

HP StreamSmart 410

User Guide

For use with the HP 39/40gs Graphing Calculators



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1 HP Mobile Calculating Laboratory

The HP Mobile Calculating Laboratory (HP MCL) consists of one or more Fourier® sensors, an HP StreamSmart 410, and an HP 39/40gs graphing calculator with the StreamSmart Aplet. Investigation and understanding of mathematics and science concepts are enhanced by the HP Mobile Calculating Laboratory, as it is designed to simplify the collection and analysis of real-world data.

Types of experiments

The Mobile Laboratory supports a number of different types of experiments, as shown in the table below.

Table 1-1 Types of experiments

Type	Description	Example
Stream	Displays a live time graph (data stream) for up to four sensors simultaneously, at rates up to 5,000 samples per second. See Chapter 2 for details.	Two students each sing a note one octave apart into separate microphones; the HP MCL displays their voice sound waves live so their wavelengths can be compared.
Stream/select events	Same as above	StreamSmart captures the dampened oscillations of a vibrating rod. Students select just the maxima of the oscillations for further analysis.
Selected events	Displays a live meter read-out for up to four sensors simultaneously; you can add a set of readings to your data set at any time. See Chapter 3 for details.	Collect pH and temperature readings from various locations around the edge of a pond.
Events-with-entry	Same as above	Collect pH and nitrate readings from various locations along a stream; add as an entry to each reading the distance from the point in the stream to a runoff drain pipe that empties into the stream.
Log	Set up a stream experiment to collect a certain number of readings at a set sampling rate. See Chapter 3 for details.	Take 20 temperature readings from a cooling cup of coffee for 10 minutes, taking one reading every 30 seconds.

1. Charge

Charge the unit. **IMPORTANT!** Before beginning, plug the StreamSmart 410 into your computer with the mini USB to USB cable that came in the package with your HP graphing calculator. You will need to charge the unit for approximately five hours. Your computer must be running for charging to occur. **DO NOT** use the cable attached to the StreamSmart 410 for charging.

The low battery symbol (🔋) indicates the StreamSmart 410 requires charging. If the battery symbol appears in the upper left corner of the screen, be sure to charge the StreamSmart 410 as soon as possible.

2. Connect

Connect a Fourier® sensor to the StreamSmart 410 using the sensor cable. The following experiment uses the Fourier® light intensity sensor, but you can use any sensor and still follow along with this guide. Note the sensor cable ends have a flat side; be sure the flat side faces up on the connection to the StreamSmart 410. Connect the StreamSmart 410 cable to the HP 39/40gs graphing calculator. Turn on both the calculator and the StreamSmart 410. Aim the sensor at a florescent light source. Make sure the switch on the sensor is set to C: 0 – 600 lux.

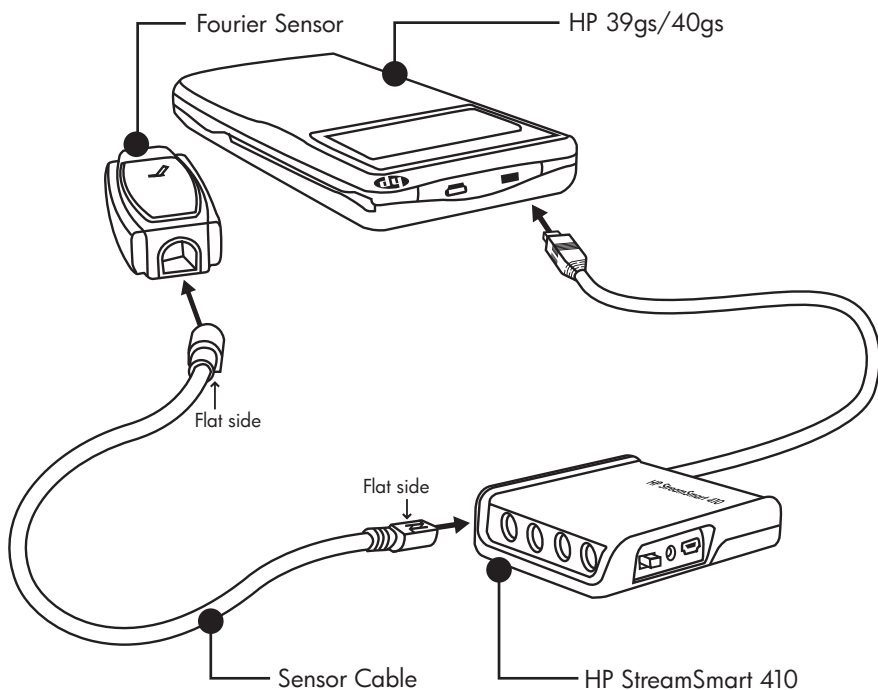


Figure 1-1 Connect the StreamSmart 410

3. Start the Application

The StreamSmart Aplet is located in the Aplet Library in the HP 39/40gs. The user runs the HP Mobile Calculating Laboratory via the StreamSmart Aplet. Please check online at www.hp.com/calculators to ensure you have the latest version of the StreamSmart Aplet. See Figure 1-2 below for instructions on accessing the application.

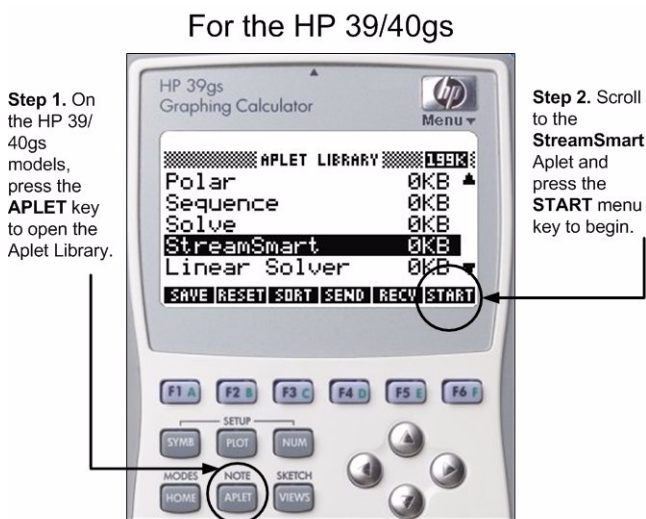


Figure 1-2 The StreamSmart Aplet on the HP 39/40gs

4. Stream

1. Once the StreamSmart Aplet starts, you will see the message, **Waiting for connection...**, quickly followed by a second message, **Waiting to start...** When this message appears, press the **START** menu key to commence data streaming.

The data stream is a graphical representation of sensor data. The horizontal axis represents time in seconds, and the vertical axis represents sensor data in units of measurement. The plot window displays a number of items, as illustrated in Figure 1-3 below.

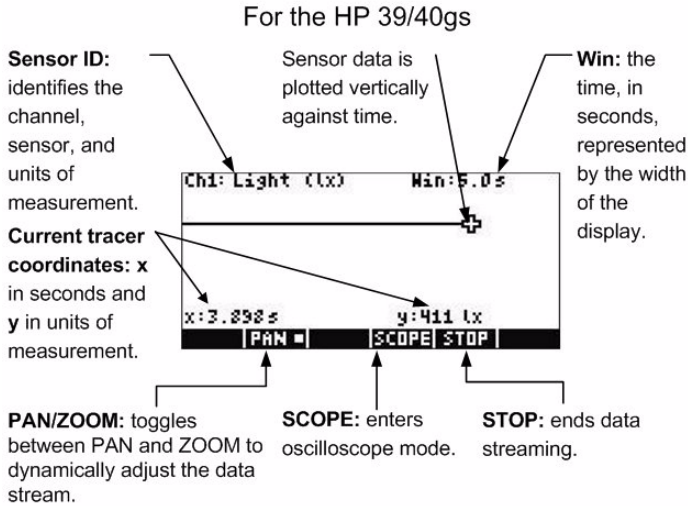







Figure 1-3 The Plot Window for the HP 39/40gs

The HP 39/40gs

The StreamSmart Aplet has the same general structure as the other HP 39/40gs Aplets. For example, the StreamSmart Aplet has the standard *Plot* and *Numeric* views. Table 1-2 below lists the standard Aplet views and their use in the StreamSmart Aplet for the HP 39/40gs. Note that the standard *Symbolic* and *Symbolic Setup* views are not used by the StreamSmart Aplet.

All of the views listed in Table 1-2 can be accessed on the HP 39/40gs via the Views menu by pressing **VIEW**.


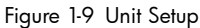
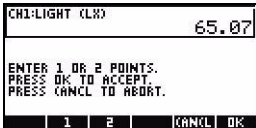


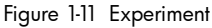
Table 1-2 StreamSmart standard views for the HP 39/40gs

View	Name/Key(s)	Description
 <p>Figure 1-4 Plot View</p>	Plot PLOT	<ul style="list-style-type: none"> View up to four data streams graphically as time graphs Perform streaming experiments See Chapter 2, <i>Streaming Experiments</i> for details
 <p>Figure 1-5 Numeric View</p>	Numeric NUM	<ul style="list-style-type: none"> View up to four sensors numerically in a meter Perform selected events and events-with-entry experiments See Chapter 3, <i>Capturing Data from Events</i> for details
 <p>Figure 1-6 Plot Setup, pg 1</p>	Plot Setup (page 1) SHIFT PLOT	<ul style="list-style-type: none"> Optional: set up the window for the graphic view of the data stream Optional: choose stacked display of multiple data streams or overlaid display (superimposed) Optional: choose data filters for display and export of data See Chapter 4, <i>Advanced Topics</i> for details
 <p>Figure 1-7 Plot Setup, pg 2</p>	Plot Setup (page 2) PAGE	<ul style="list-style-type: none"> Optional: select a history of fixed length (in seconds), or an automatic history that keeps the most current data but saves less and less of earlier data from the stream(s) See Chapter 4, <i>Advanced Topics</i> for details
 <p>Figure 1-8 Sensor Setup</p>	Sensor Setup SHIFT NUM	<ul style="list-style-type: none"> Select/deselect each channel's sensor Manually identify a sensor from a list of supported sensors

Additional Application views

In addition to these standard application views, the Views menu on the HP 39/40gs also contains views specific to the StreamSmart Aplet. Details on these views can be found in Chapter 4, *Advanced Topics*.

Table 1-3 Additional StreamSmart 410 views

View	Name/Key(s)	Description
	Unit Setup	<ul style="list-style-type: none">• Activate/deactivate channels• Select a unit of measurement for sensors with multiple units of measurement available
		
	Calibrate	<ul style="list-style-type: none">• Select a sensor's channel for software calibration of the sensor• Perform 1-point or 2-point software calibration of the selected sensor
		
	Experiment	<ul style="list-style-type: none">• Perform data logging experiments with a set duration (length in seconds) and set number of samples
		




The Statistics application

The StreamSmart Aplet works seamlessly with the Statistics Aplet on the HP 39/40gs to provide you all the tools you need to collect and analyze data.

Once you select the data you want to analyze, the data is sent to columns in the Statistics Aplet. The Statistics Aplet has ten columns available for data, C1 through C9, and C0. You may choose a destination column for each sensor's data, or use the default values provided. When you export data to the Statistics Aplet, you can choose to follow your data into the Statistics application for analysis, or stay in the StreamSmart Aplet to continue experimentation. In-depth analysis of the data, including the calculation of summary statistics (for 1 or 2 variables) and modeling bi-variate data with various fits, is performed in the Statistics Aplet. This manual contains a brief introduction to the Statistics Aplet, but for more information about the Statistics Aplet for the HP 39/40gs, refer to the *HP 39/40gs User's Guide*.

Manual conventions

Throughout this manual, a few conventions have been employed to help you find the references under discussion. There are four notational conventions, corresponding to primary key operations, shifted key operations, and operations in menus:

1. Functions on the keyboard appear in their own special font. For example, the *ENTER* key appears as . Shifted functions will be referenced both by the function name and the key combination required; for example,  (Plot Setup).
2. The HP 39/40gs calculators employ context-sensitive menus that appear along the bottom of the display. The functions in these menus are accessed via the top row of keys on the keyboard directly below the screen display. There are six of these menu keys in all. For example, in the *Plot* screen capture in Table 1-2, the four items shown in the menu are: *CHAN*, *PAN*, *SCOPE*, and *STOP*. These keys are represented in a special font. For example, *ZOOM* appears as .
3. The StreamSmart Aplet also employs dialogue boxes from time to time, as shown in the *Streamer Plot Setup* view in Table 1-2 above. The field names in menus and other data are shown in bold type. For example, in the top left corner of the *Plot Setup* dialog box in Table 1-2, there is a field named *XRNG*. In this manual, the field name is shown in bold as **XRNG**.
4. Screen captures are provided to assist you in checking your data. The actual data will vary. These screen captures are simply provided to help orient you to the software and to help you navigate through the functionality.
5. Finally, tasks are numbered to clarify steps in multi-step procedures.

Helpful hints

Remember these helpful hints and shortcuts as you use the StreamSmart Aplet:

- You can reset the **StreamSmart** Aplet at any time by pressing the **APLET** key on the keyboard and the **RESET** menu key. When prompted, press **YES** . Press **START** for a new data stream.
- The **OK** menu key is interchangeable with the **^** key; the **CANCEL** menu key and the **ON** key are also interchangeable.
- When navigating a list of options in a menu, use the alphabetical keys to jump to your choice. For example, press **7** to jump to the first item in the list that starts with the letter "P." Press **7** again to cycle through the next option that starts with "P."
- Use **+** to navigate lists of options as well. **+** advances through the list of items in order.

2 Streaming Experiments

Most often, you will simply plug up to four Fourier® sensors into the front of the StreamSmart 410, connect the StreamSmart 410 to the HP 39/40gs serial port, (press the StreamSmart 410 **ON** button if the green light is not illuminated) and then press the **START** menu key. When you start the StreamSmart Aplet and press the **START** menu key, you will find that you are immediately streaming data from all of the sensors.

In streaming experiments, data is collected in real-time, with data literally “flowing” across the screen in up to four separate streams. A streaming experiment is illustrated conceptually in Figure 2-1 below. Each section of this chapter on streaming experiments corresponds to one of the bubbles in the flow chart in the figure.

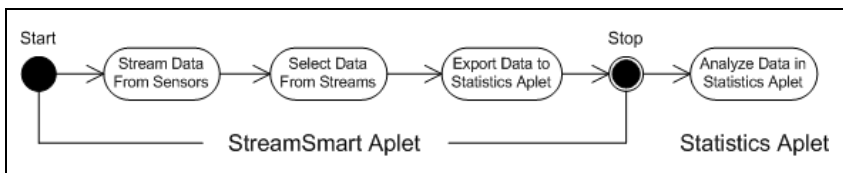


Figure 2-1 Streaming experiment

As data streams across the screen, you can modify how you view the stream(s). You can speed the streams up or slow them down simultaneously, as all four streams share the same horizontal time axis. In addition, you can move each stream up or down separately and zoom in or out on each stream vertically. Each stream has its own vertical axis. Zooming and panning each stream separately in the vertical dimension allows you to get just the right view on your experimental data. You can also stop and restart the stream(s), and choose a discreet section of the stream(s) to examine more closely. The speed at which you can collect data and the flexibility you have in viewing the data are features unique to streaming experiments performed with the HP MCL.

Table 2-1 describes what you see on screen and summarizes what you can do at each step in a streaming experiment. Use this table for quick reference. The following sections elaborate on the steps shown in the bubbles of the flow chart in Figure 2-1. Refer to these sections for more detailed information on viewing, selecting, and exporting data.

Table 2-1 Streaming experiment flow

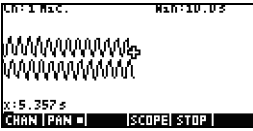





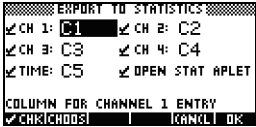

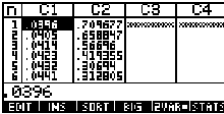

Display	Description
 <p>Figure 2-2 Stream</p>	<p>How I got there:</p> <ul style="list-style-type: none"> Press APLET Streamsmart ENTER START <p>What I see on screen:</p> <ul style="list-style-type: none"> Up to four data streams displayed graphically in real-time Channel number, sensor type and units for the current selected stream, and screen width expressed in seconds
<p>What I can do:</p> <ul style="list-style-type: none"> CHAN: select a channel (stream) to trace, etc. PAN/ZOOM: toggle between panning (scrolling) and zooming with direction keys PAN: scroll up, down, left, and right ZOOM: zoom in or out vertically or horizontally SCOPE: switch to oscilloscope mode (see Chapter 4) START/STOP: stop stream flow or start a new stream 	
 <p>Figure 2-3 Select, page 1</p>	<p>How I got there:</p> <ul style="list-style-type: none"> Press STOP EXPRT <p>What I see on screen:</p> <ul style="list-style-type: none"> Data streams Current channel and sensor, with tracer active Selected data set, based on the current channel, and the number of data points ready for export Current tracer coordinates
<p>What I can do:</p> <ul style="list-style-type: none"> ZOOM, PAN, and TRACE to navigate the data streams and find data of interest CROP LEFT and CROP RIGHT  (next page) to see more functions 	
 <p>Figure 2-4 Select, page 2</p>	<p>How I got there:</p> <ul style="list-style-type: none"> Press  <p>What I see on screen:</p> <ul style="list-style-type: none"> Same as page 1, but with different menu keys
<p>What I can do:</p> <ul style="list-style-type: none"> EDIT: choose a set number of samples between two chosen time values SUBTRACT or ADD data points to the current data set CANCL to return to the current data stream or OK to export the current data set to the Statistics application  (previous page) to return to page 1 	

Table 2-1 Streaming experiment flow






Display	Description
 <p>Figure 2-5 Export</p>	<p>How I got there:</p> <ul style="list-style-type: none"> Press  OK <p>What I see on screen:</p> <ul style="list-style-type: none"> Fields for the four StreamSmart 410 channels, each with a checkbox to select or deselect that channel for data export, and a dropdown box to choose a destination column in the Statistics application for that channel's data A checkbox to choose between staying in the StreamSmart Aplet after data export or following your data into the Statistics application

What I can do:

- **CHK:** select or deselect each channel for data export
- **CHOS:** select destination columns for the data from each sensor
- **CANCL** to return to the original data set or **OK** to send the data to the Statistics application

 <p>Figure 2-6 Analyze the Data</p>	<p>How I got there:</p> <ul style="list-style-type: none"> Press  and then press any key <p>What I see on screen:</p> <ul style="list-style-type: none"> <i>Numeric view of the Statistics application, with data in columns</i>
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What I can do:


- Scroll through the table of data using , , , and 
- Graph data using  **Auto Scale**
- **1VAR/2VAR:** toggle between analysis of 1-variable and 2-variable data
- **STATS:** view summary statistics
- See your HP Calculator's user guide for more information on the statistics application, including regression fit types and statistical plot types

Viewing a stream of data

Once the StreamSmart Aplet is started with one or more sensors and the StreamSmart 410 attached, the StreamSmart Aplet displays a graphic representation of the incoming data streams as time graphs. The horizontal dimension represents time in seconds, and the vertical dimension represents the current sensor values in relevant units. Because only one stream may be traced at a time, the display also identifies the currently selected data stream, the units of measurement of the selected stream, and the length of time represented by the width of the display screen.

The StreamSmart Aplet first tries to identify the attached sensors and makes several decisions based on the characteristics of the sensors. The StreamSmart Aplet sets the vertical scales for each data stream based on the units of the sensor and the initial readings. The StreamSmart Aplet also sets the horizontal scale for the length of time represented by the width of the display. These default settings ensure that the streams are visible in the display and moving at a perceptible rate. You can vary the speed and vertical position of the streams to meet your needs, even while the data is streaming. Occasionally, the StreamSmart Aplet may not be able to identify a sensor. See Chapter 4, *Advanced Topics* for details on how to manually identify an unrecognized sensor.

Data streams in at over 5,000 samples per second, and the data are shown graphically on a 131 x 64 pixel display. At this rate and display resolution, if each pixel column represented a single data point, the stream would move at an extremely high rate. In fact, under these circumstances, the cursor would fly along at over eight feet per second! To slow the stream down enough to make the motion easily perceptible, each pixel in each data stream represents a set of data points. The user can zoom in horizontally on the streams, essentially making each pixel represent a smaller and smaller set of data points, or zoom out, making each pixel represent a larger and larger data set. By default, the StreamSmart Aplet uses the average of these data points to represent the entire set. In other words, StreamSmart filters the data by using averages. However, you can choose other filtering methods. For advanced filtering methods, refer to Chapter 4, *Advanced Topics*. Although the data are averaged for graphing purposes, you still have access to all the data. This is a unique feature of the StreamSmart 410.

The screens shown in Figure 2-7 and Figure 2-8 illustrate the location and basic functions of the menu keys during and just after streaming. Use **ZOOM** and **PAN** to modify the appearance of the streams. **SCOPE** starts streaming in oscilloscope mode, in which the data streams from left to right across the screen, then repeats upon reaching the right edge of the display, similar to the sweep of an oscilloscope. **START/STOP** is a toggle that stops and restarts data streaming. Once you stop the stream, there are three additional functions available: *Trace*, *Export*, and *Next Page*. Use **TRACE** to view numerical characteristics of points in the data stream. **EXPR** replaces the **SCOPE** function once streaming is stopped; it opens a set of tools for selecting a final data set to analyze.  (next page) displays the second page of the menu key functions.

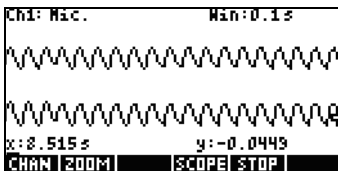


Figure 2-7 During Streaming

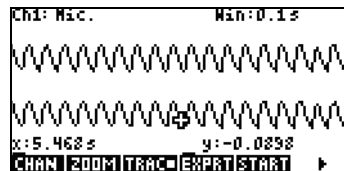



Figure 2-8 After Streaming

Table 2-2 lists the menu functions available during and just after streaming.

Table 2-2 Streaming menu keys, page 1

Menu Key	Description
CHAN	This menu key opens the channel selection menu, which allows you to select which stream to trace. By extension, you are also choosing which stream to zoom or pan vertically. Alternately, you can use the keys numbered 1-4 to select a channel.
PAN / ZOOM	This menu key is a toggle that determines how the direction keys function. Press once to activate <i>Pan</i> mode, once more to activate <i>Zoom</i> mode. The active mode is indicated by a small square after the menu mode name.
PAN	Toggles the direction keys to scroll the data streams up, down, left, and right to find data of interest. Panning horizontally affects all streams uniformly; panning vertically affects only the current, selected stream.
ZOOM	Used with the direction keys, zooms in or out, horizontally or vertically, to get the best view of the streams. Zooming horizontally affects all streams uniformly, while zooming vertically affects only the current, selected stream.
SCOPE	Switches to oscilloscope mode. In this mode, the data stream sweeps from left to right, then returns to start from the left for another sweep. See Chapter 4, <i>Advanced Topics</i> for details.
START / STOP	This toggle starts and stops data streaming. Stopping the stream(s) permits exploration of the data and selection of a final data set for export. <i>Start</i> deletes any current data set and starts a new set of streams.
TRACE	Activates <i>Trace</i> mode, allowing you to trace along any of the data streams.
EXPT	Opens the <i>Export Data</i> menu, with functions for isolating and selecting a final data set to export to the Statistics application.
	Accesses the second page of menu keys.

Zoom, *Pan* and *Trace* are radio button toggles that work in conjunction with the direction keys (▲, ▼, ◀, and ▶). Only one function is active at a time, its active status indicated by a small square after the function name. For example, **TRACE** means the tracer is active and the direction keys will be used to trace the selected stream or jump to another stream. Table 2-3 describes how the direction keys are used for each of these functions.

Table 2-3 Functions controlled by the direction keys

Menu Key		Description
ZOOM	◀ ▶	<ul style="list-style-type: none"> Use these keys to zoom in or out horizontally If you are actively streaming data, these keys speed up the stream or slow it down If streaming has stopped, trace to data of interest and then switch to <i>Zoom</i> to zoom in or out on the tracer coordinates. The tracer location stays fixed. Press ▶ to zoom in horizontally on the tracer position, effectively decreasing the amount of time represented by the width of the display Press ◀ to zoom out horizontally on the tracer position, effectively increasing the amount of time represented by the width of the display
ZOOM	▲ ▼	<ul style="list-style-type: none"> Zoom in/out vertically on the current selected data stream Press ▲ to zoom in and press ▼ to zoom out The center of the display stays fixed Decreases/increases the vertical scale, in sensor units, of the current, selected stream
PAN	◀ ▶	<ul style="list-style-type: none"> Move all stream(s) left and right in the display The screen display is a fixed window that moves back and forth along the stream(s)
PAN	▲ ▼	<ul style="list-style-type: none"> Move the current, selected stream up and down in the display Useful to separate or superimpose the streams for viewing purposes
TRACE	◀ ▶	<ul style="list-style-type: none"> Moves left or right from pixel to pixel in the current, selected data stream Displays timestamp and sensor data
TRACE	▲ ▼	<ul style="list-style-type: none"> Moves the tracer from one stream to another Press ▼ to move from channel to channel in increasing numerical order Press ▲ to move through the channels in decreasing numerical order

Besides navigating and tracing the data set to find data of interest, StreamSmart also lets you compare any two points in a single stream and manually add a data point as a row in your chosen columns in the Statistics application. These functions are found on the second page of the *Stream* menu, which is only active once streaming has stopped.

Mark and *Swap* can be used together to examine the relationship between points in the data stream currently being traced. When you press **MARK**, the StreamSmart Aplet sets a visible mark at the current tracer location. Once the mark is set you can trace to any other point in the stream. The StreamSmart Aplet displays the change in both *x* and *y* between the mark and the current tracer location (see Figure 2-9). Press **SWAP** to switch the tracer and mark locations.

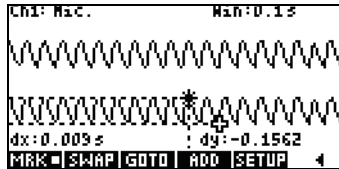



Figure 2-9 A Mark and the Current Tracer Location

Add and *Setup* are also used together when you want to build your final data set point by point. For example, suppose a data stream represents the dampened oscillations of a vibrating rod. In this case, you may want to collect just the maximum of each oscillation into a data set. Press **SETUP** to choose columns in the Statistics application for your data. Once the columns have been chosen, return to your data stream and trace to the first point you want to keep in your data set. Press **ADD** to add the data as a row to your chosen columns in the Statistics application. StreamSmart briefly displays a message telling you the row to which the data point is being exported. Continue in this fashion until you have collected all the points you want, then start the Statistics application to view and analyze your data. Table 2-4 lists the second page of menu keys and their functions.

Table 2-4 Menu keys, page 2

Menu Key	Description
MARK	Toggles <i>Mark</i> mode on and off, setting a mark at the current tracer position, or erasing the mark.
SWAP	Switches the tracing cursor and the mark on the current, selected stream.
GOTO	Permits you to jump to a specific time along the current stream.
SETUP	Sets the destination columns for data when ADD is pressed.
ADD	Adds the current data point to the default columns in the Statistics application.
	Returns to the previous page of menu keys.

Low battery symbol

The low battery symbol (🔋) indicates the StreamSmart 410 requires charging. If the battery symbol appears in the upper left corner of the screen, as shown in Figure 2-10, be sure to charge the StreamSmart 410 as soon as possible. See Chapter 1 for instructions on charging the battery.



Figure 2-10 The Low Battery Symbol

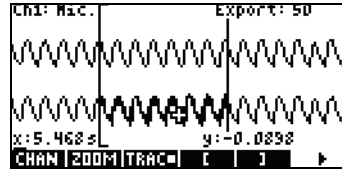


Figure 2-11 The Cropping Tools

Select data

Once you have stopped streaming data, you will want to examine the data to find just the data set you wish to analyze. The **EXPORT** menu key opens the *Export Data* menu. Here you will find all the tools you'll need to identify and select your final data set. Note that *Zoom*, *Pan*, and *Trace* are still available. In addition, you can use **[C]** and **[J]** to crop data off the left and right sides of the data set, as shown in Figure 2-11. You can also thin the data by subtracting points; if you change your mind, you can add them back.

Table 2-5 and Table 2-6 describe the new functions available on the two pages of the Export menu.

Table 2-5 Export Data Menu Keys, page 1

Menu Key	Description
[C]	Toggles left-cropping on and off. Use [←] and [→] to move the left-crop bar. Data to the left of the bar is excluded from the final data set.
[J]	Toggles right-cropping on and off. Use [←] and [→] to move the right-crop bar. Data to the right of the bar is excluded from the final data set.
[▶]	Moves to a second page of menu keys.

Table 2-6 Export Data Menu Keys, page 2

Menu Key	Description
EDIT	Lets you select a specific number of data points between two time values for export to the Statistics application.

Table 2-6 Export Data Menu Keys, page 2

Menu Key	Description
-	Subtracts 1 data point from the current data set; when shifted, subtracts 10 data points from the current data set.
+	Adds 1 data point to the current data set; when shifted, adds 10 data points to the current data set.
CANCL	Cancels the current data set selection and returns to the full set of streams.
OK	Begins exportation of the current selected data set to the Statistics application and deletes all other data.
◀	Returns to the first page of the <i>Export</i> menu.

Export a data set

Once you have selected a final data set for analysis, it is relatively simple to export your data to columns in the Statistics application. Figure 2-12 illustrates the fields of the *Export* menu.

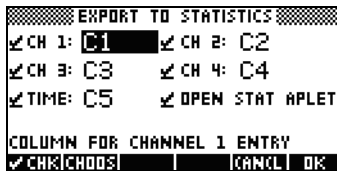


Figure 2-12 The Export Menu

There are six fields in the *Export* menu: four for the StreamSmart 410 channels, one for the timestamp associated with each data point, and one that determines what happens after the data is exported. The four channel fields, (**CH 1**, **CH 2**, **CH 3**, and **CH 4**), as well as the **TIME** field, all behave the same way. They are each preceded by a checkbox and followed by a dropdown box. The checkbox allows you to select or deselect the data from each channel for exportation. By default, all four channels and the time are selected for export. Press **CHK** to toggle between selecting and deselecting a channel. Each channel field is also followed by a dropdown box. This dropdown box permits you to choose the column in the Statistics application you want as the destination for the data from that channel. Press the **CH003** menu key to change the current column to any of the ten columns in the Statistics application. At any time, you can press **CANCL** to ignore the changes you made and return to your data set, or press **OK** to proceed with

exportation of the data. Once your data set is exported, all the other data from your experiment is deleted to make room for a new experiment. Table 2-7 summarizes the options in the *Export* dialogue box.

Table 2-7 Export menu dialog box options

Field	Menu Key	Description
CH1	<input checked="" type="checkbox"/> CHK	Toggles between selecting and deselecting the current channel. The data from any active channel (its stream) will be exported; the data from any inactive channel will not be exported.
CH2		
CH3		
CH4		
Time	<input checked="" type="checkbox"/> TIME	Opens a dropdown box with the names of the columns in the Statistics application (C1, C2, C3...C9, and C0). Choose any column as the destination for the data from this channel.
Open Stat Aplet	<input checked="" type="checkbox"/> CHK	Toggles between selecting and deselecting this option. If selected, the Statistics application will be opened after data exportation and the <i>Numeric</i> view of the data will be displayed. If deselected, you will return to the StreamSmart Aplet and data streaming after the data is exported.

Analyze data

The StreamSmart Aplet provides minimal facilities for examining and analyzing data, as most of this work is done in the Statistics Aplet after the data is exported there. The Statistics Aplet lets you view your data in a table, plot it as a graph, view summary statistics, and create 2-variable models for bi-variate data. All of this functionality is described in detail in your HP Calculator's user guide, so it is not repeated here. However, this section contains a brief summary of commonly used functions in the Statistics Aplet.

When you leave the StreamSmart Aplet and enter the Statistics Aplet, you enter the *Numeric* view of that Aplet, as shown in Figure 2-13.

n	C1	C2	C3	C4
1	.0396	.709677		
2	.0405	.658847		
3	.0414	.56646		
4	.0422	.41955		
5	.043	.3064		
6	.0441	.312805		
.0396				
EDIT INS SORT BIG 2VAR STATS				

Figure 2-13 The Statistics Aplet Numeric View

The *Numeric* view shows your columns of data arranged in a table. Although only four columns are displayed, there are actually ten columns available. Use \blacktriangleright and \blacktriangleleft to move from column to column; use \blacktriangledown and \blacktriangleup to navigate through the data in a column.

One key to understanding the Statistics Aplet is the **1VAR/2VAR** menu key. Press this key to toggle between 1-variable and 2-variable statistics. If set to **1VAR**, you are studying the data column by column; if set to **2VAR**, you are studying the

3 Capturing Data from Events

Although the StreamSmart 410 is capable of collecting data at high sampling rates, as shown in Chapter 2, it is also versatile enough to gather data from experiments of slower frequency—and even distinct events—with ease. You have seen the power of streaming data in real time at rates over 5,000 samples per second with the streaming experiment. In this chapter, we go to the opposite extreme to show you how simple it is to take a few isolated sample readings from up to four sensors at a time and collect them into a data set for analysis. The StreamSmart Aplet lets you capture data at any point in time and have the data exported to corresponding rows of separate columns in the Statistics application. Additionally, you can have the readings auto-numbered in the order in which they are collected, or you can add a numerical entry to each reading when it is taken. Figure 3-1 summarizes the steps involved in these types of experiments.

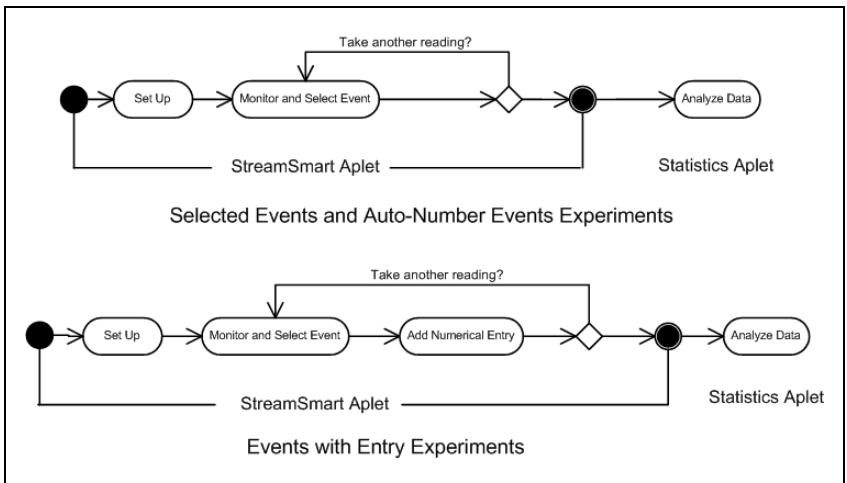


Figure 3-1 Events-with-Entry Experiments

Table 3-1 illustrates what you see on screen and summarizes what you can do at each step in experiments in which you wish to capture data from distinct events.

Table 3-1 Capturing data from discrete events

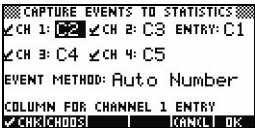
View	Description
	<p>How I got there:</p> <ul style="list-style-type: none"> Press NUM SETUP <p>What I see on screen:</p> <ul style="list-style-type: none"> The <i>Capture Events</i> Menu

Figure 3-2 Set up Experiment

What I can do:

- Select or deselect any of the four channels for data export purposes
- Choose a column for storing the data from each active channel
- Choose a column for manually adding a numeric entry
- Select to just collect the data from each event, auto-number each event, or add a numeric entry to each event


View	Description
	<p>How I got there:</p> <ul style="list-style-type: none"> Press NUM key <p>What I see on screen:</p> <ul style="list-style-type: none"> Up to four sensors and their units Current readings

Figure 3-3 Monitor and Select Events

What I can do:

- **ADD:** add a reading to the current data set
- **SETUP:** select experiment type and destination for data
- **SENSOR:** manually identify a channel's sensor
- **UNIT:** change units of measurement for a sensor
- **STAT:** go directly to the Statistics application to view and analyze the current data set

n	C1	C2	C3	C4
1	0.896	7.0827		
2	0.403	6.5847		
3	0.414	6.5847		
4	0.423	6.5847		
5	0.432	6.5847		
6	0.441	6.5847		
7	0.896	7.0827		

Figure 3-4 Analyze Data

What I can do:

- Scroll through the table of data using **▲**, **▼**, **◀**, and **▶**
- Graph data using **VIEWS** **Auto Scale**
- **1VAR/2VAR:** toggle between analysis of 1-variable and 2-variable data
- **STATS:** view summary statistics
- See your HP Calculator's user guide for more information on the Statistics application, including regression fit types and statistical plot types

Numeric view: the meter mode

Whether you choose to auto-number your selected events or add a numerical entry to each event, experiments involving a series of distinct events always start in the *Numeric View* of the StreamSmart Aplet. To access the Numeric View with the StreamSmart Aplet running, press the **NUM** key. The application displays a running meter which updates a few times per second. The meter identifies up to four attached sensors, the units for each sensor, and the current reading of each sensor. A sample display is shown below in Figure 3-5. In this figure, a microphone sensor is plugged into Channel 1, and a current sensor is plugged into Channel 4.

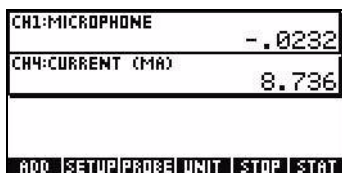


Figure 3-5 The Numeric View

Table 3-2 lists the menu items in the *Numeric View*.

Table 3-2 Menu keys in the *Numeric View*

Menu Key	Description
ADD	<ul style="list-style-type: none">• Adds the current reading(s) to the data set as a single event• See the section below titled, <i>Monitor and select events</i>
SETUP	<ul style="list-style-type: none">• Choose Selected Events, Events with Entry, or Auto Number• Select or deselect any of the four channels for data export purposes• Choose destination columns for data from each active channel• See the section below titled, <i>Set up experiment</i>
SENSOR	<ul style="list-style-type: none">• Manually identify a sensor• See Chapter 4, <i>Advanced Topics</i>
UNIT	<ul style="list-style-type: none">• Choose units of measurement for each sensor• See Chapter 4, <i>Advanced Topics</i>
STAT	<ul style="list-style-type: none">• Opens the Statistics application to view and analyze the current data set• See the section below titled, <i>Analyze the data</i>

Set up experiment

By default, pressing the **ADD** menu key will capture the current set of readings from sensors attached to Channels 1 through 4 of the StreamSmart 410. The readings will be auto-numbered, and this number will be stored in Row 1 of column **C1** in the Statistics application. The rest of the readings will be stored in Row 1 of columns **C2** through **C5**, with the reading from the sensor in Channel 1 stored in

C2, the reading from the sensor in Channel 2 stored in **C3**, etc. The next time **ADD** is pressed, the data will be stored on Row 2 of these columns. This process can be continued indefinitely.

The *Capture Events* menu lets you set up where your data will go when you press **ADD**. You can choose which channels are selected and where the data from each channel is stored in the Statistics application. Press **SETUP** to enter the *Capture Events* menu. In addition to choosing columns for your sensor data, you can also deactivate auto-numbering or choose to add an entry to the data from each selected event. Figure 3-6 illustrates the *Capture Events* menu.

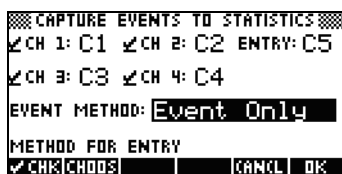


Figure 3-6 The Capture Events Menu

Like the *Export* menu discussed in Chapter 2, the *Capture Events* menu has a field for each of the four StreamSmart 410 channels. Each of these fields is preceded by a checkbox to activate/deactivate the channel, and followed by a choose box to select the Statistics application column for storing the data from that channel. There is also an **EVENT METHOD** field that controls what happens each time you press **ADD**. Here you can choose whether to simply collect the data from the sensors, auto-number each reading, or add a numeric entry to each reading. If you choose to add a numeric entry to each reading, this menu also has a fifth field, **ENTRY**, that determines the column where these numeric entries are stored.

Table 3-3 lists the items in the *Capture Events* menu and their operation.

Table 3-3 Menu keys in the Capture Events menu

Menu Key	Description
CHK	<ul style="list-style-type: none"> • Toggles the selected channel off and on.
CHOOSE	<ul style="list-style-type: none"> • Choose the destination column in the Statistic application for data from the selected channel. • Choose Selected Events, Events with Entry, or Auto Number in the Event Method field.
OK	<ul style="list-style-type: none"> • Accept changes made in the <i>Capture Events</i> menu and return to the <i>Numeric</i> view.
CANCEL	<ul style="list-style-type: none"> • Cancel changes made in the <i>Capture Events</i> menu, keep the previous configuration, and return to the <i>Numeric</i> view.

For example, in Figure 3-7 below, Channels 1 and 2 are selected for data export, but Channels 3 and 4 are not. The data from Channel 1 will be stored in **C1** and the data from Channel 2 will be stored in **C2**. Because the **EVENT METHOD** field setting is **WITH ENTRY**, each reading will prompt for a numeric entry, which will be stored in column **C3**.

Analyze the data

Once you have captured all your events, press the **STAT** menu key to proceed to the Statistics application, where your data set has been saved. For a brief summary of the Statistics application, refer to the section titled, *Analyze experimental data* in Chapter 2. For more complete information, please consult your calculator's user's guide.

Data logging

Under certain circumstances, it is desirable to run an experiment for a particular duration (e.g., 3 seconds exactly) and collect a particular number of samples (e.g., 50 samples). The StreamSmart 410 accommodates this need via the **Experiment** option under the *Views* menu, as illustrated in Figure 3-12 and Figure 3-13.

1. Press **VIEWS** **Experiment** to enter the *Experiment* menu.
2. Set **LENGTH** to **3** seconds and **SAMPLES** to **50**.
3. Press **OK** to trigger data collection.



Figure 3-12 The Experiment Menu

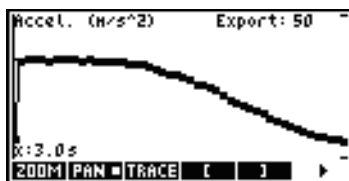


Figure 3-13 50 Readings in 3 Seconds.

Data collection is shown as a time graph, just like a streaming experiment. However, StreamSmart collects 50 discrete sets of sensor readings in a 3-second period at a uniform frequency of 1 reading every 0.06 seconds. Figure 3-13 shows 50 data points have been collected (**Export:50**) and the trace cursor readout at the far left of the screen shows that the elapsed time is exactly 3.0 seconds (**x:3.0s**). At this point, the user is ready to select and export a final data set. Refer to the section titled, *Select a set of data* in Chapter 2 for more details on selecting and exporting a data set.

4 Advanced Topics

This chapter is devoted to a number of advanced topics, including:

- Sensor setup
- Unit setup
- Calibration
- The *Plot Setup* menu
- Oscilloscope mode
- StreamSmart on the virtual HP calculators
- Keyboard shortcuts
- Mathematical detail behind the zoom and pan features

These advanced topics will help you get the most out of the HP MCL.

Sensor setup: manually identify a sensor

The StreamSmart Aplet is designed to automatically identify a Fourier® sensor attached to the StreamSmart 410. In some cases, StreamSmart may fail to identify a sensor or identify it incorrectly. In this case, you must manually identify the sensor using the *Sensor Setup* dialog box. Press **VIEW** and select the **Sensor Setup** option.



Figure 4-1 Sensor Setup

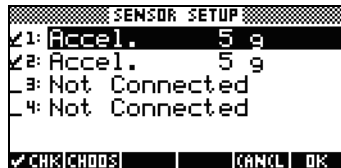


Figure 4-2 Sensor Setup Dialogue Box

Figure 4-2 shows the *Sensor Setup* dialog box with accelerometers plugged into Channels 1 and 2. Suppose that the sensor in Channel 1 is not an accelerometer, but a force sensor. With Channel 1, highlighted, press **CHDS** and select the appropriate force sensor option. In Figure 4-3, the **0-80 N Force** sensor option has been selected. Press **OK** to make this change effective and return to the *Sensor Setup* dialog box. Figure 4-4 shows the *Sensor Setup* dialog box with the new changes. Press **OK** to finalize any changes and return to the StreamSmart Aplet. Figure 4-5 shows the *Numeric* view with the new force sensor in Channel 1.

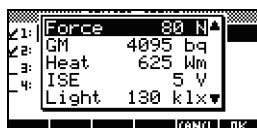


Figure 4-3 Force Sensor

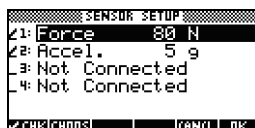


Figure 4-4 Sensor Setup



Figure 4-5 Numeric View with Force Sensor in CH1

Unit setup: manually select units for a sensor

When the StreamSmart Aplet automatically identifies a sensor, it also chooses a unit of measurement for that sensor. All subsequent readings from that sensor are shown using the current unit of measurement. Many, but not all, of the sensors have multiple units of measurement available. For sensors that do have multiple units available, you can change the unit of measurement at any time using the *Unit Setup* dialog box. Press **VIEW** and select the **Unit Setup** option to open the *Unit Setup* dialog box. In the *Numeric* view, on the HP 39/40gs, you can simply press **UNIT**.

Figure 4-6 shows the *Unit Setup* dialog box with a force sensor measuring Newtons in Channel 1 and an accelerometer measuring g's ($g=9.8 \text{ m/s}^2$) in Channel 2. Note that Channel 2 in Figure 4-6 is highlighted. Suppose you wish the accelerometer to measure in meters per second squared (m/s^2) instead. Press **CHOOSE** and select **Accel. (m/s^2)**, as shown in Figure 4-7.



Figure 4-6 Unit Setup Dialog Box



Figure 4-7 Select Units

Press **OK** to return to the dialog box with the changes shown (Figure 4-8). Press **OK** to exit the dialog box and activate the changes. Figure 4-9 shows the *Numeric* view with the new units.



Figure 4-8 Unit Setup Dialog Box

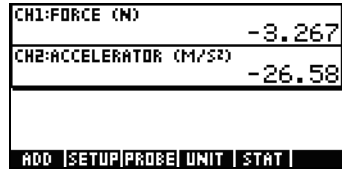


Figure 4-9 Numeric View

Calibration

Many Fourier® sensors are factory-calibrated and should not need user calibration. However, most of those that do require user calibration have an adjustment screw on the sensor itself for hardware calibration. Please refer to the documentation that comes with each sensor to determine its calibration status.

If a sensor requires calibration and no hardware calibration is available, the software calibration may be done in the StreamSmart Aplet. Software calibration has two limitations. First, it is the software being calibrated, not the sensor, which means that the new calibration settings will not be carried over if the sensor is plugged into a different calculator. Second, since the calibration is in the software, it will be applied to all sensors of that same type. The StreamSmart Aplet cannot distinguish between two sensors of the same type.

Once it has been determined that software calibration for a sensor is the only option, it should be noted that the StreamSmart 410 offers both 1-point and 2-point methods for such calibrations. A 1-point calibration simply changes the offset, while a 2-point calibration changes both offset and slope.

To perform a calibration:

1. Press **NUM** to view the sensor readings numerically. In Figure 4-10, suppose the current reading of the low-G accelerometer is incorrect, and the correct reading is **-6.433**.
2. Given that the current reading is not correct and the correct reading is known, press **VIEWS** and select the **Calibrate** option (see Figure 4-11).



Figure 4-10 Display Current Sensor Reading



Figure 4-11 Calibrate

3. Figure 4-12 shows the calibration screen, with its options for 1- or 2-point calibration. Note that the meter continues to show the live streaming of

sensor values. Press **1** to enter the correction for the current reading. The current reading is still **6.408**, but it should read **-6.433**. Enter the correct value as shown in Figure 4-13 and press **OK** to return to the calibration screen.

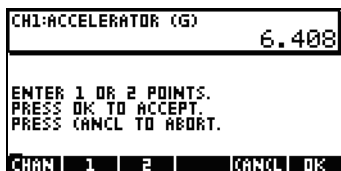


Figure 4-12 Calibration Screen



Figure 4-13 Enter the Correct Value

- Note that the calibration change is not yet effective, as you have the option of entering a second correction. The white square in the **1** key in Figure 4-14 indicates that the first point correction has been logged.
- Press **2** to enter a second point correction, or press **OK** to make the 1-point calibration effective (Figure 4-15). Of course, you can press **CANCEL** to abort the calibration process.

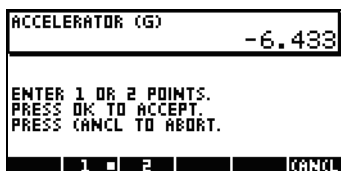


Figure 4-14 First Point Correction Logged



Figure 4-15 1-Point Calibration Effective

The Plot Setup menu

The *Plot Setup* menu gives you access to a number of advanced options for streaming experiments. Among these are overriding the default streaming window settings and the default data filtering methods.

Setting the stream window

In most cases, you will use the zoom and pan features to match the display dimensions to the set of data points you find interesting. In some cases, however, you may want to see all the data between two known time values. Suppose you have been collecting data from a microphone for a few seconds (see Figure 4-16) and you wish to look at the data from time $t=0.85$ seconds to time $t=0.95$ seconds.

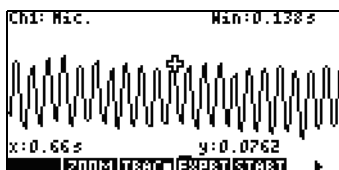


Figure 4-16 Collected Data in Streaming Window

To see this exact time interval without zooming and panning:

1. Press **[SHIFT]** **[PLOT]** to enter the *Plot Setup* menu.
2. Change the **XRNG** values to [0.85, 0.95] (Figure 4-17).
3. Press the **[PLOT]** key to return to the streaming window.(Figure 4-18).



Figure 4-17 Plot Setup Menu



Figure 4-18 Return to Streaming Window

The StreamSmart Aplet will match the minimum and maximum time values in the **XRNG** fields to the closest corresponding time values in the data set. They may not always match exactly. In Figure 4-18, the maximum x-value is indeed **0.95** and the width of the display represents **0.1** second. The next streaming experiment will maintain the width of the display at 0.1 seconds, meaning that **XRNG** will initially be **[0, 0.1]**. These values will remain in effect until new values are chosen or the StreamSmart Aplet is reset.

Plot display options

When performing experiments with multiple sensors, the StreamSmart Aplet places each data stream in its own swim-lane by default. The data streams appear in the numerical order of their channels, from top to bottom of the display. Under certain circumstances, you may want to see multiple data streams superimposed instead of separated in swim-lanes. In the *Plot Setup* menu, the **Plot Display** field allows you to choose either option. This field has two settings: **Stack** and **Overlay**. Figure 4-19 depicts the data streams from two microphones shown with the default **Stack** option, with the data streams separated in their familiar swim-lanes. Press **[CHOOS]** and select the **Overlay** option to see the streams superimposed, as in Figure 4-21.

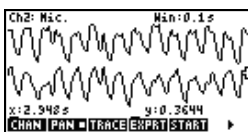


Figure 4-19 Stacked



Figure 4-20 Select Overlay

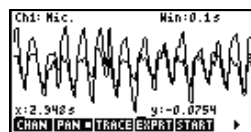


Figure 4-21 Overlaid

Filtering data for display and export

Under most circumstances, each pixel in the display of the data stream represents multiple sensor readings. Depending on the current window, each pixel could represent quite a large data set. For example, in Figure 4-22, each pixel has a width of approximately 0.1 seconds ($13s/130pixels=0.1s/pixel$). But StreamSmart 410 has collected approximately 570 readings in each 0.1 second interval. For display purposes, those 570 readings are represented by a single value. In Figure 4-22, the readings taken from 6.85 seconds until 6.95 seconds have been averaged to obtain a reading of **0.578**. The pixel containing the point (6.9, 0.578) has been turned on to represent that set of readings.

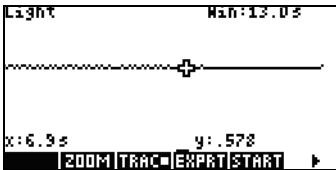


Figure 4-22



Figure 4-23

As you zoom out, each pixel represents a larger and larger set of readings. Zooming in makes each pixel represent a smaller and smaller set of readings until, when you have zoomed all the way in, each pixel finally does represent a single reading. This is fundamental to the StreamSmart solution to data collection: the full data set is available to the user and is only filtered for display and export purposes. Since the data goes through these two distinct filters before it gets to the Statistics application, the advanced user benefits from understanding the default filtering process and the other filtering options available.

During data streaming, each pixel in the display represents an interval of time and all the sample readings collected during that time interval. For example, Figure 4-22 shows the tracer at the pixel whose center is at 6.9 seconds. As stated previously, all the data collected between $x=6.85$ seconds and $x=6.95$ seconds have been represented by the average of those readings, which is 0.578. Figure 4-23 shows all the data between $x=6.9$ seconds and $x=7.0$ seconds. All that data is equivalent to the data represented by a single pixel in Figure 4-22! Only when the StreamSmart Aplet has zoomed all the way in on a set of data is there a 1:1 correspondence between pixels and data points.

The default display filter uses the numerical average of the readings in an interval to represent that set of readings. When you export the data to the Statistics application, the StreamSmart Aplet uses the same values that the display used. This method ensures that the export filter is the same as the display filter.

The StreamSmart Aplet has a number of different filtering options for both display and export purposes. Figure 4-24 shows the data stream in Figure 4-22 filtered by the average of each pixel set. Figure 4-25 shows the same data set filtered by the minimum of each pixel set, while Figure 4-26 is filtered by the maximum. The oscillations hidden in Figure 4-22 and exposed by zooming in Figure 4-23 can also be seen in Figure 4-25 and Figure 4-26, this time exposed by the filtering

methods. Once a filtering method is chosen, it is used for the current (as well as future) data streams until either the StreamSmart Aplet is reset or another filtering method is chosen.

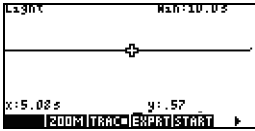


Figure 4-24



Figure 4-25



Figure 4-26

To choose a display filtering method:

1. Press **SHIFT** **PLOT** to enter the *Plot Setup* menu and use the **▼** key to highlight the **DISPLAY FILTER** field (Figure 4-27).
2. Press **CHOOSE** to see the list of options (Figure 4-28).
3. Use **▼** and **▲** to highlight your selection and press the **OK** key.
4. Press **PLOT** to return to the graphic view using the new filtering method.



Figure 4-27 Plot Setup Menu

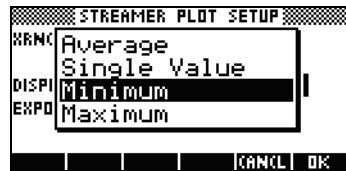


Figure 4-28 Display Filter Options

Table 4-1 summarizes the display filtering options available in the **Display Filter** field of the *Plot Setup* menu.

Table 4-1 Display Filters

Name	Description
Average	Uses the average of the data in each pixel to represent the data.
Single Value	Uses a single value to represent the data.
Minimum	Uses the minimum value to represent the data.
Maximum	Uses the maximum value to represent the data.

In the same way that data is filtered for display in the StreamSmart Aplet, it is also filtered for export to the Statistics application.

To choose an export filtering method:

1. Press **SHIFT** **PLOT** to enter the *Plot Setup* menu and use the **▼** key to highlight the **EXPORT FILTER** field.
2. Press the **CHOOSE** menu key to see the list of options.
3. Use **▼** and **▲** to highlight your selection and press **OK**.

- Press **PLOT** to return to the graphic view, and then press **EXPORT** to export data to the Statistics application using the new filtering methods.

The export options are the same as the options for display filtering, with two additions. The additional options are summarized in Table 4-2.

Table 4-2 Additional export filters

Name	Description
Auto	This is the default option. It matches the export filter to the display filter.
WYSIWYG	This option filters the data so that the scatter plot in the Statistics application matches the graph in the StreamSmart Aplet exactly. The results of this filtering depends on your zoom level.

Data history

By default, StreamSmart 410 collects data from a single sensor at approximately 5,000 samples per second while streaming. At this rate, the StreamSmart Aplet can collect approximately 16.5 seconds of data before memory is full. You can use the options in the *Experiment* menu to increase the time allotted to an experiment, or you can change the way the StreamSmart Aplet allocates memory to data streams via the **History** field in the second page of the *Plot Setup* menu. Press **SHIFT** **PLOT** **PAGE** to access this menu. Figure 4-29 illustrates the second page of the *Plot Setup* menu with the **History Type** field highlighted. By default, this field is set to **Fixed**, meaning that the StreamSmart Aplet will store all data collected during streaming for a fixed amount of time. The amount of time will vary, depending on the number of sensors in use. The current duration (in seconds) is shown in the **History** field. In this case, streaming can continue for a total of 16.453 seconds before earlier data is dropped. You can change the **History Type** from **Fixed** to **Auto** by pressing **CHOOSE** and selecting the **Auto** option (see Figure 4-30). If the **History Type** is set to **Auto**, then data will be saved indefinitely, but less and less of the earlier data is kept.

In either case, you can start data streaming and just let it run indefinitely. The **Fixed** option simply drops data older than the **History** value, while **Auto** thins the older data to make room for new data.



Figure 4-29 Plot Setup Menu, page 2



Figure 4-30 Select History Type

Oscilloscope mode

While streaming data in the *Plot* view, the StreamSmart Aplet provides you with the option of *Oscilloscope* mode. Press **SCOPE** to activate *Oscilloscope* mode. This menu key is a toggle, so press it again to return to normal data streaming.

Oscilloscope mode works with a trigger to enable an oscilloscopic view of your data stream. With no trigger set, *Oscilloscope* mode displays the incoming data in sweeps. Data streaming occurs from left to right across the screen. When the stream hits the right edge of the display, it continues by returning to the left edge of the display and again streams from left to right. Each sweep takes the same amount of time and you can zoom in or out horizontally to adjust the sweep time. These features allow you to visually capture data that varies periodically, such as sound waves.

A trigger can be set in order to position the data at a specific display location when the trigger is crossed. You can set an ascending or descending trigger. An ascending trigger starts the sweep at the trigger position when the data values first exceed the trigger value. A descending trigger starts the sweep when the data values first drop below the trigger value. The operation of the trigger mechanism assures that when the triggering value is reached, the first data point is plotted where the dotted trigger lines intersect. You can also set a two-way trigger.

While in *Oscilloscope* mode, the zoom and pan features both work as they do during data streaming. The result is that you can manipulate the visual display of an oscillating data stream to meet your specific needs rather easily. Table 4-3 and Table 4-4 describe the menu key functions available in *Oscilloscope* mode.

Table 4-3 Oscilloscope menu keys, page 1






Menu Key	Description
ZOOM / PAN	This key toggles between zooming and panning (scrolling) with the direction keys.
ZOOM	When on, use the direction keys to zoom in or out, vertically or horizontally, to adjust the size of the oscilloscope window in sensor units or seconds.
PAN	When on, use the direction keys to scroll vertically or horizontally in the display.
TRGR	Toggles the trigger off and on. When on, use the direction keys to set the location of the trigger.
SCOPE	This key toggles <i>Oscilloscope</i> mode off and on.
START / STOP	This key toggles between start and stop. Press STOP to stop the stream of data; press START to begin a new data stream.
	This key displays the second page of the oscilloscope menu.

Table 4-4 Oscilloscope menu keys, page 2

Menu Key	Description
	Sets a two-way trigger that operates whether it is crossed from below or above. Use the direction keys to set the location of the trigger.
	Sets an ascending trigger. Use the direction keys to set the x- and y-positions for the trigger.
	Sets a descending trigger. Use the direction keys to set the x- and y-positions for the trigger.
	Returns to the first page of the oscilloscope menu.


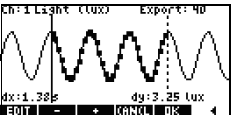
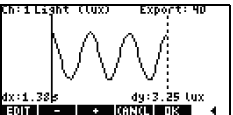
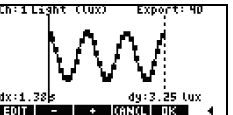










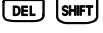



StreamSmart 410 and the virtual calculators

The StreamSmart 410 may be used in conjunction with the HP 39/40gs Virtual Graphing Calculator software on your computer. This use is effective when demonstrating the StreamSmart 410 to an audience or in a classroom setting. You can also demonstrate an experiment in this way. The StreamSmart 410 connects to a computer using a mini-USB to USB cable. This cable came with your HP 39/40gs graphing calculator. Connect the StreamSmart 410 to your computer, launch the HP 39/40gs Virtual Graphing Calculator application, and start the StreamSmart Aplet. For further information regarding the HP 39/40gs Virtual Graphing Calculator software for your computer, please visit www.hp.com/calculators.

Keyboard shortcuts

Table 4-5 lists the keyboard shortcuts for the StreamSmart Aplet. These shortcuts are available either during or just after streaming.

Table 4-5 Keyboard shortcuts

Key(s)	Description	
	Toggles through the three options available for viewing a final data set after streaming and prior to export. See Figure 4-31, Figure 4-32, and Figure 4-33.	
		
	Figure 4-31 Figure 4-32 Figure 4-33	
	Zooms in vertically, during or after streaming.	
	Zooms out vertically, during or after streaming.	
	Zooms in horizontally, during or after streaming.	
	Zooms out horizontally, during or after streaming.	
	Adds ten points to the currently selected data set, while in the <i>Export</i> menu.	
	Subtracts ten points from the currently selected data set, while in the <i>Export</i> menu.	
	Opens the Sensor Setup menu.	
	Opens the Unit Setup menu.	
	After one or more vertical zooms,  returns to the original view of the current data stream.	
	After vertical zooms on multiple streams,   returns all streams to their original views.	
	Numeric keys 1-4 can be used to select channels 1-4 for tracing.	

Mathematical details: zoom, pan, and trace

Table 4-6 and Table 4-7 elaborate on how zooming and panning work. Table 4-8 concludes the section with an explanation of tracing.

Table 4-6 Zoom






Application Feature	Key	Description
Zoom		The horizontal center line remains fixed, but the window contracts vertically. Y_{max} decreases and Y_{min} increases in such a way that their average remains the same. The graph appears to stretch out. If the graph is not centered vertically, the graph may drift as well as stretch.
Zoom		Like Zoom  , the horizontal center line remains fixed, but the view dilates vertically. Y_{max} increases and Y_{min} decreases in such a way that their average remains the same. The graph appears to shrink vertically. Again, if the graph is not centered vertically, it may drift as it shrinks as well.
Zoom		<i>Zoom in horizontally:</i> decreases the time duration represented by the window's width. The current tracer position remains fixed. X_{min} increases and X_{max} decreases accordingly. If data is streaming, the appearance is that the data stream speeds up (increases the "current" of the stream). If streaming has stopped, the appearance is a dynamically increasing horizontal dilation about the vertical segment $X=X_{tracer}$, where X_{tracer} is the x-coordinate of the current tracer location.
Zoom		<i>Zoom out horizontally:</i> increases the time duration represented by the window's width. The current tracer position remains fixed. X_{min} decreases and X_{max} increases accordingly. If data is streaming, the appearance is that the data stream slows down (decreases the "current" of the stream). If streaming has stopped, the appearance is a dynamic horizontal contraction of the data with respect to the vertical segment $X=X_{tracer}$. Once the data stream has contracted to the point where it all fits in the display, continuing to zoom in contracts with respect to the left edge of the display. Zooming out horizontally will eventually stop with data still visible in a handful of pixel columns.

Table 4-7 Pan







Application Feature	Key	Description
Pan		Moves the stream upwards. The values of Ymax and Ymin are decreased by equal amounts.
Pan		Moves the stream downwards. The values of Ymax and Ymin are increased by equal amounts.
Pan		Moves the stream to the right. The values of Xmin and Xmax are decreased by equal amounts.
Pan		Moves the stream to the left. The values of Xmin and Xmax are increased by equal amounts.

Table 4-8 Trace

Application Feature	Key	Description
Trace		Moves the trace cursor along the data stream, from pixel to pixel, to the right. The values of X-Min and X-Max only change if the cursor traces beyond the right edge of the display.
Trace		Moves the trace cursor along the data stream, from pixel to pixel, to the left. The values of X-Min and X-Max only change if the cursor traces beyond the left edge of the display.

Warranty, Regulatory, and Contact Information

Battery notices

For information about removing a battery, refer to the user guide included with the product.

WARNING! Risk of explosion if battery is replaced by an incorrect type. Dispose of used batteries according to the instructions.

WARNING! To reduce the risk of fire or burns, do not disassemble, crush, or puncture; do not short external contacts; do not dispose of in fire or water.

WARNING! Keep the battery away from children.

WARNING! To reduce potential safety issues, only the battery provided with the StreamSmart 410, a replacement battery provided by HP, or a compatible battery purchased as an accessory from HP should be used with the product.

WARNING! Risk of explosion if battery is replaced by an incorrect type. Dispose of used batteries according to the instructions.

Charging the battery

WARNING! Before beginning, plug the StreamSmart 410 into your computer with the mini USB to USB cable that came in the package with your HP graphing calculator. You will need to charge the unit for approximately five hours. Your computer must be running for charging to occur. **DO NOT** use the cable attached to the StreamSmart 410 for charging.

WARNING! Do not try and replace the battery pack. The battery pack is not removable. If you have problems charging the unit, contact the manufacturer using the contact information listed below. If handled improperly, batteries can burst or explode, releasing hazardous chemicals.

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This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at personal expense.

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Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods in order to maintain compliance with FCC Rules and Regulations.

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The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Hewlett-Packard Company may void the user's authority to operate the equipment.

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Products bearing the CE marking comply with the following EU Directives:

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- EMC Directive 2004/108/EC
- Ecodesign Directive 2009/125/EC, where applicable

CE compliance of this product is valid if powered with the correct CE-marked AC adapter provided by HP. Compliance with these directives implies conformity to applicable harmonized European standards (European Norms) that are listed in the EU Declaration of Conformity issued by HP for this product or product family and available (in English only) either within the product documentation or at the following web site: www.hp.eu/certificates (type the product number in the search field). The compliance is indicated by one of the following conformity markings placed on the product:



For non-telecommunications products and for EU harmonized telecommunications products, such as Bluetooth® within power class below 10mW.



For EU non-harmonized telecommunications products (If applicable, a 4-digit notified body number is inserted between **CE** and **!**).

Please refer to the regulatory label provided on the product. The point of contact for regulatory matters is: Hewlett-Packard GmbH, Dept./MS: HQ-TRE, Herrenberger Strasse 140, 71034 Boeblingen, GERMANY.

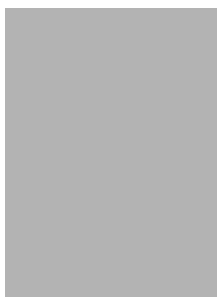
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This symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or the shop where you purchased the product.

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In addition to the one year hardware warranty, your HP calculator also comes with one year of technical support. If you need assistance with warranty, please refer to the warranty information on the product CD. HP customer care can be reached by either email or telephone. Before calling please locate the call center nearest you from the list provided. Have your proof of purchase and calculator serial number ready when you call. Telephone numbers are subject to change, and local and national telephone rates may apply. A complete list is available on the web at: www.hp.com/support.

Contact Information

Table 5-9 Contact Information

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Antigua	1-800-711-2884	Argentina	0-800-555-5000
Aruba	800-8000; 800-711-2884	Austria Österreich	01 360 277 1203
Bahamas	1-800-711-2884	Barbados	1-800-711-2884
Belgique (Français)	02 620 00 85	Belgium (English)	02 620 00 86
Bermuda	1-800-711-2884	Bolivia	800-100-193
Botswana	www.hp.com/support	Brazil Brasil	0-800-709-7751
British Virgin Islands	1-800-711-2884	Bulgaria	www.hp.com/support
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Chile	800-360-999	China 中国	800-820-9669
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