folders of the remote unit. Use these folders like the host RAM and Flash folders to open, delete, move, and copy files (see pages 80–81). You *cannot* open a file directly from the remote GLX; you must first move the file to the host GLX's RAM or Flash folder.



The Data Files screen with a remote GLX connected

Settings Screen



Settings screen

The Settings screen contains the controls for how the GLX environment looks and acts.

To Open the Settings Screen

From the Home Screen, do one of the following:

use the arrow keys to highlight the Settings icon, then press ✓; or

click the Settings icon.

The Settings icon on the Home Screen

Settings

To change any of the settings, use the arrow keys to highlight the setting and press ✓.

If you are using a mouse, click the desired setting.

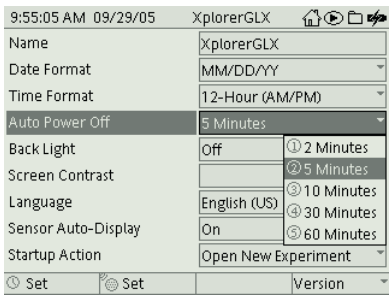
Name If the active file (see page 79) has not been named, the GLX's name appears in the Top Bar. By default, the name of the GLX is "XplorerGLX." If you are working with more than one GLX and would like to uniquely identify each one, change the name of each GLX. Highlight Name and press ✓. Type the new name[36] and press ✓.

[36]See "Multipress Text Input Mode" on page 90.

Date Format The date shown in the Top Bar can be displayed in two formats: month/day/year (MM/DD/YY) or day/month/year (DD/MM/YY). Highlight Date Format and press ✓ to switch between the two options.

Time Format The time shown in the Top Bar can be displayed in either 12-hour or 24-hour format. Highlight Time Format and press ✓ to switch between the two options.

See "F1 Set Date and Time" below to manually set the date and time.



Auto Power Off This setting controls how many idle minutes the GLX will wait before it automatically shuts off or goes into sleep-between-samples mode when running on battery power. See "Auto Power Off" on page 8 for more information.

Highlight Auto Power Off and press ✓ to open the menu. Use the arrow keys to highlight the desired time and press ✓.

Back Light From anywhere in the GLX environment, the easiest way to turn the screen's back light on or off is to hold ⌂ and press ✓.

You can also operate the back light from the Settings screen. Highlight Back Light and press ✓ to open the menu. Use the arrow keys to highlight the desired menu option and press ✓ or press the number on the keypad corresponding to the desired menu option. The options are:

- Off;
- On;
- Keypress (10 s): the back light is normally off, but turns on when you press any key and stays on for 10 seconds; and
- Keypress (30 s): the back light is normally off, but turns on when you press any key and stays on for 30 seconds.

Screen Contrast From anywhere in the GLX environment, hold down ⌂ and press the up or down arrow key to adjust the screen contrast.

From the Settings screen, you can also highlight Screen Contrast and press + to make the screen darker or − to make it lighter.

Language The GLX has several language options. Highlight Language and press ✓ to open the menu. Use the arrow keys to highlight the desired language and press ✓.

An arrow (⌄) in the lower right corner of the menu indicates that more menu options are available, but not visible; press the down arrow key to move the highlight to the bottom of the menu, then press the arrow key again to make more options visible.

Language Options:

English
Svenska
Norsk
日本語
中文(繁體)
中文(简体)
Italiano
Dansk
Deutsch
Français
Português
Español
Türkçe
العربية

Sensor Auto-Display Sensor Auto-Display causes the GLX to automatically launch a display (such as the Graph) when you plug in a single sensor while viewing the Home Screen, or when you turn on the GLX with a sensor connected. This feature is designed to simplify basic data collection with a single sensor.

Sensor Auto-Display is on by default. To turn it off, highlight it in the Settings screen and press ✓.

Startup Action There are two options for Startup Action. By default, the Startup Action is set to "Open New Experiment," which causes the creation of a new, empty data file every time the GLX starts up.

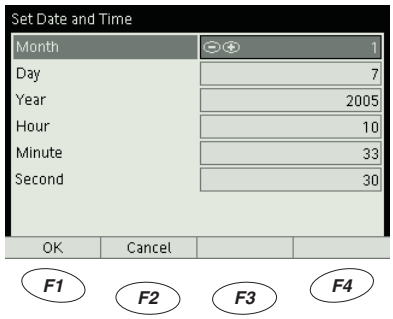
The other Startup Action option is "Open Last File," which makes the GLX open the most recently saved file whenever it starts up. It is convenient to use this option if you plan to turn the GLX off and on during an activity, or if the GLX is likely to automatically turn itself off due to being left idle.

To change the Startup Action, highlight it in the Settings screen and press ✓.

Settings Screen Function Keys

F1 Set Date and Time

The date and time are set automatically when you connect the GLX to a computer running DataStudio.



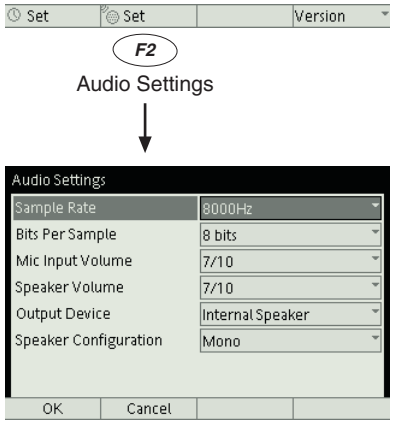
Follow these steps to set the date and time manually.

1. Press F1. A dialog box will open with settings for Month, Day, Year, Hour, Minute, and Second.
2. Use the up and down arrow keys to highlight the setting you would like to change.
3. Press + or − to increase or decrease the selected setting; *or* press ✓, enter the setting on the keypad and press ✓ again.[37]
4. Repeat steps 2 and 3 until all desired settings have been changed.
5. Press F1 to accept changes or press F2 to cancel changes.

[37] If the Time Format is 12-Hour (AM/PM), then a menu will open when you highlight Hour and press ✓; use the up and down arrow keys to select the hour and press ✓ again.

F2 Audio Settings Dialog Box

From the Settings screen, press F2 to open the Audio Settings dialog box.[38] The audio settings determine how audio notes (see page 25) are recorded and played back. Some of the Output screen's default settings (see page 39) are also based on these settings. After changing any of the settings, press F1 to accept the changes or F2 to cancel.



Audio Settings dialog box

Sample Rate and Bits Per Sample These two settings determine the quality and size of recorded audio notes. Higher values of either setting result in higher-quality audio, but also make audio notes use more of the GLX's memory.

Mic Input Volume This setting determines the sensitivity of the GLX's microphone when used for recording audio notes. When set to Automatic, the mic volume adjusts itself in response to the present sound level.

Speaker Volume This setting determines the loudness of audio-note playback and sound output.

Output Device To play audio notes and sound output through the GLX's built-in speaker, set Output Device to Internal Speaker. Set Output Device to Headphones or External Speaker if you have headphones or powered stereo speakers connected to the GLX's signal output port.

Speaker Configuration This setting determines how sound generated in the Output Screen is played through headphones or external speakers. If Output Device is set to Headphones or External Speakers, the two options are Mono and Stereo; if Output Device is set to Internal Speaker, the only option is Mono.

[38] **To change an audio setting**

Keypad

1. From the Settings screen press F2 to open the Audio Settings dialog box.
2. Use the arrow keys to highlight the desired setting.
3. Press ✓.
4. If a menu opens, use the arrow keys to select the desired value and press ✓.

Mouse

1. At the bottom of the Settings screen, click Set to open the Audio Settings dialog box.
1. Click the desired setting.
2. If a menu opens, click the desired value.

F4 Version

Press F4 to see the version numbers of the Firmware, Core, and Power Manager installed on your GLX. These version numbers represent the updatable portions of the GLX's operating system.

Chapter 4: Navigation and Input

Data Source Menus

The axes of the Graph, the columns of the Table, the sections of the Digits display, and the Meter each have a data source field, which you access to choose what data to display. Selecting any of these data source fields opens a data source menu containing a list of all available data sources.

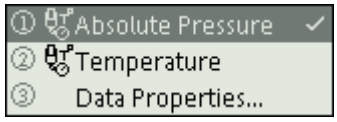
Identifying a Data Source

- In one of the simplest cases—a GLX with one single-measurement sensor connected, and no calculations or manually entered data—the data source menu contains two items, as illustrated to the right. In this example, there is only one data source option, so it is selected automatically.

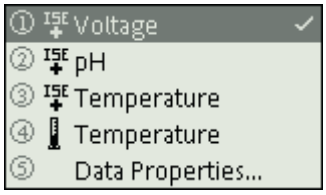
Selecting the other option in the menu, Data Properties, opens the Data Properties dialog box for the selected measurement. See "Accessing Data Properties" on page 90.

- In this example, the GLX is connected to two single-measurement sensors: a Temperature Sensor and a Relative Pressure Sensor. There are two data sources to choose from. The selected data source has a check mark next to it. The two data sources are from two different sensors, so each has a different icon.

- Certain sensors make more than one measurement. The data source menu pictured here is from a GLX connected to a Pressure/Temperature Sensor. Note that the two data sources have the same icon, indicating that they both come from the same sensor.



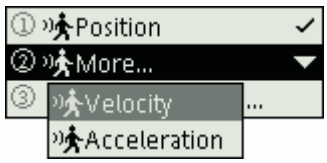
- The menu pictured to the right is from a GLX connected to two sensors: a Temperature Sensor and pH/ORP/ISE/Temperature Sensor. The pH/ORP/ISE/Temperature Sensor makes several measurements, one of which is Temperature. There are two data sources named "Temperature," one from the pH/ORP/ISE/Temperature Sensor and one from the Temperature Sensor. You can tell which sensor each temperature measurement is from by looking at the icons next to the measurement names.



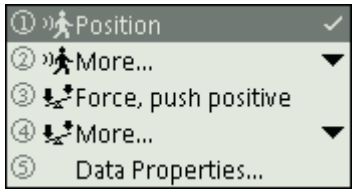
Expanding the Data Source Menu

- The menu pictured to the right is from a GLX connected to a Motion Sensor.

The Motion Sensor makes three measurements: Position, Velocity, and Acceleration. Only one measurement, Position, is visible. The "More" option that appears with a Motion Sensor icon indicates that other measurements are available from that sensor, but are not shown. Select "More" to see the other available measurements.



- In the menu pictured to the right, two sensors are present that each have hidden measurements. There are two "More" options, one for each sensor. They can be distinguished by their different icons.



Accessing Data Properties

Selecting the Data Properties option from a data source menu opens the Data Properties dialog box for the selected measurement. In this example, the Data Properties for Relative Pressure would open.

To access the Data Properties of another measurement, first select that measurement from the data source menu, then open the menu again and select Data Properties.

For information on the Data Properties dialog box, see page 69.

Multipress Text Input Mode

Multipress text input is used to enter numbers and letters through the keypad of the GLX. Each of the GLX's input keys has a number and several letters or punctuation marks printed on it. In multipress mode, repeatedly pressing a key will cycle through these characters.

The 7 key (7) will cycle through punctuation marks, not all of which are printed on the key. The characters in the cycle are:

7 ? ! @ ( ) , : ; & ~ % # < >

The 0 key (0) cycles through two characters: 0 and a space.

The decimal point key (.) cycles through two characters: a period (or decimal point) and E, which is used often in scientific notation.

Using a USB Keyboard

For most users, text entry is faster and easier with a USB keyboard[1] connected to the GLX. A keyboard also allows the input of capital letters in areas of the GLX environment where Shift and Caps Lock are not available.

[1]PASCO part PS-2540 or PS-2541

Most keys on the GLX's keypad have an obvious equivalent key on an attached USB keyboard. The less obvious keyboard equivalents are shown in the table below.

GLX Key	USB Keyboard Equivalent
✓	Enter and Return
⌂	Home
▶	F5
⚐	F6
⌫	Backspace and Delete
X	* (asterisk)

Scientific Notation

The GLX displays very large and very small numbers using scientific notation. You can also input any number using scientific notation. On the GLX, the letter E, when it is placed between two numbers (with no spaces) is interpreted as meaning "times 10 raised to the power of…."

The letter E can always be input by pressing the decimal point key ( ) twice, even when the GLX is not in multipress text input mode.

Below are some examples of scientific notation and their normal equivalents.

5E2 = 500

1.234E5 = 123400

56.789E1 = 567.89

6.518E-3 = 0.006518

A lowercase e can be used interchangeably with uppercase E:

4.35e5 = 4.35E5 = 435000

A number expressed in scientific notation must not have a space adjacent to the E. The number to the left of the E can contain a decimal point, but one is not required. The number to the right of the E must not contain a decimal point.

Printing

The Graph, Table, Calculator, Sensors, Output, Notes, Meter, and Stopwatch screens can all be printed on certain models of printers[2] connected to the GLX's USB port. In these screens, select the print command (or commands) from the F4 menu.

To install a printer on the GLX, simply connect it to the GLX's USB port using the cable that came with your printer. Drivers for compatible printers are factory installed on the GLX and updated whenever the GLX receives a firmware update (see page 93).

[2]The list of compatible printers is continually increasing as new printer models become available. For an up-to-date list of compatible printers, visit www.pasco.com or contact PASCO technical support at:

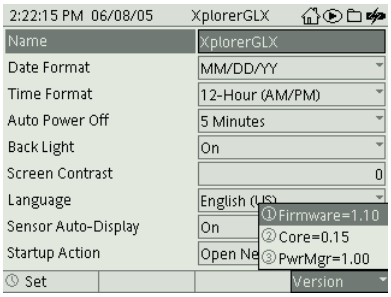
support@pasco.com
or
(916) 786-3800
or
(800) 772-8700

Chapter 5: Hardware Maintenance and Operation

Firmware Update

From time to time, PASCO issues a free update to the firmware that runs on the GLX. Updates include new and improved features and bug fixes. Send in the registration card that you received with your GLX, or register at www.pasco.com/glx to be notified of new updates.

To check the version of firmware currently installed on your GLX, open the Settings screen (see page 85) and press F4.



Version numbers displayed in the Settings screen

You can always download the latest update from www.pasco.com/glx. Follow the instructions at the website to download the update to your computer or a USB flash drive. When you download the firmware update, also download the latest revision of this Users' Guide from the same web page.

Installing updates may delete files saved in the RAM and Flash folders of the GLX. Transfer stored files to your computer before upgrading the GLX. (See "Transferring Files" on page 100.)

Updating from a Computer

Once the update is on your computer, connect the GLX to the USB port and run DataStudio. When DataStudio detects a GLX running an older firmware version, it will give the option of upgrading that GLX. (See "GLX with DataStudio" on page 99.)

Updating from a USB Flash Drive[1]

Connect the USB flash drive containing the update to the GLX's USB port. Open the Data Files screen (see page 78). Press F4 to open the Files menu and select Upgrade GLX Firmware.

[1]To update the firmware from a flash drive, the previous firmware version must be 1.35 or later.

Battery and Power

Battery Charging

To charge the battery, simply connect the GLX to the AC power adapter. The GLX will automatically power on. If its battery is less than fully charged, the GLX will begin to charge the battery and remain powered on until the battery is fully charged.[2]

If the battery is fully charged and AC power is connected, the GLX will automatically save data and shut down after 60 minutes of idle time.[3] It will periodically power on and top off the battery as needed.

The typical full charging time for a new battery at room temperature is about 14 hours. When practical, allow the GLX to charge its battery in a room-temperature or cooler environment. Place the GLX on a flat surface with its stand unfolded to accommodate air flow and heat dissipation.

[2]The icon in the upper-right corner of the display indicates the condition of the battery. See page 11 for details.

[3]**The GLX is considered idle when**

- the GLX is *not* collecting data,
- the Stopwatch is *not* running,
- the GLX is *not* connected to a computer running DataStudio, and
- the GLX is *not* receiving input through its keypad, a mouse, or a USB keyboard.

See "Timed Auto Power Off" on page 8 for more information.

While charging, the GLX monitors its own temperature to prevent overheating. The maximum recommended ambient temperature for charging is 32 °C (90 °F) without sensors, or 28 °C (82 °F) with *four maximum-load sensors*[4] connected. If the GLX becomes too hot, it will temporarily stop charging to allow itself to cool, resulting in a longer charge time.

[4]A maximum-load sensor is one that draws 100 mA of current from the GLX, such as the PASPORT CO_2 sensor. Most PASPORT sensors draw much less current.

Battery Power and Data File Storage

The GLX's RAM (random-access memory) requires a small amount of power. In order to preserve stored data, the GLX automatically shuts down when its battery begins to run low. At that point, AC power must be connected within three days to preserve data files stored in the RAM folder.

When powered off, disconnected from AC power, and starting with a *fully charged* battery, the GLX will store RAM data for two weeks.

Flash memory does not require power. Data files stored in the Flash folder will be preserved indefinitely even if the battery runs down or is removed.

For permanent storage, save files in the GLX's Flash folder or transfer files to a USB Flash drive or a computer.[5]

[5]See "Data Files Screen" on page 78 for more information.

GLX Storage

To maximize the long-term performance of the battery, keep it charged as much as possible. Note that the battery will drain slowly even when the GLX is powered off and disconnected from AC power. When you are not using the GLX, follow these storage guidelines:

- **Whenever possible:** Keep the GLX connected to AC power.
- **Unplugged for more than a few days:** Backup your data and allow the battery to fully charge before disconnecting the AC power.
- **Unplugged for more than a month:** Backup your data, allow the battery to fully charge, then follow the instructions under "Manual Internal Disconnection" below. A disconnected battery or a GLX in "deep sleep" mode can be stored for up to a year before you should recharge it.

Battery Disconnection

Automatic Internal Disconnection

When it is unplugged and turned off, the GLX uses a small amount of battery power to preserve data saved in RAM. In order to avoid fully discharging the battery (which is not good for it), the GLX will go into "deep sleep" mode when *either* of these conditions is met:

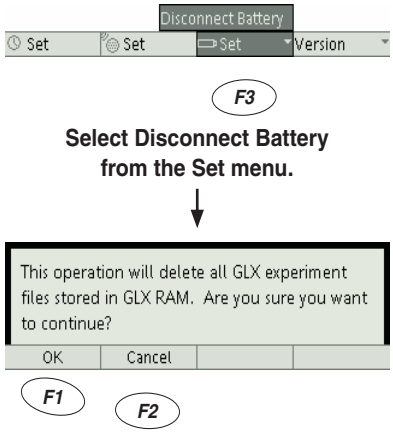
- The GLX has been unused and unplugged for two weeks.
- The battery has drained to a critical level.

When the GLX enters deep sleep mode, it disconnects its battery by opening a switch on its circuit board. At this point, data saved in RAM is lost, but data saved in Flash is preserved. Connect the GLX to AC power or press the reset button (on the back of the GLX) to turn it back on.

Manual Internal Disconnection

If you anticipate that your GLX will be left unused and unplugged for more than a month, manually put it into deep sleep mode. This will make it more likely that the battery will be charged the next time you use it. Follow these steps:

1. Leave the GLX plugged in until the battery is fully charged.
2. Unplug the AC Adapter.
3. Open the Settings screen (see page 85).
4. Press F3 to open the Battery Set menu. Press ✓ to select Disconnect Battery.
5. You will see a warning message (right). If you are sure that you want to disconnect the battery, press F1 for OK.
6. The GLX disconnects its battery and powers off. To turn the GLX back on, connect the AC adapter or press the reset button on the back (using a paper clip).



Battery Disconnection for Early Hardware Versions

Some earlier versions of the GLX do not contain a switch for internal battery disconnection.[6] If you have one of these models and you follow the manual disconnect instructions above, the GLX will display a message indicating that it does not support internal battery disconnection. If this is the case, store the GLX connected to AC power *or* remove the battery door on the back of the GLX and unplug the battery. (Do not connect the AC adapter when the battery in not installed.)

[6] A GLX that does *not* contain an internal battery switch can be identified by the *first four digits* of its serial number, which will be *less than* **0626**. These units were manufactured in 2005 and early 2006. You will find the serial number on the barcode sticker on the back of the GLX.

Battery Capacity

The operating time for a single battery charge depends on many factors including the age and history of the battery, the number and type of sensors connected, the use of sound output, and the backlight. At an ambient temperature of 25 °C, a GLX with a newer battery, no PASPORT sensors connected (using only the included temperature and voltage probes), sound output turned off and backlight off will operate for about six to seven hours before it automatically saves data and shuts down.

You can maximize the operating time by unplugging sensors when they are not collecting data, using the backlight only when necessary, and turning off the GLX while not in use.

If the GLX will be collecting data over a long time, set the sampling period of all sensors to 30 s or greater (see page 56). This will allow the GLX to conserve power by "sleeping" between samples. In this mode of data collection, the battery will last for several days or more.

Battery Reconditioning and Replacement

As with all rechargeable batteries, the GLX's nickel metal hydride battery will lose capacity with age and repeated use. Under typical conditions, the battery can be used for about 500 charge-discharge cycles before capacity loss becomes significant.

When the battery's capacity begins to decrease, it will continue to function, but it will require more frequent recharging, and the maximum unpowered time for the GLX to store data in RAM will decrease.

If this happens, try to recondition the battery by running it through three complete, uninterrupted charge-discharge cycles: Disconnect the AC adapter. Plug in a sensor. Start data collection and wait until the GLX shuts down due to low battery. Plug in the AC adapter and let the GLX charge *uninterrupted* until the battery gauge indicates full (about 14 hours). Repeat this cycle at least two more times.

If the battery can not be reconditioned, replace it with a new battery[7] (PASCO part PS-2527): Use a Phillips screwdriver to remove the screws securing the battery door on the back of the GLX. Remove the door, unplug the old battery, and install the new battery in its place. Replace the door.

To calibrate the GLX's battery gauge for the new battery, run it through one full charge-discharge cycle: Connect the AC adapter and allow the battery to fully charge. Then disconnect the AC adapter, plug in a sensor, start data collection, and allow the battery to discharge until the GLX automatically shuts down.

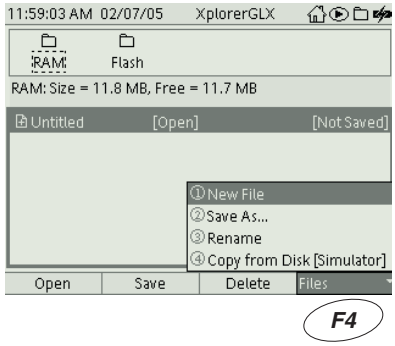
[7]To avoid damage to the GLX, remove the AC adapter before disconnecting the battery.

To preserve data files in the GLX's RAM folder, transfer them to the Flash folder, a USB storage device, another GLX, or a computer. See "Data Files Screen" on page 78 and "Using the Xplorer GLX with a Computer" on page 99 for instructions.

Resetting

To Start a New Experiment

To start a new experiment without turning off the GLX, go to the Data Files screen (see page 78), press F4 to open the Files menu, and press 1 to select New File. Previous data, displays, and sensor settings will be unloaded from the GLX and returned to their default configurations.



Start a new experiment

To Force the GLX to Restart

The following procedures are not necessary in normal GLX operation. They will force the GLX to restart and may also result in the loss of data saved in RAM.

- Press and *hold* ⏻ for 5 seconds. The GLX will power off.
- Press the key sequence Esc, ⌂, 0. The GLX will restart.
- Use a paperclip to press the recessed Reset button on the back of the GLX (see picture). The GLX will power off or restart depending on the state of its battery and the presence of AC power.

To Restore the GLX to Factory Configuration

These procedures are not recommended during normal GLX operation. All data files and system settings will be deleted. The normal method for deleting files stored in RAM or Flash is described on page 80.

Follow these steps to reset system settings to factory defaults and delete saved data in RAM.

1. Turn the GLX off then on again.
2. When the Splash Screen is visible, press the key sequence Esc - ⌫.

Splash screen

3. *Connect the GLX to a computer running DataStudio to re-install sensor data sheets*.

Follow these steps to reset system settings to factory defaults and delete saved data in RAM and Flash.

1. Turn the GLX off then on again.

2. When the Splash Screen is visible, press the key sequence Esc - ⌂.

3. *Connect the GLX to a computer running DataStudio to re-install sensor data sheets*.

Operating Temperature

The GLX can be operated and stored without damage at temperatures between -10 °C and 40 °C. Do not leave the GLX in a parked car or other environment that may exceed this range. Protect the GLX from long-term exposure to direct sunlight, which may heat the unit above the specified limit even if the surrounding air temperature is less than 40 °C. Temperatures at the extremes of this operating range may affect battery performance, measurement accuracy, and display contrast. Whenever possible, use and store the GLX at or close to normal room temperature.

Chapter 6: Using the Xplorer GLX with a Computer

The GLX can be connected to a computer[1] to transfer files, to collect data using DataStudio software, and to install updates to the GLX.

[1]Supported operating systems include Windows 98/2000/ME/XP, Mac OS 9, and Mac OS X.

GLX with DataStudio

When used with a computer, the GLX requires DataStudio version 1.9.5 or later.[2] Before connecting the GLX to your computer, install the version of DataStudio that you received on a CD-ROM with your GLX or download the most recent version from www.pasco.com.

[2]For file transfer and firmware updates, the GLX Simulator can be used instead of DataStudio. See "GLX Simulator" on page 103.

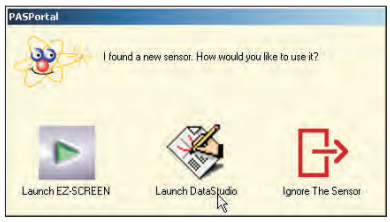
Connecting the GLX to a Computer

With the GLX powered on, use the USB host-connection cable (included with the GLX) to connect the smaller USB port of the GLX to the USB port of your computer.

Launching DataStudio

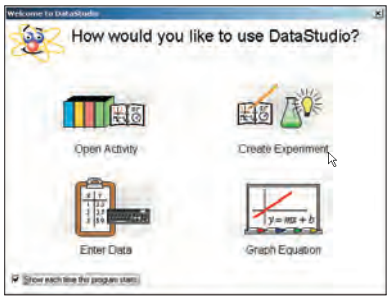
- If there is a new file saved on the GLX[3], your computer will automatically launch DataStudio when the GLX is connected.
- If there are sensors connected to the GLX, but no new files, the PASPortal window will open when the GLX is connected to the computer. In the PASPortal window, click Launch DataStudio.

[3]A new file is one that has been saved since the last time the GLX was connected to a computer.



- If the PASPortal window or DataStudio does not automatically launch, start DataStudio via the icon on your computer's desktop. When you see the "Welcome to DataStudio" window, click Create Experiment.

Desktop icon



Transferring Files

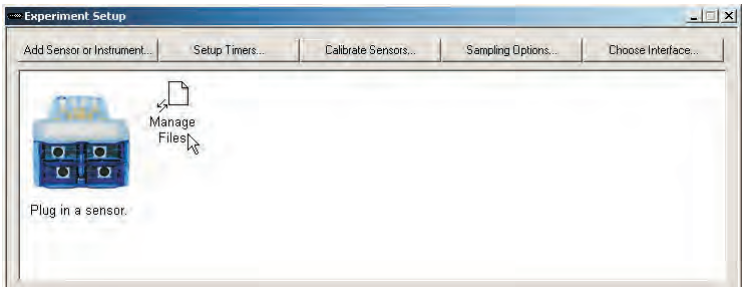
GLX File Manager

If DataStudio detects a GLX with new files saved on it, it automatically opens the GLX File Manager.

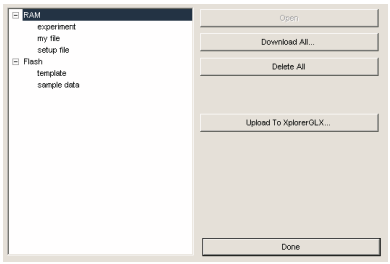
You can also manually open the GLX File Manager with these steps.

1. Click the Setup button (in DataStudio's main button bar). The Experiment Setup window will open.

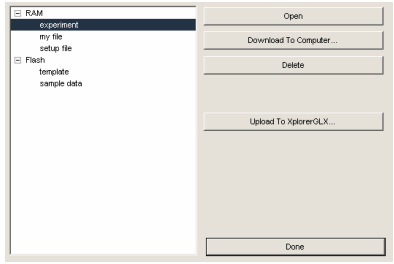
2. In the Setup window, click the Manage Files icon. The GLX File Manager will open.



The left side of the GLX File Manager window shows the files that are saved in the RAM and Flash folders of the GLX. Click a file or folder to select it; the selected file or folder is highlighted in blue.



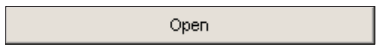
GLX File Manager with a folder selected



GLX File Manager with a file selected

The right side of the window contains five buttons, described below.

Open The Open button is available when a file is selected. When you click Open, the selected file will be copied from the GLX. DataStudio will translate it into a DataStudio file and open it. The original file will remain on the GLX.



Download Click the Download button to copy a file or files from the GLX to your computer.

If a GLX folder is selected, the Download button is labeled "Download All." When you click the button, DataStudio will prompt you to select a folder on your computer to copy the GLX files into. The files on your computer will have the same name as the files on the GLX. The original files will remain on the GLX.

When a single GLX file is selected, the Download button is labeled "Download to Computer." Click the button to download the file. DataStudio will prompt you

to select a folder on your computer and a file name for the downloaded copy of the file.

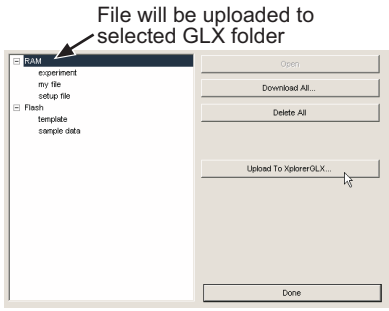
GLX files saved on your computer's disk have the file extension **.glx**. They can be opened with DataStudio or copied to another GLX.

Delete Click the Delete button to delete a file or files from the GLX.

When a GLX folder is selected, the Delete button is labeled "Delete All." Click the button to delete all of the files in the selected folder.

When a single GLX file is selected, click the Delete button to delete the file.

Before deleting a file from the GLX, DataStudio will prompt you for confirmation. Click "Yes" to proceed with the deletion, or click "No" to cancel the deletion.



Upload To copy a GLX file from your computer to the GLX, first select the GLX folder that you would like the file to be saved in, then click the Upload button. DataStudio will prompt you select a file on your computer's disk to be uploaded.

The file to be uploaded must be a GLX file with a **.glx** extension. GLX files can be created by a GLX or by the GLX Simulator.

Done Click Done to close the GLX File Manager.

To Transfer Files Between GLXs Through DataStudio

You can also transfer files directly from one GLX to another; see "GLX-to-GLX File Transfer" on page 84.

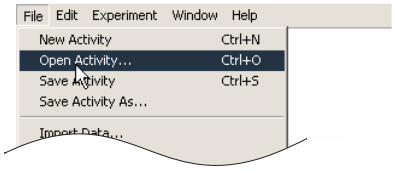
1. Connect the first GLX to a computer, start DataStudio, and open the GLX File Manager.

2. Select the GLX file to be copied and click the Download button to save the file to your computer's disk.

3. Disconnect the first GLX and connect the other GLX.

4. Click the Upload button and select the file that you have just saved on the computer. The file will be copied to the connected GLX.

To Open a GLX File in DataStudio



To open a file that has been copied from the GLX to your computer, click the File menu in DataStudio and select Open Activity. In the File Open dialog box, select the file to be opened. DataStudio will translate the file into a DataStudio file and open it.

How GLX Files Translate to DataStudio Files

The GLX and DataStudio use different file formats. DataStudio can open GLX files, but the GLX cannot open DataStudio files. When you open a GLX file in

DataStudio, the file is translated into a DataStudio file. Most components of the GLX file, listed below, appear in the new DataStudio file.

- Numeric data sets
- Data properties of data sets and measurements
- Sensor settings, such as calibrations and samples rates
- Timers
- Sampling mode
- Data displays
- Calculations
- Notes pages, which appear in DataStudio as a Workbook display

To comply with the DataStudio file format, certain components of the original GLX file may be altered, including the following.

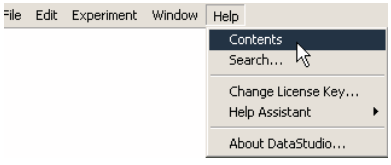
- Text data sets. DataStudio 1.9.5 does not support text data sets. They are replaced in the DataStudio file with a numeric data set containing zeros in place of the text.
- Tools in the Graph and Table displays, such as linear fit and statistics.
- Graph scale settings.
- Sound Output settings.

Once a file has been opened in DataStudio (either directly from the GLX, or after having been downloaded to the computer's disk) it is a DataStudio file. If you save it, it will be saved with a **.ds** extension.

Collecting Data with DataStudio

When the GLX is connected to a computer running DataStudio, sensor setup and data collection are controlled from DataStudio. The GLX operates in DataStudio Mode, acting only as an interface routing data from the sensors to the computer.

While in DataStudio-connected mode, the GLX screen reads "DataStudio Connected." In this mode, only two of the GLX keys are functional: ▶ and F. You can press ▶ on the GLX instead of clicking the Start or Stop buttons in DataStudio. If DataStudio is in Manual Sampling mode, F on the GLX has the same function as the Keep button in DataStudio.



For complete instructions on using DataStudio, click DataStudio's Help menu.

GLX Sound and Sound Level Sensors in DataStudio

To use the GLX's microphone as a sound sensor or sound level sensor in DataStudio, you must manually select it in the Experiment Setup window. Click the Setup button in DataStudio to open the Experiment Setup window. In that window, click the button labeled "Add Sensor or Instrument" and select GLX Sound Level Sensor or GLX Sound Sensor from the PASPORT sensors list.

GLX Simulator

When you install DataStudio version 1.9.5 (or later) on a Windows computer, a second piece of software, the GLX Simulator, is also installed. To start the simulator, run the executable file[4] XplorerGLX.exe.

[4]The GLX Simulator is usually installed in c:\Program Files\DataStudio\

The Simulator requires Windows 2000 or Windows XP

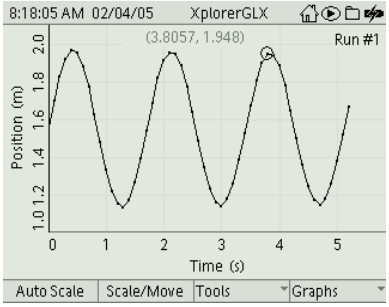
The GLX Simulator behaves like a real GLX. To "press" keys on the Simulator keypad, click them with the computer's mouse, or press the equivalent key on the computer's keyboard. (See page 90 for keyboard equivalents.)

Up to four PASPORT sensors connected to your computer through any type of PASPORT interface will be treated by the Simulator like sensors connected to a real GLX.

The GLX Simulator

Virtual Motion Sensor

If you are using the GLX Simulator without real sensors, you can select the Virtual Motion Sensor to simulate a sensor. The Simulator will behave like a real GLX connected to a Motion Sensor measuring an object oscillating with a frequency of about 0.6 Hz and with an amplitude of 0.8 m.



Simulated data from the Virtual Motion Sensor

Screen Capture

Click the Copy Screen button to copy an image of the Simulator's screen to the computer's clipboard. The image can then be pasted into another application (such as a word processor) by selecting Paste from that application's Edit menu.

Screen Mirroring

When a real GLX is connected to the computer, the Mirror GLX Screen option appears in the Simulator. Select this option to make the screen of the real GLX appear in the Simulator. The Copy Screen button will capture an image of the real GLX's screen.

File Transfer between Simulator and GLX

Files that you have created or modified in the Simulator can be saved and transferred to a real GLX with the following procedure.

1. In the Simulator, open the Data Files screen (see page page 78).

2. Click F4 to open the Files menu.

3. Click Copy to Disk. The Simulator will prompt you to select a folder and name for the file to be saved.

4. Transfer the saved file to the GLX through DataStudio (see page 100) or a USB storage device (see page 83).

You can also open a GLX file in the Simulator. In the Data Files screen of the Simulator, click F4 to open the Files menu and click Copy from Disk.

Part 2:

Sample Activities

The following pages contain step-by-step instructions for science activities and experiments that can be done with the GLX, its included temperature and voltage probes, and commonly available supplies; no PASPORT sensors are required.

Activity 1: Calorimetry

Equipment	Quantity
Xplorer GLX	1
Fast-response Temperature Probes	2
20 g Brass Masses	3
Styrofoam Cups	3
String	1 m
Hot Water (50 to 70 °C)	500 ml
Room-temperature Water	500 ml

Background

In this experiment, you will add a hot piece of metal to room-temperature water and measure the temperature change of the water. How does doubling the mass of the added metal affect the temperature change?

Before You Begin

Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.
4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

Procedure

Equipment Set-Up

1. Fill a Styrofoam cup with hot water.
2. Tie a string to each mass, and lower all three masses into the hot water. Let the masses warm up for about 10 minutes.
3. Label two other cups “Cup 1” and “Cup 2.” Put 250 ml of room-temperature water into each cup.
4. Put one temperature probe in each cup of room-temperature water. Use a paperclip to secure each probe to the rim of the cup so that the end of the probe is about midway between the bottom and the surface of the water.

GLX Set-Up

1. Connect the temperature probes.[1]

a) Connect the probe in Cup 1 to one of the temperature ports on the left side of the GLX.

b) Connect the probe in Cup 2 to the other temperature port.

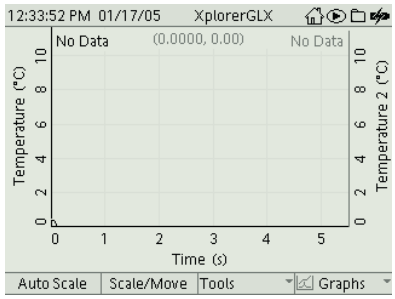
c) If there are other sensors connected to the GLX, remove them.

[1]Optional: after connecting the probes, perform the alignment calibration described on page 77.

2. Set up the Graph to display both temperatures versus time.

a) Press (⌂) to return to the Home Screen; press (F1) to open the Graph.

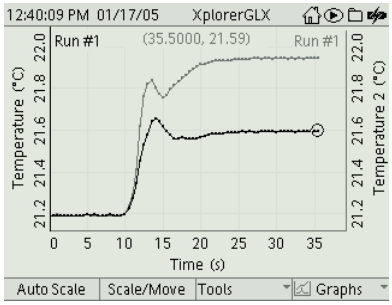
b) The Graph will automatically be set up for the first temperature probe. Press (F4) to open the Graphs menu, press (4ghi) to select Two Measurements mode. The second temperature probe will be added to the Graph.



Graph in Two Measurements mode

Data Collection

1. Press (►) to start data collection.
2. Remove the masses from the hot water. Lower one mass into Cup 1; lower two masses into Cup 2.
3. Gently stir the water in both cups.
4. Press (F1) to automatically scale the Graph.
5. After both temperature measurements have stabilized, press (►) to stop data collection.



Analysis

1. Use the Delta Tool to find the temperature change in Cup 1.

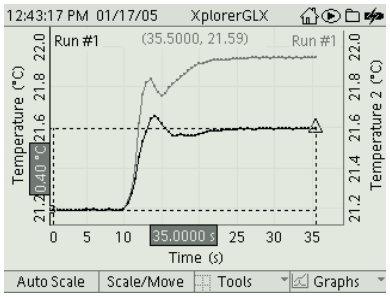
a) Press (F3) to open the Tools menu; press (2tuv) to turn on the Delta Tool.

b) Press the up arrow to move one of the cursors to the first data point.

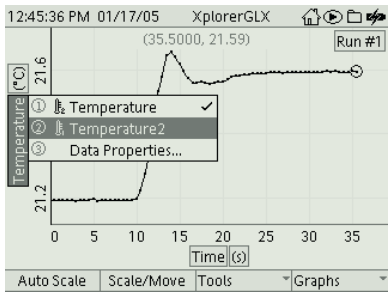
c) Hold (Esc) and press (⌫) to swap control to the other cursor; press the down arrow key to move that cursor to the last data point.

The Delta Tool should now show the changes in temperature and time from the first to the last data point.

Cup 1 temperature change = _____



2. Create a new graph page showing only the temperature in Cup 2 versus time.

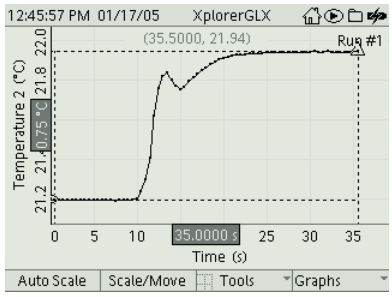


a) Press F4 to open the Graphs menu; press 7 to select New Graph Page.

b) On the new graph page, press ✓ *twice* to open the data source menu.

c) Press the down arrow key to highlight Temperature2 and press ✓.

3. Use the Delta Tool to find the temperature change in Cup 2.



a) Press F3 to open the Tools menu; press 2 to turn on the Delta Tool.

b) Press the up arrow to move one of the cursors to the first data point.

c) Hold Esc and press ⌫ to swap control to the other cursor; press the down arrow key to move that cursor to the last data point.

The Delta Tool should now show the changes in temperature and time from the first to the last data point.

Cup 2 temperature change = _____

4. How does the temperature change in Cup 2 compare to the temperature change in Cup 1?

_____

_____

_____

5. If you repeated this experiment with *three* masses in Cup 2, what do you think the temperature change of Cup 2 compared to Cup 1 would be?

_____

_____

_____

6. Why did this experiment call for Styrofoam rather than glass containers?

_____

_____

_____

Activity 2: Melting Point Depression

Equipment	Quantity
Xplorer GLX	1
Fast-response Temperature Probes	2
Test Tubes	2
Test Tube Rack	1
Deionized Water	110 mL
NaCl	1 g

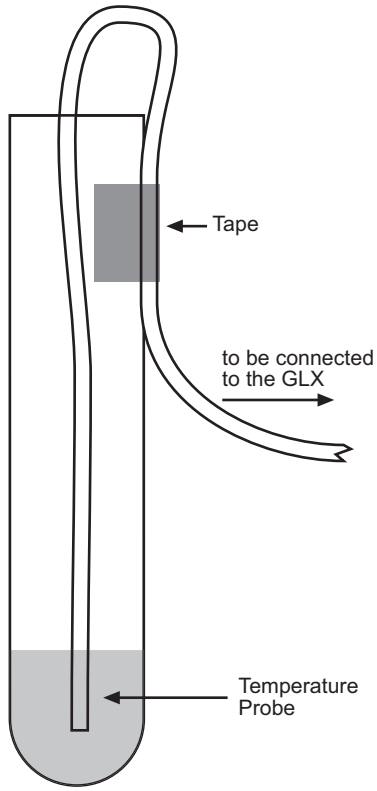
Background

How does the addition of salt affect the melting point of a solution? In this experiment, you will measure the temperature over time of frozen salt water and pure water as they melt. From the recorded data, you will identify and compare the melting points of both liquids.

Pre-lab: Prepare Frozen Solutions

Prepare the frozen solutions at least one day in advance.

1. Make a solution of 1 g NaCl in 100 ml of deionized water. Add enough to a test tube to fill it to a depth of about 1 cm.
2. Add the same amount of deionized water to a second identical test tube.
3. Place a fast-response temperature probe in each test tube. The ends of the probes should be immersed. Use tape to secure the probes in place.
4. Label both test tubes and label the connectors of both probes for easier identification.
5. Place both test tubes (along with the probes) in a freezer.



Before You Begin

Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.
4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

Procedure

1. **Remove the frozen solutions from the freezer.**

2. **Connect the temperature probes.**

   a) Connect the temperature probe measuring the pure water ice to Temperature Port 1 on the left side of the GLX.

   b) Connect the other probe to Temperature Port 2.

3. **Press ► to start data collection.**

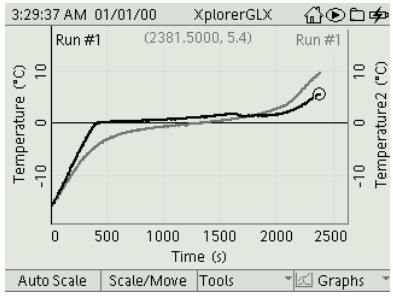
4. **Set up the Graph to display both temperature measurements.**

   a) Press ⌂ to return to the Home Screen; press F1 to open the Graph.

   b) Press F4 to open the Graphs menu; press 4ghi to select Two Measurements mode.

   c) Press F1 to automatically scale the Graph.

5. **Continue data collection until both solutions have reached 5 °C. Press ► to stop data collection.**



Graph in Two Measurements mode displaying both temperatures

Analysis

Describe the temperature versus time plots of both solutions. How are they similar? How do they differ? Which solution melts at a lower temperature?

Activity 3: Heat Transfer by Radiation

Equipment	Quantity
Xplorer GLX	1
Fast-response Temperature Probes	2
Aluminum Can, Painted Black	1
Aluminum Can, Unpainted[1]	1
Hot Water (50 to 70 °C)	500 mL
Tongs or Mitt (for handling hot cans)	1

[1]Use empty beverage containers or PASCO part TD-8570A, which includes one black can and one unpainted can.

Background

You may have observed that dark objects heat up faster than light-colored objects when exposed to sunlight, but how does the color of an object affect its rate of cooling? In this experiment you, will record the temperature of two water-filled cans as they cool. One can is painted black, the other can is unpainted. Which can do you think will cool faster?

Before You Begin

Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.
4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

Procedure

Equipment Set-Up

1. Place a fast-response temperature sensor in each can. Secure the probes with tape.
2. Prepare hot water (50 to 70 °C), but don't fill the cans yet.

GLX Set-Up

1. Connect the temperature probes.

a) Connect the probe measuring the black can to Temperature Port 1 on the left side of the GLX.

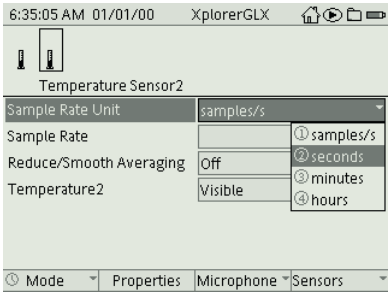
b) Connect the probe measuring the unpainted can to Temperature Port 2.

2. Set the sampling periods of both probes to 10 seconds.

a) Press (home) to return to the Home Screen; press (F4) to open the Sensors screen.

b) Observe the top part of the screen and note which sensor ("Temperature Sensor" or "Temperature Sensor 2") is selected.

c) With Sample Rate Unit highlighted, press (✓) to open the menu; press (2abc) to select seconds.



Select seconds from the Sample Rate Unit menu

d) Press the down arrow to highlight Sample Rate; press (+) until the value is set to 10 seconds.

e) Press the left or right arrow to select the other sensor.

f) Repeat steps c and d to set the sampling rate for the newly selected sensor to 10 seconds.

3. Set up the Graph to display both temperatures.

a) Press (home) to return to the Home Screen; press (F1) to open the Graph. The Graph is automatically set up to display data from the first temperature probe.

b) Press (F4) to open the Graphs menu; press (4ghi) to select Two Measurements mode. The second temperature measurement will be added to the Graph.

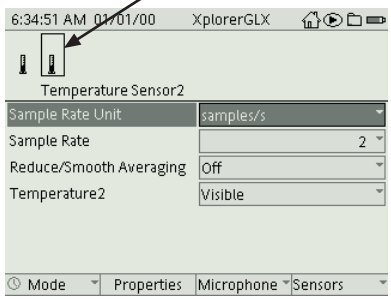
Data Collection

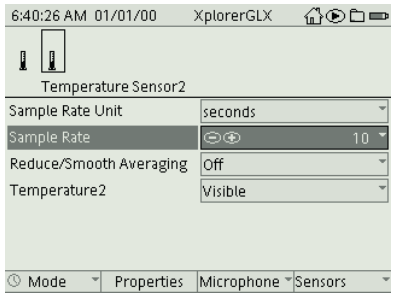
1. Fill both cans with equal amounts of hot water.
2. Press (▶) to start data collection.
3. Press (F1) to automatically scale the Graph.
4. Gently swirl the cans as data will be collected for about 15 minutes.
5. Press (▶) to stop data collection.

Analysis

Which can cooled faster? Why?

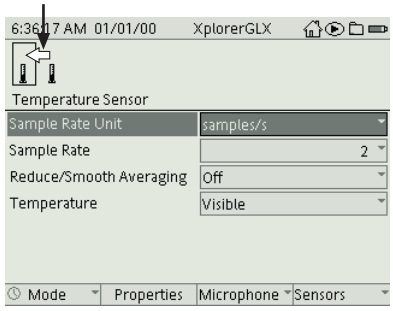
Observe which sensor is selected

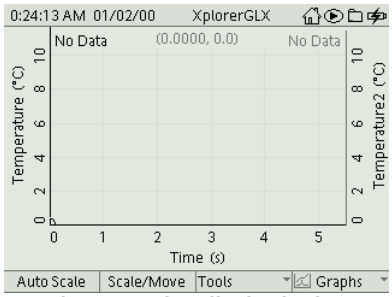




Set the Sample Rate to 10 seconds

Press ◁ or ▷ to select the other sensor





Graph prepared to display both temperature measurements

Activity 4: Newton's Law of Cooling

Equipment	Quantity
Xplorer GLX	1
Fast-response Temperature Probes	2
Styrofoam Cups	2
Test Tube	1
Tape	10 cm
Sand	100 g
Hot Water (50 to 70 °C)	500 mL

Background

Newton's Law of Cooling states that the rate of temperature change of a body is proportional to its relative temperature, *r*, or the body's temperature minus the temperature of the surroundings. Mathematically, Newton's Law of Cooling can be written:

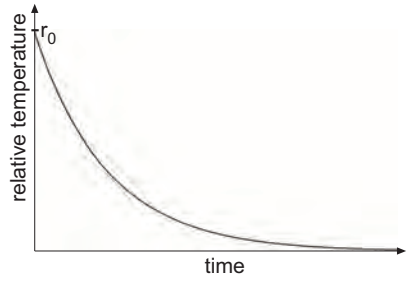
(eq. 1) $$\frac{dt}{dT} = -kr$$

where d*T*/d*t* is the rate of temperature change and *k* is a constant greater than 0.

Another way to write Newton's Law of Cooling is

(eq. 2) $$r = r_0 e^{-kt}$$

where *r* is the relative temperature at time *t*, and r_0 is the relative temperature at $t = 0$. A graph of Equation 2 is shown to the right.



In this experiment, you will record and graph the temperature of a hot object (a test tube full of sand) as it cools. You will then compare the experimental data with the theoretical graph.

Before You Begin

Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.
4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

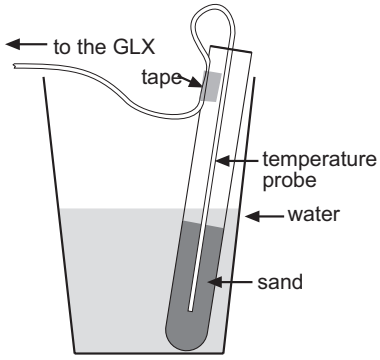
Procedure

Equipment Set-Up

1. Place the end of a fast-response temperature probe in the test tube, then fill the test tube about one-third full of sand, as pictured to the right. The probe should be embedded in the sand. Use tape to secure the probe.

2. Partially fill a cup with hot water (50 to 70 °C) and immerse the sand-filled portion of the test tube. Let the sand warm up for a few minutes while you set up the GLX.

3. Tape a second temperature probe to the inside wall of an empty cup. (This probe will be used to measure the temperature of the surrounding air.)



Immerse the sand-filled portion of the test tube in hot water

GLX Set-Up

1. Connect the first temperature probe to the GLX.

a) Connect the temperature probe that is in the test tube to Temperature Port 1 on the left side of the GLX.

b) If there are other sensors connected to the GLX, remove them.

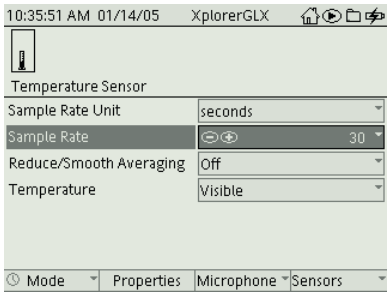
2. Set the sampling rate to 30 seconds between samples.

a) Press (⌂) to go to the Home Screen.

b) Press (F4) to open the Sensors screen.

c) Use the up and down arrow keys to highlight Sample Rate Unit. Press (✓), then press (2tuv) to select "seconds."

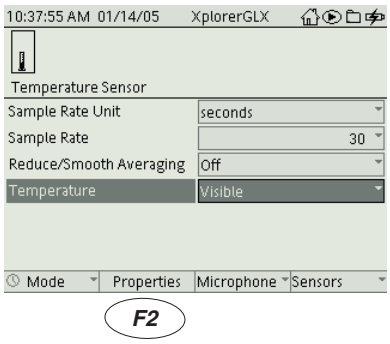
d) Press the down arrow key to highlight Sample Rate. Press (+) or (−) to set the time between samples to 30 seconds.



Set the sampling rate to 30 s between samples

3. Rename the measurement.

a) In the Sensors screen, use the arrow keys to highlight the measurement named "Temperature"



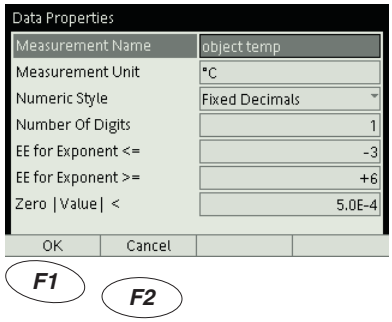
b) Press (F2) to open the Data Properties box.

c) Use the up and down arrow keys to highlight Measurement Name and press (✓) to make it editable.

d) Type "object temp" and press (✓).[1]

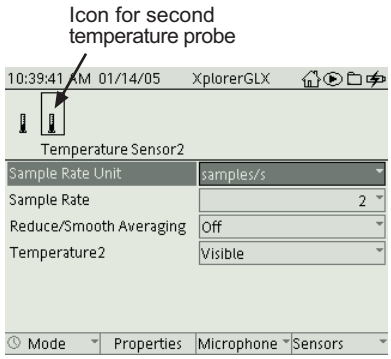
[1]To enter text, use multipress text entry (see page 90) or an attached USB keyboard (see page 90).

e) Press F1 to accept the changes and return to the Sensors screen.



4. Connect the second sensor to the GLX.

Connect the temperature probe that will measure the air temperature to Temperature Port 2 of the GLX. You will see the new icon appear in the upper part of the Sensors screen with a box around it.



5. Set the sample rate of the second sensor and rename the measurement.

a) Repeat step 2 to set the sampling rate of the second sensor to 30 seconds between samples.

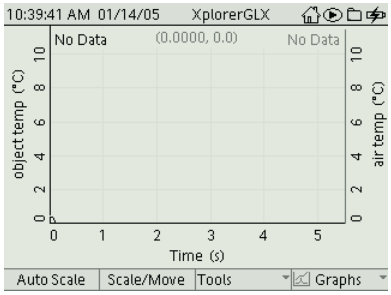
b) Repeat step 3 to set the Measurement Name to "air temp."

6. Set up the Graph display to plot Object Temperature and Air Temperature versus Time.

a) Press ⌂ to return to the Home Screen.

b) Press F1 to open the Graph display. The display will be automatically set up to graph object temp versus Time.

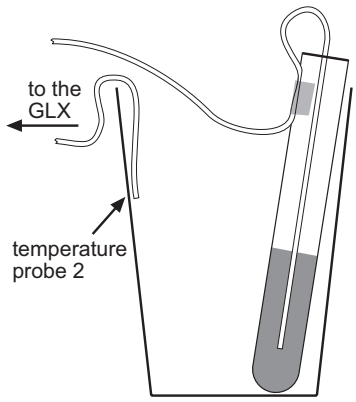
c) Press F4 to open the Graphs menu, and press 4 to select Two Measurements mode. Air temp will be added to the Graph.



Graph prepared to display object temp and air temp vs. Time

Data Collection

1. Remove the test tube from the hot water and dry it thoroughly with a paper towel.
2. Place the test tube in the empty cup so that the sand is several centimeters away from the air temperature probe.
3. Press ▶ to start data collection.
4. Press F1 to automatically scale the Graph.
5. After the sand has cooled to about 30 °C, press ▶ to stop data collection.



Place the test tube in the empty cup so that the sand is several centimeters away from the air temperature probe

Analysis

Observe the graph of Object Temperature versus time and Air Temperature versus Time. If the experiment were allowed to run indefinitely, what would the relationship between object and air temperature eventually be?

_____

_____

_____

1. Create a calculation for relative temperature.

a) Press (home) to return to the Home Screen; press (F3) to open the Calculator.

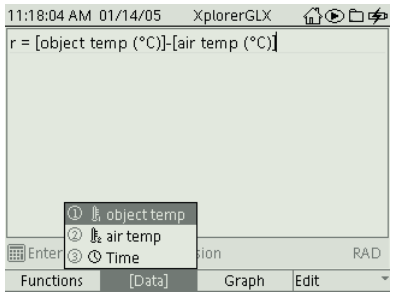
b) If you see the Num Lock symbol in the lower right corner of the screen, press (F4) to open the Edit menu, then press (1 pqrs) to turn Num Lock off.

c) Enter:

r = [object temp (°C)] - [air temp (°C)] (✓)

Use multipress text entry to type "r".

To insert [object temp (°C)] and [air temp (°C)] press (F2) to open the [Data] menu, select the desired data from the menu, and select units of °C.



F2

Open the [Data] menu and select the desired data to insert into the calculation

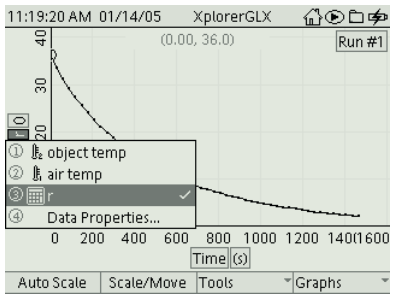
d) Remember to press (✓) to complete the calculation.

2. Make a new graph of *r* versus *t*.

a) Press (home) to return to the Home Screen; press (F1) to open the Graph.

b) Press (F4) to open the Graphs menu; press (7 ?!) to select New Graph Page.

c) Press (✓) *twice* to open the data source menu. Select *r* from the menu.

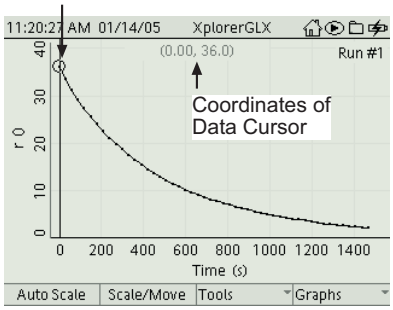


3. Does the graph of Relative Temperature versus Time appear to agree with Equation 2?_____

4. What is the initial relative temperature at Time = 0?

To find the initial relative temperature, press the up arrow key to move the Data Cursor to the first data point.

Press the up arrow to move the Data Cursor to the first data point.



Initial temperature, r_0 = _____

In order to find the value of the constant *k* for this cooling curve, you can use another expression of Newton's Law of Cooling, derived from Equation 2:

(eq. 3) $$\ln\frac{r}{r_0} = -kt$$

On a graph of $\ln(r/r_0)$ versus *t*, the slope will equal $-k$.

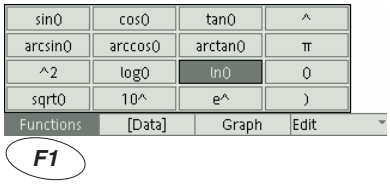
5. Create a calculation for $\ln(r/r_0)$

a) Press ⌂ to return to the Home Screen; press F3 to open the Calculator.

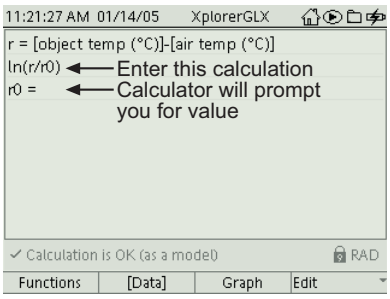
b) On a blank line, enter:

ln(r/r0) ✓

c) To insert the ln() function, press F1 to open the Functions menu, use the arrow keys to highlight ln(), and press ✓.



d) The Calculator will prompt you on the next line to enter the value of r_0. Type the initial relative temperature and press ✓.

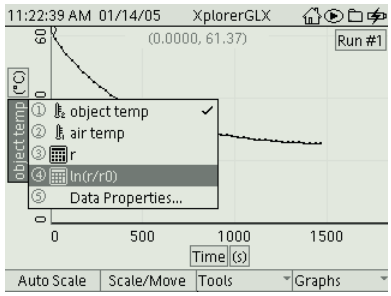


6. Make a graph of $\ln(r/r_0)$ versus *t*.

a) Press ⌂ to return to the Home Screen; press F1 to open the Graph display.

b) Press F4 to open the Graphs menu; press 7 to select New Graph Page.

c) Press ✓ *twice* to highlight the data source menu. From the menu select ln(r/r0).

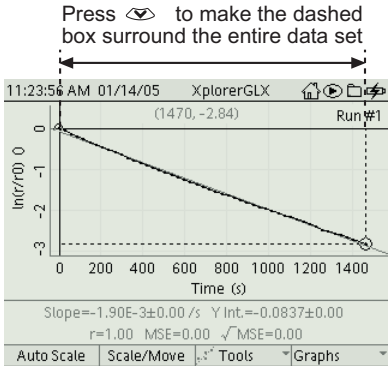


7. Apply a linear fit and find the value of *k*.

a) Press F3 to open the Tools menu; press 5 to select Linear Fit.

b) Press the down arrow key to make the dashed box surround the entire data set.

c) The slope of the best-fit line equals *k*.



k = _____ (include units)

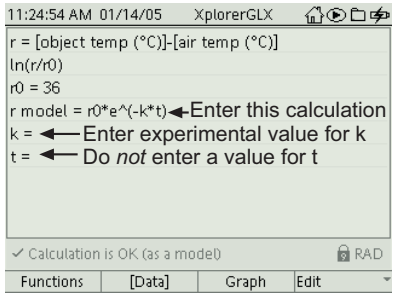
Now that you have experimental values for the constants r_0 and *k*, you can substitute them into Equation 2 and compare that model to the collected data.

8. Enter Equation 2 into the Calculator using your experimental values of r_0 and *k*.

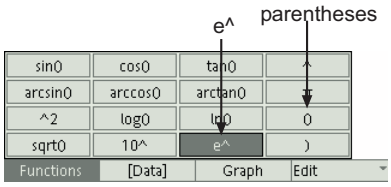
a) Press ⌂ to return to the Home Screen; press F3 to open the Calculator.

b) On a blank line, enter:

r model = r0 * e^(-k*t) ✓



c) To insert the function e^, press F1 to open the Functions menu, use the arrow keys to highlight e^, and press ✓.



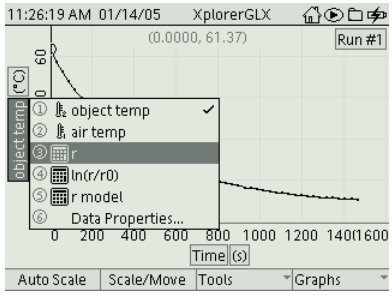
Also open the Functions menu to select and insert the pair of parentheses.

d) The Calculator will prompt you to enter the values of k and t. (It does not prompt you for r_0 because you entered that constant in step 5.)

e) Enter the value of k that you found in step 7 and press ✓.

f) Time is the variable that will be plotted on the horizontal axis, so do not enter a value for t.

9. Compare collected relative temperature data with the modeled data.

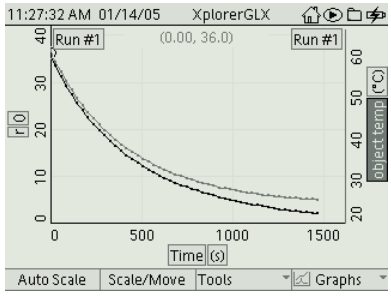


a) Press ⌂ to return to the Home Screen; press F1 to open the Graph display.

b) Press F4 to open the Graphs menu; press 7?! to select New Graph Page.

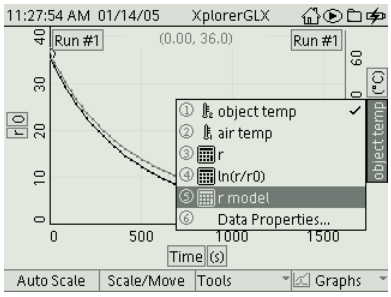
c) Press ✓ *twice* to highlight the data source menu. From the menu, select r (the collected data).

d) Press F4 to open the Graphs menu; press 4ghi to select Two Measurements mode.



e) Press ✓ to turn on the highlight, then press the left arrow key repeatedly until the second data source (on the right side of the Graph) is highlighted.

f) Press ✓ to open the data source menu and select r model.



10. Does the modeled equation agree with the collected data? If it deviates, can you explain why?

_____

_____

_____

Activity 5: Microclimate Temperature Variation

Equipment	Quantity
Xplorer GLX	1
Fast-response Temperature Probe	1

Background

In this activity, you will measure and record the air temperature at different outdoor locations within a small area to investigate how ground cover and nearby objects affect air temperature.

Before You Begin

Start a new experiment on the GLX.

1. Press (⌂) to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press (✓) to open the Data Files screen.
3. Press (F4) to open the Files menu and press (1 pqrs) to select New File.
4. When the GLX asks if you would like to save the previous file, press (F1) to save or (F2) not to save.

Procedure

Preparation

Sketch a map of the area you will be investigating. Mark several locations on the map and assign each a different short name. For each location, note the type of ground cover (concrete, grass, bare earth, etc.) and nearby objects, such as buildings or trees.

GLX Set-Up

1. Connect a temperature probe.

a) Connect a fast-response temperature probe to one of the temperature ports on the left side of the GLX.

b) If there are other sensors connected to the GLX, remove them.

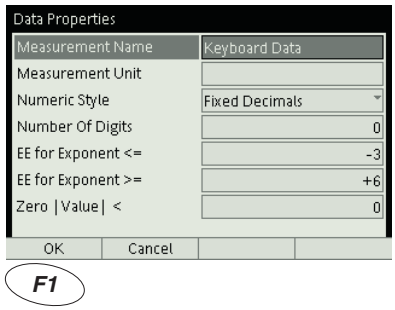
2. Put the GLX into Manual Sampling mode.

a) Press (⌂) to return to the Home Screen; press (F4) to open the Sensors screen.

b) Press (F1) to open the Mode menu.

c) Press the down arrow key to highlight Manual and press ✓.

d) The Data Properties window will open with the Measurement Name set to "Keyboard Data." Press F1 to accept this setting.



3. **Press ⌂ to return to the Home Screen; press F2 to open the Table. The Table will be automatically set up to display Temperature and Keyboard Data.**

Data Collection

1. Press ▶. The GLX is now measuring temperature, but not recording it.

2. Take the GLX to one of the locations marked on your map.

3. Hold the probe about 1 meter above the ground, but do not touch the end of the probe. Shield the probe from direct sunlight. Wait about 15 seconds to allow the probe to equilibrate.

4. Press ⚐ to record a single temperature measurement.

5. The GLX will prompt you for Keyboard Data. Press F3 to turn off Num Lock. Type the location name (press each key repeatedly to cycle through different letters).

   Press F1. When the GLX asks if you would like to treat the data as text, press F1 for OK.

6. Move to another location. Hold the probe 1 meter above the ground and out of direct sunlight. Wait 15 seconds. Press ⚐ to record a measurement. When the GLX prompts you, type the location name and press F1.

7. Repeat step 6 for all of the other locations marked on your map.

8. After you have recorded the temperature at every location, press ▶ to complete data collection.

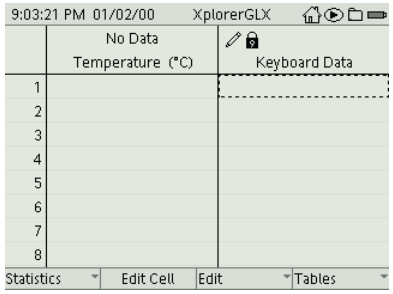
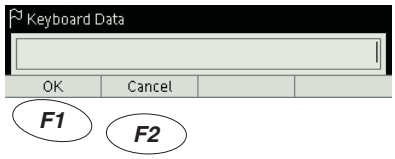


Table prepared to display Temperature and Keyboard Data



Analysis

1. Copy the recorded temperatures from the GLX to your map.

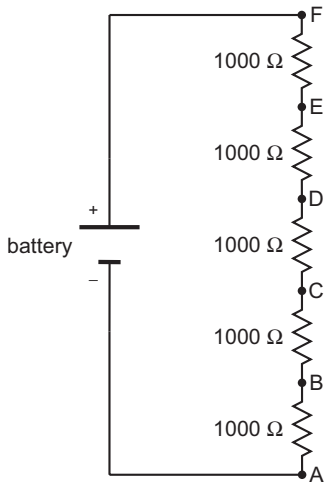
2. Based on your data, describe how different types of ground cover and nearby objects appear to affect the air temperature.

Activity 6: Voltage versus Resistance

Equipment	Quantity
Xplorer GLX	1
Voltage Probe	1
Resistors, 1000 Ω	5
Battery and Battery Holder ("AA," "C," "D," or similar)	1
Short Alligator Clip Leads	6

Background

In this experiment, you will construct the circuit pictured to the right and measure the voltage (relative to the negative terminal of the battery) at points A through F. For each point in the circuit, the GLX will record the measured voltage (*V*) and the total resistance across which the voltage was measured (*r*).



Sketch a prediction of the graph of *V* versus *r*. Explain your prediction in terms of what you know about

- how current flows through the circuit;
- the relationship between voltage, current, and resistance; and
- the total resistance of two or more resistors in series.

Before You Begin

Start a new experiment on the GLX.

1. Press (⌂) to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press (✓) to open the Data Files screen.
3. Press (F4) to open the Files menu and press (1 pqrs) to select New File.
4. When the GLX asks if you would like to save the previous file, press (F1) to save or (F2) not to save.

Procedure

Equipment Set-Up

1. Using the battery, battery holder, resistors, and alligator clip leads, construct the circuit pictured on the previous page.

2. Lay out the circuit on a piece of paper so you can label the parts of the circuit. Label points A through F and the positive and negative terminals of the battery.

GLX Set-Up

1. Connect the voltage probe to the GLX.

a) Connect the voltage probe to the voltage port on the left side of the GLX.

b) If there are other sensors connected to the GLX, remove them.

2. Configure the GLX for manual sampling.

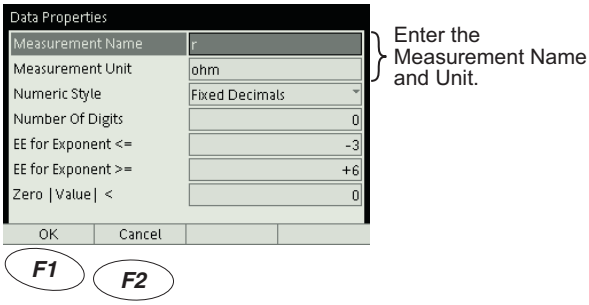
a) Press ⌂ to return to the Home Screen; press F4 to open the Sensors screen.

b) Press F1 to open the Mode menu; press 2tuv to select Manual.

The Data Properties dialog box for the manually entered resistance data will open.

c) With Measurement Name highlighted, press ✓; type “r” and press ✓.

d) Press the down arrow key to highlight Measurement Unit. Press ✓, type “ohm”, and press ✓.



e) Press F1 to approve these data properties and close the Data Properties window.

3. Prepare the Graph to plot voltage versus resistance.

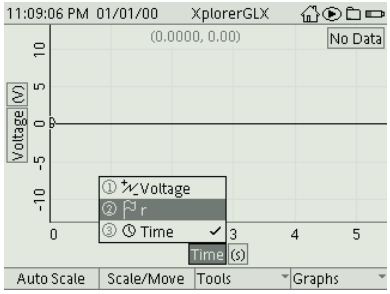
a) Press ⌂ to return to the Home Screen; press F1 to open the Graph.

The Graph will be automatically set up for voltage versus time. In the next step, you will select resistance (instead of time) for the horizontal axis.

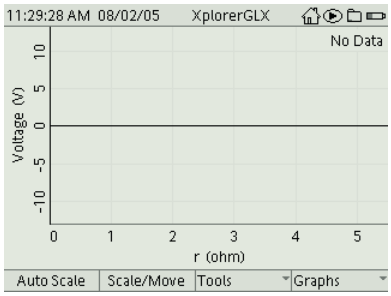
b) Press ✓ to turn on the highlight; press the down arrow key to highlight “Time.”

c) Press ✓ to open the data source menu.

d) In the data source menu, use the arrow keys to highlight “r” and press ✓.



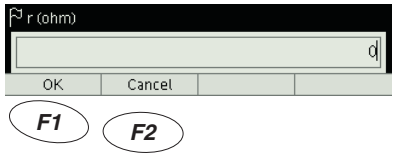
Select resistance for the horizontal axis



Graph prepared to plot *V* vs. *r*

Data Collection

1. Press ►. The GLX is now measuring voltage, but it is not recording data.
2. Connect the black lead of the voltage probe to the negative terminal of the battery.
3. Place the red lead of the probe in contact with the circuit at point A.
4. Press ⚑ to record a single voltage measurement.
5. The GLX will prompt you to enter *r*, the total resistance across which the voltage is measured. (For point A, *r* = 0.) Type the value of *r* and press F1.



6. Repeat steps 3, 4, and 5 for points A through F.
7. When you are finished recording data, press ►.

Analysis

1. **Press F1 to automatically scale the Graph.**
2. **Does your data appear to agree with your prediction?**

   _____

   _____

   _____

3. **Apply a linear fit to the graph and find the slope.**

   a) Press F3 to open the Tools menu; press 5 to select Linear Fit.

   b) What is the slope (including units) of the best-fit line?

   slope = _____

   c) What physical quantity does the slope represent?

   _____

   _____

   _____

Activity 7: Induced Electromotive Force

Equipment	Quantity
Xplorer GLX	1
Voltage Probe	1
Coil[1]	1
Bar Magnet	1

[1]Use a coil with a few hundred turns, such as the one included with PASCO part CI-6512.

Background

When a permanent magnet passes through a coil, the changing magnetic flux induces and electromotive force (EMF) or voltage in the coil. According to Faraday's Law of Induction:

$$\varepsilon = -N\frac{d\phi}{dt}$$

where ε is the induced EMF, N is the number of turns in the coil, and $d\phi/dt$ is the rate of change of magnetic flux through the coil.

In this activity, you will drop a magnet through a coil while the GLX records and graphs the induced EMF versus Time. The area under the under the curve represents the total change in flux.

Before You Begin

Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.
4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

Procedure

Equipment Set-Up

1. Clamp or mount the coil so that the magnet can be dropped through it.
2. Place something soft under the coil to prevent the magnet from breaking.
3. Connect the voltage probe to the coil so that it will measure the voltage across the coil.

GLX Set-Up

1. Connect the voltage probe to the GLX.

a) Connect the voltage probe to the voltage port on the left side of the GLX.

b) If there are other sensors connected to the GLX, remove them.

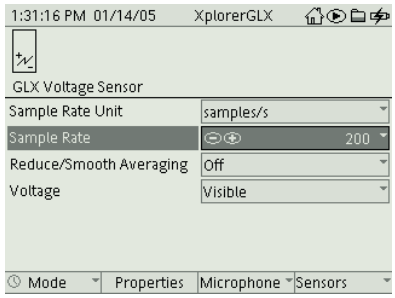
2. Set the sampling rate to 200 Hz.

a) Press ⌂ to return to the Home Screen.

b) Press F4 to open the Sensors screen.

c) Press the down arrow key to highlight Sample Rate.

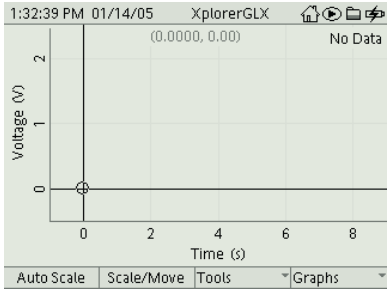
d) Press + repeatedly to set the Sample Rate to 200 Hz.



3. Open the Graph display.

a) Press ⌂ to return to the Home Screen.

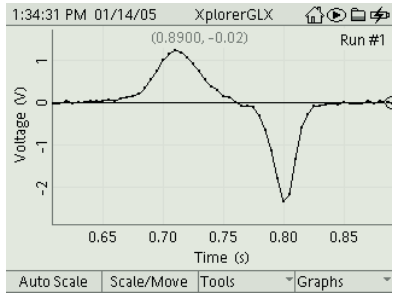
b) Press F1 to open the Graph display. The display will be automatically set up to graph Voltage versus Time.



Data Collection

1. Hold the magnet about 2 cm above the coil.

2. Press ▶; drop the magnet through the coil; press ▶ again.



Analysis

1. Scale the Graph.

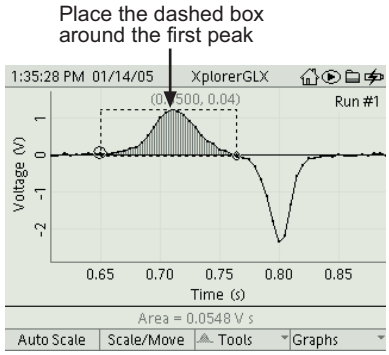
a) Press F1 to automatically scale the Graph.

b) Press F2 to enter Scale mode, press F2 again to enter Move mode. Use the left and right arrow keys in both modes to zoom in on the positive and negative peaks.

See page 16 for detailed instructions on using Move and Scale modes.

2. Find the area under the first peak.

a) Press F3 to open the Tools menu; press 6mno to select the Area Tool.



b) Use the left and right arrow keys to move the right side of the dashed box to the right side of the first peak.

c) Hold Esc and press ⌫ to swap the cursor to the other side of the dashed box.

d) Use the left and right arrow keys to move the left side of the dashed box to the left side of the first peak.

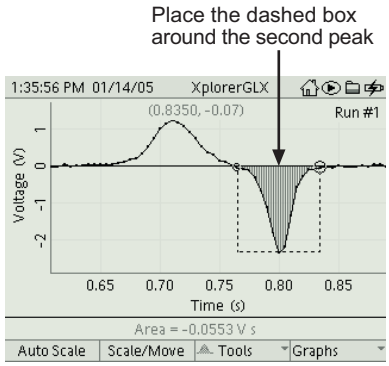
See page 20 for detailed instructions on using the Area Tool.

Area under the first peak = _____ (include sign and units)

3. Find the area under the second peak.

Repeat step 2 to position the dashed box around the second peak.

Area under the second peak = _____



4. Compare the incoming flux (area under the first peak) to the outgoing flux (area under the second peak).

_____

_____

_____

5. Why is the outgoing peak higher than the incoming peak?

_____

_____

_____

6. Why are the peaks opposite in direction?

_____

_____

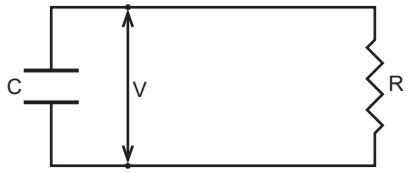
_____

Activity 8: Capacitor Discharge

Equipment[1]	Quantity
Xplorer GLX	1
Voltage Probe	1
Capacitor (between 0.015 and 1 F)	1
Resistor (between 100 and 1000 Ω)	1
Battery and battery holder ("AA," "C," "D," or similar)	1
Alligator Clip Leads	4

[1]Use separate electronic components or the PASCO EM-8678 Charge/Discharge board, which includes a capacitor, resistors, and battery holder.

Background



In the circuit pictured above, the rate at which the voltage, *V*, decreases is directly proportional to the voltage. Mathematically, this can be written:

(eq. 1) $$\frac{dV}{dt} = -\tau V$$

where dV/dt is the rate of voltage change, and τ is a constant greater than 0 known as the Capacitive Time Constant. The negative sign indicates that the voltage *decreases* over time.

Equation 1 can be rewritten:

(eq. 2) $$\ln\frac{V}{V_0} = -\tau t$$

where V is the voltage at any given time, t; and V_0 is the voltage at $t = 0$.

In this experiment, you will create a circuit like the one in the diagram. The GLX will measure and graph voltage over time as the capacitor discharges. From the collected data, you will determine the capacitive time constant, τ, of your circuit.

Before You Begin

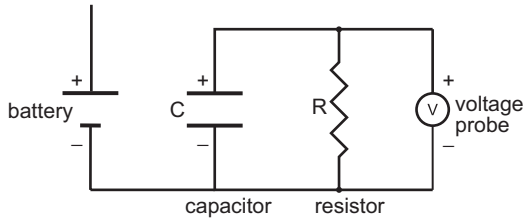
Start a new experiment on the GLX.

1. Press ⌂ to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press ✓ to open the Data Files screen.
3. Press F4 to open the Files menu and press 1 pqrs to select New File.

4. When the GLX asks if you would like to save the previous file, press F1 to save or F2 not to save.

Procedure

Equipment Set-Up



1. Create the circuit pictured above. Note that the negative terminal of the battery is connected, but the positive terminal is not. The voltage probe is connected so that it will measure the voltage across the capacitor.

2. Record your values of capacitance and resistance. (Measure them directly if you have capacitance and resistance meters, or record their nominal values.)

   C = _____

   R = _____

GLX Set-Up

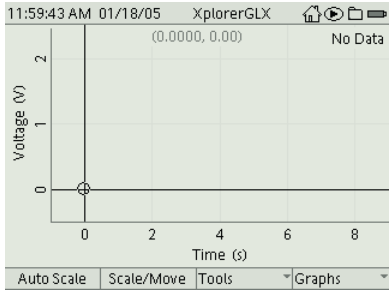
1. Connect the voltage probe to the GLX.

a) Connect the voltage probe to the voltage port on the left side of the GLX.

b) If there are other sensors connected, remove them.

2. Set up the Graph to plot Voltage versus Time.

Press ⌂ to return to the Home Screen; press F1 to open the Graph. The display will be automatically set up to graph Voltage versus Time.



Graph prepared to plot *V* vs. *t*

Data Collection

1. Charge the capacitor by temporarily connecting the positive terminal of the battery to the positive terminal of the capacitor. Keep the connection for about 5 seconds before proceeding to the next step. (Do not leave this connection in place for too long, as it will drain the battery.)

2. Disconnect the positive terminal of the battery and immediately press ► to start data collection.

3. Press F1 to automatically scale the Graph.

4. After the voltage has dropped below 0.1 V, press ► to stop data collection.

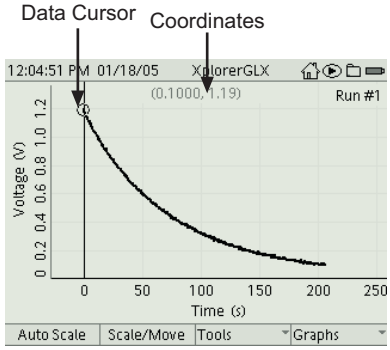
Analysis

From Equation 2, it is apparent that, on a graph of $\ln(V/V_0)$ versus t, the slope would equal $-\tau$. In this analysis, you will find the value of the constant V_0, calculate $\ln(V/V_0)$ for every recorded value of V, create a graph of $\ln(V/V_0)$ versus Time, and find its slope.

1. What was the voltage recorded at $t = 0$?

Press the up arrow key to move the Data Cursor to the first recorded point. The coordinates of the point are displayed at the top of the Graph.

V_0 = _____



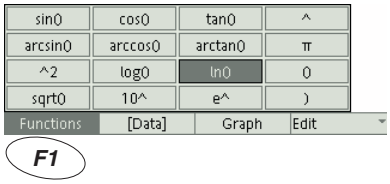
2. Create a calculation for $\ln(V/V_0)$.

a) Press (⌂) to return to the Home Screen; press (F3) to open the Calculator.

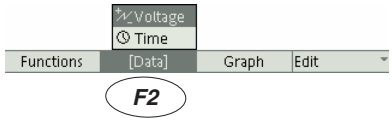
b) On a blank line, enter[2]

ln([Voltage (V)]/v0) (✓)

To insert the ln() function, press (F1) to open the Functions menu, used the arrow keys to highlight ln(), and press (✓).

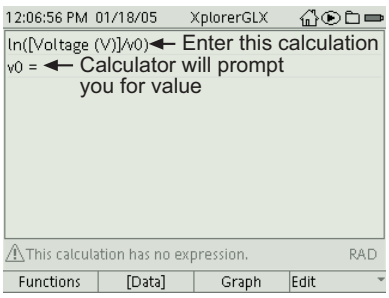


To insert [Voltage (V)], press (F2) to open the [Data] menu and select Voltage.



To type the letter v on the GLX keypad using multipress text input, turn *off* Num Lock[3] and press (2tuv) several times until the letter v appears.

c) The Calculator will prompt you on the next line to enter the value of v0. Type the initial voltage and press (✓).



[2] For more information on multipress text entry, see page 90.

[3] If Num Lock is on (as indicated by the icon 🔒 in the lower right corner of the screen), press (F4) then press (1copy) to open the Edit menu and turn off Num Lock.

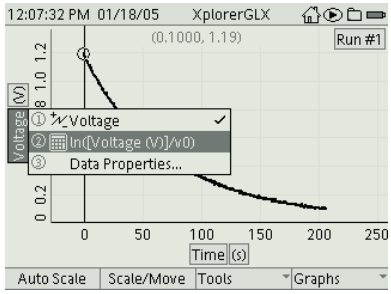
For more information on multipress text entry, see page 90.

3. Make a graph of $\ln(V/V_0)$ versus *t*.

a) Press (⌂) to return to the Home Screen; press (F1) to open the Graph display.

b) Press (F4) to open the Graphs menu; press (7?!) to select New Graph Page.

c) Press (✓) *twice* to highlight the data source menu. Select ln(v/v0) from the menu



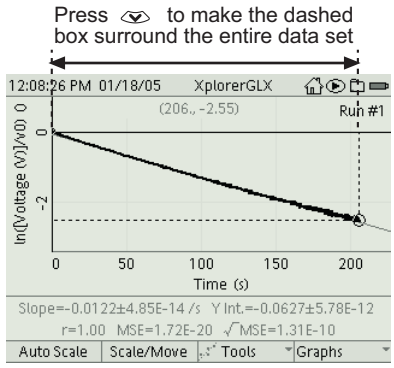
4. Apply a linear fit and find the value of τ.

a) Press (F3) to open the Tools menu; press (5jkl) to select Linear Fit.

b) Press the down arrow key to make the dashed box surround the entire data set.

c) The slope of the best-fit line equals τ.

τ = _____ (include units)



5. (Optional) Repeat the experiment with different resistors. Make a graph of R versus τ. What is the relationship between time constant and resistance?

6. (Optional) Repeat the experiment with different capacitors. Make a graph of C versus τ. What is the relationship between time constant and capacitance?

Activity 9: Constructive and Destructive Interference

Background

When two sound waves with identical frequencies and amplitudes combine, they may interfere constructively or destructively. When constructive interference occurs, the resulting tone is louder than either of the individual tones. When interference is destructive, the combined tone is less loud than the individual tones. For two waves of equal frequency, the type of interference depends on the phase relationship between the waves.

In this activity, you will use the GLX to generate two tones at 440 Hz while varying the phase of one.

Before You Begin

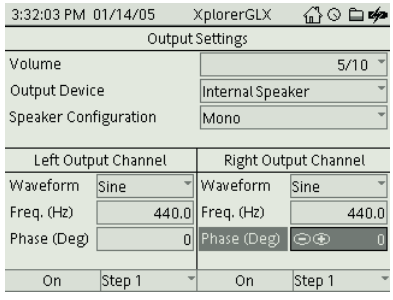
Start a new experiment on the GLX.

1. Press (⌂) to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press (✓) to open the Data Files screen.
3. Press (F4) to open the Files menu and press (1 pqrs) to select New File.
4. When the GLX asks if you would like to save the previous file, press (F1) to save or (F2) not to save.

Procedure

1. Press (⌂) to return to the Home Screen.
2. Use the arrow keys to highlight the Output icon and press (✓).

3. If the Speaker Configuration is not already set to Mono, use the arrow keys to highlight Speaker Configuration and press (✓) to set it to Mono.
4. Use the arrow keys to highlight the Phase of the Right Output Channel (as pictured to the right).
5. Press (F3) to turn on the Right Output Channel.
6. Press (+) and (−) to vary the phase of the Right Output wave. As you vary the phase of the wave between -360° and +360°, how does the sound change?



_____

_____

_____

7. Set the phase of the Right Output wave back to 0°.

8. Press F1 to turn on the Left Output Channel. How does the addition of the Left Output wave affect the sound that you hear?

_____

_____

_____

9. Press + and − to vary the phase of the Right Output wave again. As you vary the phase of the Right Output wave between -360° and +360°, how does the sound of the combined waves change?

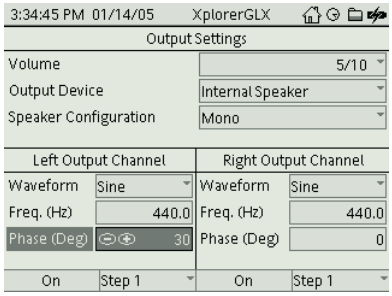
10. Listen to the sound. At what values of phase does maximum *destructive* interference occur?

_____

_____

_____

11. Press the left arrow key to highlight the Phase of the Left Output Channel. Press + to set the phase to 30°.



12. Press the right arrow key to highlight the Phase of the Right Output Channel again. While listening to the combined tone, vary the phase of the Right Output wave between -360° and +360°.

13. With the Left Channel phase set at 30°, at what values of phase (for the Right Channel) does maximum *destructive* interference occur?

_____

_____

_____

Activity 10: Beat Frequency

Background

When two sound waves with slightly different frequencies combine, the pattern of interference produced is known as beats. The rate at which the beats occur is the beat frequency.

In this activity, the GLX will generate two tones whose frequencies differ by Δf, and you will hear the resulting beats. By varying the frequency of one of the tones, you will discover the relationship between Δf and beat frequency.

Before You Begin

Start a new experiment on the GLX.

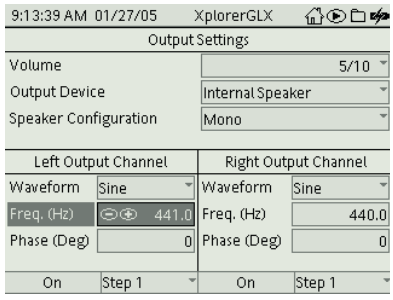
1. Press (⌂) to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press (✓) to open the Data Files screen.
3. Press (F4) to open the Files menu and press (1pqrs) to select New File.
4. When the GLX asks if you would like to save the previous file, press (F1) to save or (F2) not to save.

Procedure

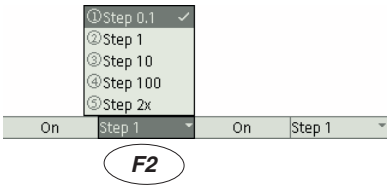
GLX Set-Up

1. Press (⌂) to return to the Home Screen.
2. Use the arrow keys to highlight the Output icon and press (✓).

3. If the Speaker Configuration is not already set to Mono, use the arrow keys to highlight Speaker Configuration and press (✓) to set it to Mono.
4. Use the arrow keys to highlight the Frequency of the Left Output Channel (as pictured to the right) and press (+) to increase the Frequency to 441 Hz.



5. Press (F2) to open the Left Step Size menu. Press the up arrow key to highlight Step 0.1, then press (✓).



Data Collection

1. Press F1 and F3 to turn on the Left and Right Output Channels. Describe what you hear.

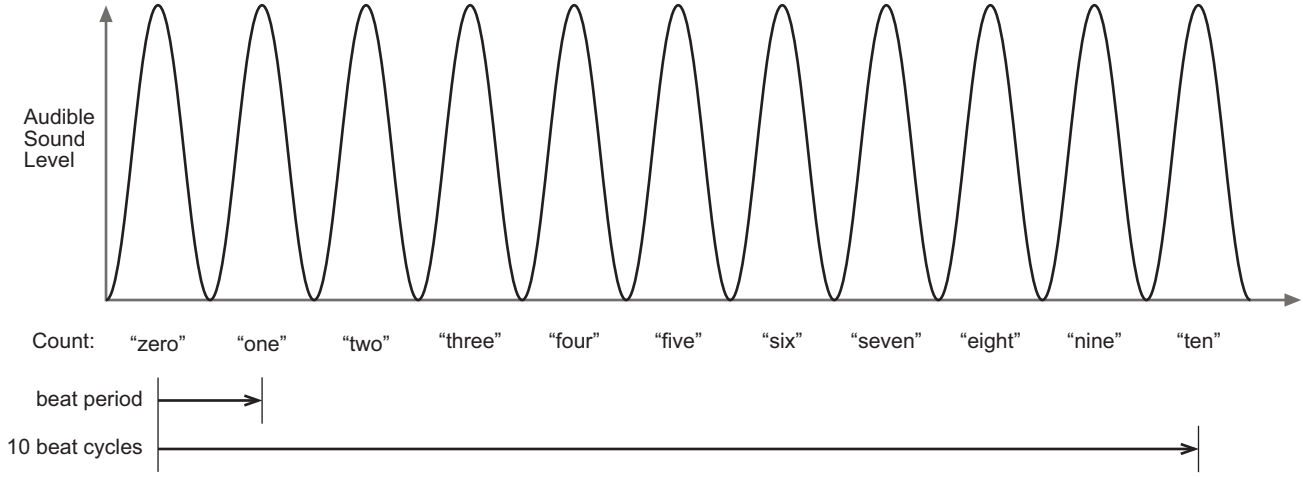
   _____

   _____

   _____

2. In the chart on the next page, write the frequencies of the Left and Right Output Channels (f_{left} and f_{right}).

You will use the GLX's Stopwatch screen to time the beat period. Since it is not practical to measure the very short time between two beats, you will time 10 full beat cycles and later divide by 10 to calculate the period. Start timing on beat "zero" and stop timing on beat "ten," as illustrated below.



3. Press ⌂ to return to the Home Screen; use the arrow keys to highlight Stopwatch and press ✓.

4. Count the beats, "zero, one, two, three, …, ten." Press F1 on beat "zero" to start timing. Press F1 again on beat "ten" to stop timing.

5. Write the elapsed time of 10 cycles in the chart below.

6. Press F2 to reset the Stopwatch.

7. Press ⌂ to return to the Home Screen; use the arrow keys to highlight Output and press ✓.

8. Use the arrow keys to highlight the Frequency of the Left Output Channel.

9. Press + *twice* to increase the Frequency by 0.2 Hz.

10. Record the Frequencies of the Left and Right Output Channels in the next line of the chart.

11. Repeat steps 3 through 10 until you have written data in 6 lines of the chart.

12. While viewing the Output Screen, press F1 and F2 to turn off both output channels.

Left Channel Frequency f_{left}	Right Channel Frequency f_{right}	Frequency Difference Δf	Elapsed Time for 10 Beat Cycles	Beat Period T_{beat}	Beat Frequency f_{beat}

Analysis

1. For each line of the chart, calculate and record the frequency difference ($\Delta f = f_{left} - f_{right}$) and beat period, T_{beat}. (You can do these calculations in your head.)

2. Press ⌂ to return to the Home Screen; press F3 to open the Calculator. Use the calculator to calculate the beat frequency, f_{beat}, for each line of the chart.

$$f_{beat} = 1/T_{beat}$$

3. According to your data, what is the relationship between Δf and f_{beat}?

_____

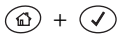
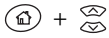
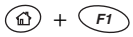
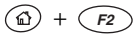
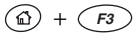
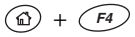
_____

_____

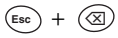
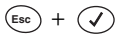
Index

Shortcut Summary

These keys and key combinations work from any screen in the GLX environment.

Start and stop data collection	
Backlight	
Contrast	
Graph	
Table	
Calculator	
Sensors	
Home Screen	
Next Screen	
Previous Screen	

Use these shortcuts when working in the Graph Screen.

Swap Cursors	
Toggle Active Data	

PASCO scientific
XplorerGLX Font Software
PRODUCT LICENCE AGREEMENT

Read this license agreement carefully before signing it. You may use this PASCO Product only if you agree to the following terms and conditions. If you do not agree to the following terms and conditions, you must not use the PASCO Product. The following are the terms and conditions to which you agree upon when opening the package:

1. The PASCO Product contains font software which generates typeface designs (“Font Software”) You may not alter Font Software for the purpose of adding any functionality which such Font Software did not have when delivered to you as part of the PASCO Product. You may not embed Font Software into a document which is distributed as a commercial product in exchange for a fee or other consideration (For example, End-Users shall not embed Font Software into an electronic book that is offered to the public for a fee).

2. The PASCO Product may be used with your computer only and may not be reformatted or decompiled for any purpose. The PASCO Product can only be used for your “Internal Use” and not for resale, sublicensing, or further distribution. As used herein, “Internal Use” shall mean use in the course of your customary and ordinary business. Internal Use shall not include any distribution whatsoever of the PASCO Product or any component thereof except that you may electronically distribute Internal Use documents created by the PASCO Product in a static graphic image or in an embedded electronic document which is distributed in a format that permits only the viewing and printing (and not the editing, altering, enhancing, or modifying) of such static graphic image or embedded document. Internal Use shall not include any use of the PASCO Product by entities that are neither your authorized employees nor your authorized agents. All such employees and agents shall be notified by you as to the terms and conditions of this End-User Agreement and shall agree to be bound by it. As used herein. “Internal Use” shall occur when an individual is able to give commands (whether by keyboard or otherwise) that are followed by the Font Software, regardless of the location in which the Font Software resides.

3. The PASCO Product may not be used to create any electronic document in which Licensed Type Software is embedded in a document in a format, which may be edited, altered, enhanced, or modified by the recipient of such document.

4. The PASCO Product may not be duplicated or copied except for one copy for archival purposes, program error verification or to replace defective media. All copies must remain in your possession and bear the copyright notices contained on the original except that an archival copy may be placed for safekeeping in the hands of a third party that otherwise has no right to use such copy. All archival copies placed in hands of a third party must contain all proprietary notices set forth on the original PASCO Product.

5. No copies of the PASCO Product may be produced for any purpose other than those purposes expressly permitted in paragraph 2 above.

6. This license does not transfer any right, title, or interest in the PASCO Product to you except as specifically set forth herein. You are on notice that PASCO claims protection of this software product under copyright laws. The PASCO Product may have been developed by an independent third party software supplier, which holds copyright or other proprietary rights to its software product. You may be held responsible by this supplier for any infringement of such rights by you.

7. PASCO reserves the right to terminate this license upon breach. In the event of termination, you will be required to return all copies of this product or provide PASCO with a certificate of destruction of all copies.

8. In the event you modify the PASCO Product or include it in any other software program, upon termination of this license, you agree either to remove the software product or any portion thereof from the modified program and return it to PASCO or to provide PASCO with a certificate of destruction thereof.

9. If this product is acquired under the terms of a (i) GSA contract - use, reproduction or disclosure is subject to the restrictions set forth in the applicable ADP Schedule contract, (ii) DOD contract - use, duplication or disclosure by the Government is subject to restrictions set forth in subparagraph (c)(1)(ii) of 252.277-7013; (iii) Civilian agency contract - use, reproduction, or disclosure is subject to 52.277-19(a) through (d) and restrictions set forth in the accompanying End User Agreement. MONOTYPE IMAGING Ltd, Unit 2 Perrywood Business Park, Salfords, Surrey, RH1 5DZ, England.