HP StreamSmart 410 User Guide

For use with the HP 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 graphing calculator with the StreamSmart application. 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.

Туре	Description	Example
Stream	Displays a live time graph (data stream) for up to four sensors simultaneously, at rates up to 5,700 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.

Table 1-1 Types of experiments

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 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 Application Library in the HP 39/ 40gs, and the StreamSmart application is located in the APPS menu in the 50g. The user runs the HP Mobile Calculating Laboratory via the StreamSmart application on the HP 39/40gs and HP 50g graphing calculators. Please check online at www.hp.com/calculators to ensure you have the latest version of the StreamSmart application. See Figure below for instructions on accessing the application.



Figure 1-2 The StreamSmart Application on the HP 39/40gs and HP 50g

HP Mobile Calculating Laboratory

4. Stream

 Once the StreamSmart application 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 (HP 39/40gs) or START (HP 50g) 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 Windows for the HP 39/40gs and the HP 50g

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 can be accessed on the HP 39/40gs via the Views menu by pressing $\overline{\rm VEWS}.$

View	Name/Key(s)	/Key(s) Description	
Chilmsc. Hanilu.US MMMP WWA x:1.9755 Chan Lean - Iscopel Stop Figure 1-4 Plot View	Plot PLOT	 View up to four data streams graphically as time graphs Perform streaming experiments See Chapter 2, <i>Streaming Experiments</i> for details 	
(H1:MICROPHONE0232 (H4:CURRENT (MR) 8.736 800 [Setup[Probe] unit stop stat Figure 1-5 Numeric View	Numeric	 View up to four sensors numerically in a meter Perform selected events and events-with-entry experiments See Chapter 3, Capturing Data from Events for details 	
STREAMER PLOT SETUP NENG 10 PLOT DISPLAY: Stack DISPLAY FILTER: Average EXPORT FILTER: Average EXPORT FILTER: Auto ENTER MINIMUM HORIZONTAL VALUE ENTER FILTER: Average FIGURE 1-6 Plot Setup, pg 1	Plot Setup (page 1) SHIFT (PLOT	 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, Advanced Topics for details 	
STREAMER PLOT SETUP HISTORY TYPE: Fixed HISTORY: 14.479 CHOOSE HOW DATA IS SAVED CHOOSE A PROFE Figure 1-7 Plot Setup, pg 2	Plot Setup (page 2) PtiGE T	 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, Advanced Topics for details 	
Z1: PH CPH) Z2: Temp. (C) 3: 4: 4: Chrightodsi Canal ok Figure 1-8 Sensor Setup	Sensor Setup	 Select/deselect each channel's sensor Manually identify a sensor from a list of supported sensors 	

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

The HP 50g

The application for the HP 50g is structured similarly to that of the HP 39/40gs, with minor differences in how you access the functions. Table 1-3 below lists the standard application views and their use for the HP 50g.

To access these views, press APPS, highlight the StreamSmart application and press the OK menu key.

View	Name/Key(s) Description	
Khi: Light (tx) Win:5.0s x:2.525s y:13.49 tx Struct Promitrance/detralstate Figure 1-9 Plot View	Plot (Graph)	 View up to four data streams graphically as time graphs Perform streaming experiments See Chapter 2, Streaming Experiments for details
CHITLIGHT (1x) 13.45 ETUR I AND IPLATIQUAT Figure 1-10 Numeric View	Numeric XETER (menu key)	 View up to four sensors numerically in a meter Perform selected events and events-with-entry experiments See Chapter 3, <i>Capturing Data</i> from Events for details
Plot View Setup () Store 5. Plot Display: Stock Display Filter: Average Export Filter: Average Nistory Type: Fixed Nistory Type: Fixed Nistory Type: Fixed Nistory Type: Fixed Figure 1-11 Plot Setup	Plot Setup	 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 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, Advanced Topics for details
Isonsor Setup 23: Light 600 1x 23: Not Connected 23: Not Connected 24: Not Connected 24: Not Connected 24: Not Connected 25: Not Connected 26: Not Connected	Sensor Setup (T F6 (Table)	 Activate and deactivate individual channels from the four channels of the StreamSmart 410 See Chapter 4, Advanced Topics for details

Table 1-3 Streamsmart standard views for HP 50g

Additional StreamSmart 410 views

In addition to these standard application views, the Views menu on the HP 39/ 40gs also contains views specific to the StreamSmart application. These views can be found on the 50g via the **SETUP** menu key once you have opened the StreamSmart application. Details on these views can be found in Chapter 4, *Advanced Topics*.

View	Name/Key(s)	Description
21: Accel. (9) 22: Accel. (9) 3: -4: ✓CHK[CHODS] (ANKL) OK Figure 1-13 Unit Setup	Unit Setup	 Activate/ deactivate channels Select a unit of measurement for sensors with multiple units of measurement available
CH1:MICROPHONE0244 CH4:CURRENT (MA)3113 ADD [SETUP PROBE] UNIT [START] STAT Figure 1-14 Calibrate	Calibrate	 Select a sensor's channel for software calibration of the sensor Perform 1-point or 2-point software calibration of the selected sensor
EXPERIMENT LENGTH: 10 SAMPLES: 100 ENTER LENGTH OF EXPERIMENT (SEC) EDIT CANCLE OK Figure 1-15 Experiment	Experiment	 Perform data logging experiments with a set duration (length in seconds) and set number of samples

Table 1-4 Additional StreamSmart 410 views

The Statistics application

The StreamSmart application works seamlessly with the Statistics Aplet with the 39/40gs to provide you all the tools you need to collect and analyze data. With the HP 50g, the same functionality is provided by a statistics application. StreamSmart does the collection of the data and selection of a final data set for analysis, then exports the data directly to the Statistics Aplet, or Σ DAT, where additional graphing and analysis occurs.

Once you select the data you want to analyze, the data is sent to columns in the Statistics Aplet or Σ **DAT**. The Statistics application 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 and Σ DAT, 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 environment of the HP graphing calculator. 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. For more information about statistics on the HP 50g, refer to the HP 50g User's Guide.

Comparison of HP 39/40gs and HP 50g

The table below summarizes the differences between the HP 39/40gs and the HP 50g calculators for data streaming.

View	HP 39/40gs	HP 50g
Start the SS410 application	Press (APLET) , StreamSmart, START	Press APPS StreamSmart,
Plot View	Press PLOT, STREET	Press 🕤 F3 (Graph), 🛛 🛙 🕅
Numeric View	Press NUM, STHRT	In Plot View, press METER, or press
Plot Setup View	Press SHIFT PLOT	Press 🕤 F2 (Win)
Sensor Setup View	Press SHIFT NUM	Press 🕤 F1 (Y=)
Additional Views	Press VIEWS	In Plot View, press
Oscilloscope View	Press PLOT, SCOPE	In Plot View, press (NXT), SCOPE
Views Menu	Press VIEWS	Press MODE to enter Views menu
Sensor Setup	Press ^(VIEWS) and select Sensor Setup	Press 🕤 F1 (Y=)
Unit Setup	Press ^(VIEWS) and select Unit Setup	Press (2D/3D)
Calibrate a sensor	Press ^(VIEWS) and select Calibrate	Press (STO) to calibrate

Table 1-5 Comparison of HP 39/40gs and HP 50g

Manual conventions

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

- Functions on the keyboard appear in their own special font. For example, the ENTER key appears as [NTR]. Shifted functions will be referenced both by the function name and the key combination required; for example, [NTR] [PLOT] (Plot Setup).
- 2. The HP 39/40gs and 50g 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 **EULT**.
- 3. The StreamSmart application 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 application:

- On the HP 39/40gs, at any time, you can reset the **StreamSmart** Aplet by pressing the APLET key on the keyboard and the **GESET** menu key. When prompted, press **START** for a new data stream.
- On the HP 50g, reset the StreamSmart application by pressing the **EANCL** key to reset. Press the APPS key, highlight **StreamSmart**, and press **DK**.
- The **DK** menu key is interchangeable with the **MB** key; the **CHNCL** menu key and the **ON** keys are also interchangeable.
- When navigating a list of options in a menu on the HP 39/40gs, 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. The key takes you backwards through the list of items.

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 calculator serial port, (press the **ON** button if the green light is not illuminated) and then press the **STREE** (HP 39/40gs) or **DK** (HP 50g) menu key. When you start the StreamSmart application and press the **STREE** or **DK** menu keys, 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.

Although very similar to the 50g, the application information described below is specific to the HP 39/40gs models. For a summary of the differences among the HP 50g and HP 39/40gs calculators, refer to the information listed in Table 1-5 in Chapter 1.

Table 2-1 Streaming experiment flow

Display	Description
Ch: 1 Hat: Han: 10.03 MMM/WWWWW/45 WWWWWWMMMM x: 5, 357 s GRAN FRANCI SCOPEL STOP I Figure 2-2 Stream	 How I got there: Press APLET Streamsmart ENTER STHET What I see on screen: 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

What I can do:

- 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

Display

Description

How I got there: • Press STOP EXPRT

- What I see on screen:
 - Data streams
 - Current channel and sensor, with tracer active

Figure 2-3 Select, page 1

- Selected data set, based on the current channel, and the number of data points ready for export
- Current tracer coordinates

What I can do:

- 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



How I got there:

Press

What I see on screen:

• Same as page 1, but with different menu keys

Figure 2-4 Select, page 2

What I can do:

- 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
CH 1: 01 2 CH 2: C2 2 CH 1: 01 2 CH 2: C2 2 CH 1: C3 2 CH 4: C4 2 TIME: C5 2 OPEN STAT APLET COLUMN FOR CHANNEL 1 ENTRY 2 CHINGEDOD Figure 2-5 Export	 How I got there: Press Press Press What I see on screen: 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 application after data export or following your data into the Statistics application

What I can do:

- CHK: select or deselect each channel for data export
- CHOOS: 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

n Ci	C2	CS	C4
1.0396	.709677 .658847	2000/02002000000	
3 .0414 4 .0423	. 419355		
6 0441	:31280s		
.0396			
EDIT INS	SERT	RIG 200	R=ISTRIA

Figure 2-6 Analyze the Data

What I can do:

- Scroll through the table of data using O, O, O, and O
- Graph data using VEWS 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 application is started with one or more sensors and the StreamSmart 410 attached, the StreamSmart application 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.

How I got there:

• Press **DE** and then press any key

What I see on screen:

Numeric view of the Statistics application, with data in columns

The StreamSmart application first tries to identify the attached sensors and makes several decisions based on the characteristics of the sensors. The StreamSmart application sets the vertical scales for each data stream based on the units of the sensor and the initial readings. The StreamSmart application 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 application 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 up to 5,700 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 application 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 **DUM** and **PHN** to modify the appearance of the streams. **SCUPE** 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. **SCUPE** 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. **SCUPE** 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

Ch1: Mic.	Win:0.1s
www	~~~~~~
mmm	&www.we
X : 5 . 468 s Chan i 200m i trat	y:-0.0898 ⊡≣XIANNANAN ►

Figure 2-8 After Streaming

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

Table	2-2	Streaming	menu	keys,	paqe	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 /200M	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.
200M	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, Advanced Topics 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.
EXPRT	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 (O, O, O, and O). Only one function is active at a time, its active status indicated by a small square after the function name. For example, **TRICO** 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.

Menu Key		Description
200M		 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
200M		 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		 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		 Move the current, selected stream up and down in the display Useful to separate or superimpose the streams for viewing purposes
TRACE		Moves left or right from pixel to pixel in the current, selected data streamDisplays timestamp and sensor data
TRACE		 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

Table 2-3	Functions	controlled	by the	direction	keys
-----------	-----------	------------	--------	-----------	------

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 MRE, the StreamSmart application 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 application displays the change in both x and y between the mark and the current tracer location (see Figure 2-9). Press SLATP 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 **FUD** 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.

Menu Key	Description
MRK	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 HDD is pressed.
ADD	Adds the current data point to the default columns in the Statistics application.
•	Returns to the previous page of menu keys.

Table 2-4 Menu keys, page 2

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 **EXERT** 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 **ECO** and **ECO** at 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.

Menu Key	Description
E	Toggles left-cropping on and off. Use 🕑 and ④ to move the left-crop bar. Data to the left of the bar is excluded from the final data set.
]	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 2-5 Export Data Menu Keys, page 1

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.

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.
4	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.

EXPORT TO STATISTICS
∠сні: Від с ніг: С2
⊻снз⊧СЗ ⊻снч⊧С4
⊻TIME: C5 🖌 OPEN STAT APLET
COLUMN FOR CHANNEL 1 ENTRY
V CHKICHOOSI I ICANCLI OK

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 tour channels and the time are selected for export. Press **CHIE** 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 **CHIE** menu key to change the current column to any of the ten columns in the Statistics application. At any time, you can press **CHIE** to ignore the changes you made and return to your data set, or press **DIE** 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.

Field	Menu Key	Description		
CH1 CH2 CH3	√ СНК	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.		
Time	THOOS	Opens a dropdown box with the names of the columns in the Statistics application (C1, C2, C3C9, and C0). Choose any column as the destination for the data from this channel.		
Open Stat application Open Stat internation Open Stat opened after do of the data will return to the Stru- streaming after		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 application and data streaming after the data is exported.		

Table 2-7	Export me	enu dialog	box options
-----------	-----------	------------	-------------

Analyze data

The following section refers specifically to the HP 39/40gs. 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	******	200000000000	
5	0405	.658847			
ų,	: ŏ423	.419355			
5	- 2432	.30694			
	.0111	. 3100/3			
.0396					
EDIT INS SORT BIG EVAR-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 () and () to move from column to column; use () and () to navigate through the data in a column.

One key to understanding the Statistics Aplet is the **LVHR**/**LVHR** menu key. Press this key to toggle between 1-variable and 2-variable statistics. If set to **LVHR**, you are studying the data column by column; if set to **LVHR**, you are studying the relationship between any two columns of data. Press SMB to enter the Symbolic view of the Aplet and define which columns to study. With *1-VAR* mode active, the Symbolic view lets you define up to five histograms or box-and-whisker plots. Each plot can take one column for its data and another for its frequency, or one column for the data and a common frequency you enter manually. With *2-VAR* mode active, the Symbolic view lets you define up to five scatter plots. Press SHFT SMB (Plot Setup) to select a fit model for each scatter plot.

The easiest way to see a graph of your data is to press **WEW** and select the **Autoscale** option. If your graph is a scatter plot, press **MENU** and then **FIT** to see the fit model plotted with your data. The views of the Statistics Aplet are summarized in Table 2-8 and Table 2-9. For more information, please refer to your HP Calculator's user guide.

Symbolic	Plot	Numeric
8EU#STATISTICS SYMBOLIC VIEW ✓ S1: DI ✓ Fit1: m*X+b S2: Fit2: m*X+b ENTER INDEPENDENT EOIT I ✓ CHRICCI ISHORI EVAL	+ + + 51(1):1.5 MEND	
Figure 2-14 Define an Analysis	Figure 2-15 Statistical Plot	Figure 2-16 Table of Values

Table 2-8 Views in the Statistics Aplet

Table 2-9 Shifted Views in the Statistics Aplet

Symbolic Setup SHIFT SYMB	Plot Setup SHIFT PLOT
EDUSTATISTICS SYMBOLIC SETUP ANGLE MEASURE: Radians SIFIT:Linear SEFIT:LogFit SFFIT:ExPFit SYFIT:Power SFFIT: IFIGIT CHOOSE STATISTICS MODEL TYPE	SEUSSISSTATISTICS PLOT SETUP XRNG: 455 YRNG: 333333, 5, 2 Simark: # Semark: & Simark: # Symark: :: Semark: X Enter Minimum Horizontal Value Edit Page #
Figure 2-17 Choose Fits	Figure 2-18 Setup the Graph

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 speeds 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 application 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.

View	Description
GAPTURE EVENTS TO STATISTICS CH 1: C2 ZCH 2: C3 ENTRY: C1 ZCH 3: C4 ZCH 4: C5 EVENT METHOD: Auto Number COLUMN FOR CHANNEL 1 ENTRY ZCHRICHODS Figure 3-2 Set up Experiment	How I got there: • Press WM ETUT What I see on screen: • The Capture Events Menu
What I can do:	
• Select or deselect any of the four c	hannels for data export purposes
• Choose a column for storing the do	ata from each active channel
Choose a column for manually add	ding 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
CH1:CURRENT (A)	How I got there:
2.15 CH4:VOLTAGE (V) 1.465	• Press (www) key What I see on screen:
	• Up to four sensors and their units
ADD ISETUPIPROBELUNIT I STAT I	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



How I got there:

Press STHT

What I see on screen:

• Numeric view of data in the Statistics application

Figure 3-4 Analyze Data

What I can do:

- Scroll through the table of data using ⓐ, ⊙, ④, and ⊙
- Graph data using VEWS 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 application. To use the Numeric View, attach at least one sensor to the StreamSmart 410 and connect the StreamSmart 410 to your HP graphing calculator. Start the StreamSmart application and press the **Numeric** (Second a numerical entry) (SECEND on the HP 50g). Press the **STRENT** menu key to begin monitoring the sensor(s). 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.

CH1:MICROPHONE	0232
CH4:CURRENT (MA)	8.736
ADD SETUP PROBE UN	IIT STOP STAT

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	 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	 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, Set up experiment
SENSOR	Manually identify a sensorSee Chapter 4, Advanced Topics
UNIT	Choose units of measurement for each sensorSee Chapter 4, Advanced Topics
STAT	 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 **HDD** 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 **NOD**. 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.

∭CAPTURE EVENTS TO STATISTICS∭ ∠CH 1: C1 ∠CH 2: C2 ENTRY: C5
∠сн в: СЗ ∠сн ч: С4
EVENT METHOD: Event Only
METHOD FOR ENTRY
VCHK[CHOOS] (AN(L) OK

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 **MDD**. 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.

Menu Key	Description
🖌 СНК	Toggles the selected channel off and on.
CHOOS	 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	 Accept changes made in the Capture Events menu and return to the Numeric view.
CANCL	 Cancel changes made in the Capture Events menu, keep the previous configuration, and return to the Numeric view.

Tuble 3-3 Mente Reys III Ine Cupiole Lyenis mente	Table 3-3	Menu	keys	in the	Capture	Events	menu
---	-----------	------	------	--------	---------	--------	------

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**.

CAPTURE EVENTS TO STATISTICS ∠CH 1: C1 ∠CH 2: C2 ENTRY: C3 _CH 3: C4 _CH 4: C5 EVENT METHOD: With Entry COLUMN FOR CHANNEL 2 ENTRY METHODS

Figure 3-7 An Events-with-Entry Setup

In Figure 3-7, **C2** is highlighted as the destination for data from the sensor in Channel 2 of the StreamSmart 410. Pressing **CHS** now will deselect Channel 2 for exporting data. Pressing the **CHDE** menu key drops down a list of **C1** through **C9**, and **C0**, from which you can choose any other column for the data from the sensor in Channel 2.

In Figure 3-8, the **EVENT METHOD** field is highlighted, showing that **With Entry** has been selected. You may choose to have the events auto-numbered or skip adding any numerical entries to the events (**Event Only**). Press the **EULOS** menu key to make a selection from these three options, as shown in Figure 3-9.

∭CAPTURE EVENTS TO STATISTICS∭ ∠CH 1: C1 ∠CH 2: C2 ENTRY:C3			
_сн з: С4 _сн ч: С5			
EVENT METHOD: With Entry			
METHOD FOR ENTRY Z CHRICHODS			

Figure 3-8 Event Method Field

EAE¥ 5 CH 5 CH 5 CH	PTURE EVENTS TO STATISTI Event Only With Entry Auto Number	cs C2 97
METH	OD FOR ENTRY (ANKL)	OK

Figure 3-9 Event Method Options

Press **DK** to accept all your changes at any time, or the **EANCL** menu key to cancel all changes; either way, you will return to the *Numeric* view.

Monitor and select events

Once you have activated the proper channels and set destinations for the data from these channels, you are ready to begin collecting data. Of course, you can always just start by collecting data using the default columns. To capture an event, just press the **MOD** menu key. If you have selected to capture events only, or to have them auto-numbered, you will see a display similar to the one depicted in Figure 3-10, which shows that your event data are being added to the current data set. If you have selected to add events to your entry, the display will appear as shown in Figure 3-11, prompting you to add your numerical entry to the event just captured.



ENTRY:	ENTER 1	ENTR	/ 1	***
ENTER ENT Edit	RY FOR	THIS	EVENT 1 CANCL DR	:

Figure 3-11 With Entry



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 **VEWS Experiment** to enter the *Experiment* menu.
- 2. Set LENGTH to 3 seconds and SAMPLES to 50.
- 3. Press **DK** 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 application is designed to automatically identify a Fourier \mathbb{R} 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 **VEWS** and select the **Sensor Setup** option on the HP 39/40gs, as shown in Figure 4-1; on the HP 50g, press **Destine** and select the **Sensor Setup** option.



Figure 4-1 Sensor Setup

SENSOR	SETUP
∠ı Accel.	59
∠≊Accel.	59
L≇ Not Conne	ected
9 Not Conne	ected
V CHKICHOOS	ICHNCL OK

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 **CIUUS** and select the appropriate force sensor option. In Figure 4-3, the **O-80 N Force** sensor option has been selected. Press **CIUS** 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 **CIUS** to finalize any changes and return to the StreamSmart application. Figure 4-5 shows the *Numeric* view with the new force sensor in Channel 1.



Unit setup: manually select units for a sensor

When the StreamSmart application 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 **VEWS** and select the **Unit Setup** option on the HP 39/40gs to open the *Unit Setup* dialog box. In the *Numeric* view, on the HP 39/40gs, you can simply press **UNIT**. On the HP 50g, press (2D/3D).

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 m/s²) 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/s²) instead. Press **CHODE** and select **Accel. (m/s²)**, as shown in Figure 4-7.

∠1: Force (N)	
∠² <mark>Accel. (</mark> 9)	
_ 3:	
_ 4:	
VCHKICHOOSI I ICANCLI OK	

Figure 4-6 Unit Setup Dialog Box



Figure 4-7 Select Units

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

Zl:Force (†	SETUP
∠²Rccel. •	(m/s²)
_ 3:	
- 4:	
a cus cunnel	

Figure 4-8 Unit Setup Dialog Box

CH1:FORCE (N)	-3.;	267
CH2:ACCELERATOR (M/SZ)	-26	.58
ADD SETUP PROBE UNIT	STAT	

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 application. 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 application 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:

- Press we 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.
- Given that the current reading is not correct and the correct reading is known, press VEWS and select the Calibrate option (see Figure 4-11).

CH1:ACCELERATOR (G)	6.408
ADD SETUPIPROBE UNIT	STAT



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 **IIII** 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 **DR** to return to the calibration screen.

CH1:ACCELERATOR (G)	6.408
ENTER 1 OR 2 POINTS. Press ok to accept. Press (ancl to abort.	
CHANII Z I IC	AN(L OK

Figure	4-12	Calibration	Screen

VALUE:	CALIBRATION
-6.433	I IGNCLI OK



- 4. 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.
- 5. Press 🚺 to enter a second point correction, or press 🛄 to make the 1point calibration effective (Figure 4-15). Of course, you can press **THNCL** to abort the calibration process.

ACCELERATOR (G)	-6.433
ENTER 1 OR 2 POINTS. Press ok to accept. Press (ancl to abort.	
1 . 2	CANCL

CH1:ACCELERATOR (G)	-6.433
ADD SETUP PROBE UNIT	STAT

Figure 4-14 First Point Correction Logged

The Plot Setup menu

=-		-	
	_		
AND ISETHBIBROREI HAIT I STAT			
- HER 19 CLAIM (19 DEC) AND 1 2101			

Figure 4-15 1-Point Calibration Effective

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 application 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 application is reset.

Plot display options

When performing experiments with multiple sensors, the StreamSmart application 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 swimlanes. Press **CHOPS** and select the **Overlay** option to see the streams superimposed, as in Figure 4-21.



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 Statistic 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 application 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 application uses the same values that the display used. This method ensures that the export filter is the same as the display filter.

The StreamSmart application 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 application is reset or another filtering method is chosen.



To choose a display filtering method:

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

XRNG Ø	PLOT SETUP
PLOT DISPLAY:	Stack
DISPLAY FILTER:	Average
EXPORT FILTER:	Auto
CHOOS PI	AGE 🔻 📔

Figure 4-27 Plot Setup Menu

XRN(Dispi Expo	∭STREAMER PLOT SETUP∭ Average Single Value Minimum Maximum	I
		OΚ

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 application, it is also filtered for export to the Statistics application.

To choose an export filtering method:

- 1. Press **SHFT POT** to enter the *Plot Setup* menu and use the **(**) key to highlight the **EXPORT FILTER** field.
- 2. Press the CHIIIS menu key to see the list of options.
- 3. Use 👁 and 🏵 to highlight your selection and press 💵.

Advanced Topics

 Press PLOT to return to the graphic view, and then press PLOT 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.

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 application exactly. The results of this filtering depends on your zoom level.

Table 4-2 Additional export filters

Data history

By default, StreamSmart 410 collects data from a single sensor at approximately 5,700 samples per second while streaming. At this rate, the StreamSmart application 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 application allocates memory to data streams via the **History** field in the second page of the *Plot Setup* menu. Press SHET E FILE 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 application 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 HUDE 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.

NISTORY TYPE: F1 HISTORY: 16	LOT SETUP ********* xed . 453
CHOOSE HOW DATA I Choos 🔺 Pag	S SAVED

Figure 4-29 Plot Setup Menu, page 2

HISTO	‱STRE RY TYP	AMER E:	PLOT i xei	SETUP G lass	
HISTI	Auto Fixe	ed i			
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Figure 4-30 Select History Type

Oscilloscope mode

While streaming data in the *Plot* view, the StreamSmart application provides you with the option of *Oscilloscope* mode. Press **SUPP** 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.

Menu Key	Description
ZOOM/ PAN	This key toggles between zooming and panning (scrolling) with the direction keys.
200M	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 Oscilloscope mode off and on.
START /STOP	This key toggles between start and stop. Press STUP 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 4-3 Oscilloscope menu keys, page 1

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.
_ 4 —	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.
4	Returns to the first page of the oscilloscope menu.

StreamSmart 410 and the virtual calculators

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

Keyboard shortcuts

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

Table 4-5 k	Keyboard	shortcuts
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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.
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	Figure 4-31 Figure 4-32 Figure 4-33
÷	Zooms in vertically, during or after streaming.
X	Zooms out vertically, during or after streaming.
Ŧ	Zooms in horizontally, during or after streaming.
	Zooms out horizontally, during or after streaming.
SHIFT +	Adds ten points to the currently selected data set, while in the <i>Export</i> menu.
SHIFT -	Subtracts ten points from the currently selected data set, while in the <i>Export</i> menu.
VARS	Opens the Sensor Setup menu.
MATH	Opens the Unit Setup menu.
DEL	After one or more vertical zooms, DEL returns to the original view of the current data stream.
DEL SHIFT	After vertical zooms on multiple streams, DEL SHIFT returns all streams to their original views.
-4	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	Кеу	Description
Zoom	٢	The horizontal center line remains fixed, but the window contracts vertically. Ymax decreases and Ymin 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. Ymax increases and Ymin 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	١	Zoom in horizontally: decreases the time duration represented by the window's width. The current tracer position remains fixed. Xmin increases and Xmax 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=Xtracer, where Xtracer is the x-coordinate of the current tracer location.
Zoom		Zoom out horizontally: increases the time duration represented by the window's width. The current tracer position remains fixed. Xmin decreases and Xmax 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=Xtracer. 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.

Application Feature	Кеу	Description
Pan	٢	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	ightarrow	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	۲	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.

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5 Warranty, Regulatory, and Contact Information

Battery notices

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 computer, a replacement battery provided by HP, or a compatible battery purchased as an accessory from HP should be used with the computer.

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! The battery pack is not removable. Do not try and replace the battery pack. 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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Limited Hardware Warranty Period

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Regulatory Information

Federal Communications Commission Notice

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 in a residential installation. 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. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

Cables

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.

Modifications

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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This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- 1. This device may not cause harmful interference
- This device must accept any interference received, including interference that may cause undesired operation.

If you have questions about the product that are not related to this declaration, write to:

Hewlett-Packard Company P. O. Box 692000, Mail Stop 530113 Houston, TX 77269-2000

For questions regarding this FCC declaration, write to:

Hewlett-Packard Company P. O. Box 692000, Mail Stop 510101 Houston, TX 77269-2000 or call HP at 281-514-3333

To identify your product, refer to the part, series, or model number located on the product.

Canadian Notice

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Avis Canadien

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

European Union Regulatory Notice

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

Low Voltage Directive 2006/95/EC

- EMC Directive 2004/108/EC
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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 **!**).

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Perchlorate Material - special handling may apply

This calculator's battery may contain perchlorate and may require special handling when recycled or disposed in California.

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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**.

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Costa Rica	0-800-011-0524	Croatia	www.hp.com/support	

Table 5-1 Contact Information

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US Virgin Islands	1-800-711-2884	United States	800-HP INVENT
Venezuela	0-800-474-68368 (0-800 HP INVENT)	Vietnam Viêt Nam	+65-6272-5300
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根据中国《电子信息产品污染控制管理办法》

	有毒有害物质或元素					
部件名称	铅 (Pb)	汞 (Hg)	偏(Cd)	六 价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCA	х	0	0	0	0	0
外觀豪 /字鍵	0	0	0	0	o	0
O:表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。						
X:表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求。						
表中标有"X"的所有音	『件都符合	欧盟RoHS	法规			
"欧洲议会和欧盟理事会2003年1月27日关于电子电器设备中限制使用某些有害物质的2002/95/EC						

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注:环保使用期限的参考标识取决于产品正常工作的温度和湿度等条件

Α

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