HP StreamSmart 410 User Guide

For use with the HP Prime Graphing Calculator

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1 HP MCL Introduction

The HP Mobile Calculating Laboratory (HP MCL) consists of one or more Fourier® sensors, an HP StreamSmart 410, and an HP Prime graphing calculator with the DataStreamer app. The HP MCL is used to collect and analyze real-world experimental data.

Types of supported experiments

The HP MCL supports a number of different types of experiments, as shown in Table 1-1 below.

Table 1-1 Types of supported experiments

Type	Description	Example
Stream	Displays a live time graph (data stream) for up to four sensors simultaneously. 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	DataStreamer 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 2 for details.	Take 20 temperature readings from a cooling cup of coffee for 10 minutes, taking one reading every 30 seconds.

Manual conventions

Throughout this manual, a few conventions have been employed to help you distinguish calculator keys from touch buttons and other on-screen options.

1. Calculator keys appear in their own special font. For example, the ENTER key appears as Enter. Shifted functions are referenced by both the required key combination and the function name; for example, Shift Symb (Symbolic Setup).
2. The HP Prime calculators employ menus of context-sensitive touch buttons that appear along the bottom of the display. The touch buttons in these menus are represented with special graphics; for example, ZOOM appears as Zoom.
3. The DataStreamer app also employs dialog boxes and input forms. The field names in these are shown in bold type. For example, the field name XRNG is shown in bold as **X Rng**.
4. Screen captures are provided to guide you, though your display may vary slightly from the figures shown.
5. In multi-step procedures, steps are numbered.

Helpful hints

Remember these helpful hints and shortcuts as you use the DataStreamer app:

- You can reset the DataStreamer app at any time by pressing Apps then tapping Reset. When prompted, tap OK. Tap Start to restart the app; tap Start for a new data stream.
- OK is interchangeable with Enter.

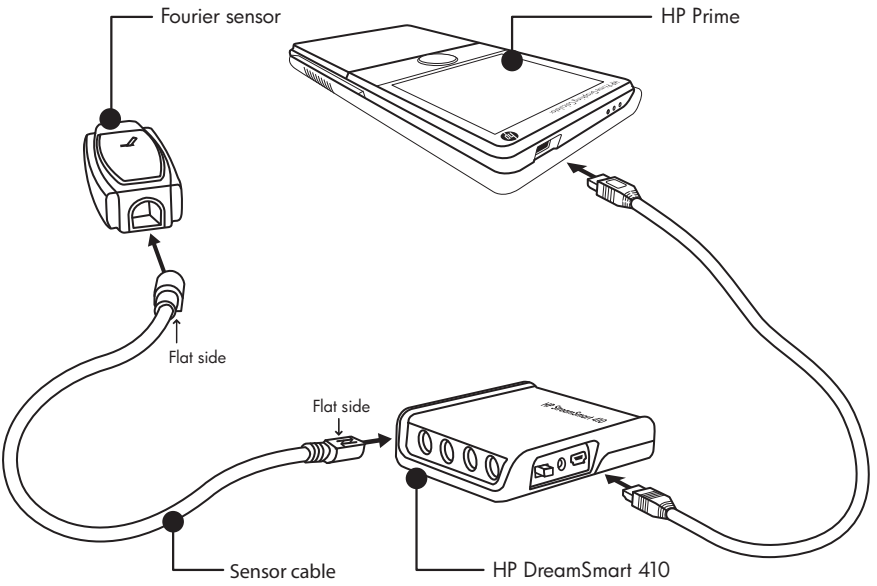
1. Charge

Charge the unit. **IMPORTANT!** Before beginning, plug the StreamSmart 410 into your computer with the mini-USB to USB cable that came with your HP StreamSmart 410. 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.

2. Connect

Connect a Fourier® sensor to the StreamSmart 410 using the sensor cable. The figure below shows the Fourier® light intensity sensor, but any supported sensor connects in a similar manner. 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 to the HP Prime graphing calculator using the mini-USB to micro-USB cable that came with your HP StreamSmart 410. Turn on both the calculator and the StreamSmart 410.



Connect the HP MCL

3. Launch

The HP MCL is controlled via the DataStreamer app. See the figure below for instructions on accessing the app.

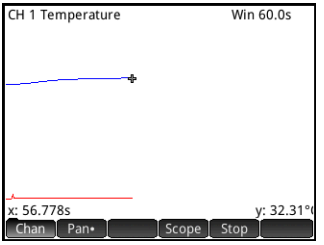
The DataStreamer app

4. Stream

The DataStreamer app starts in the Plot view. You will see the message, **Waiting for connection...**, quickly followed by a second message, **Waiting to start...**. When this second message appears, tap Start to start streaming data. 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 view displays a number of other items, as illustrated in the figure below

.



The Plot view

The DataStreamer app

The DataStreamer app has the standard Plot and Numeric views, like most of the other HP Prime apps. Table 1-2 below lists the views and their uses in the DataStreamer app. The standard Symbolic view is not used by the DataStreamer app.

Table 1-2 DataStreamer app views

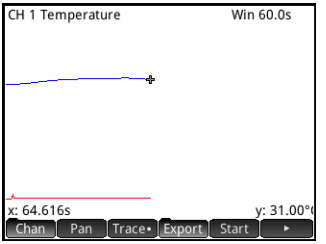
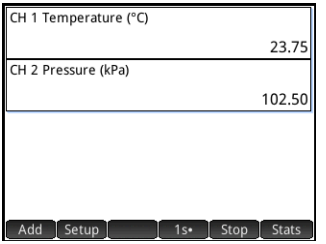
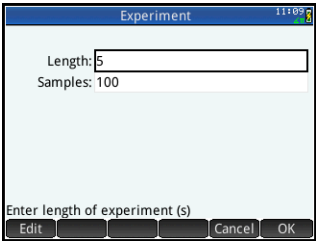
View	Display
Plot view Press Plot Setup.	
• View up to four data streams graphically as time graphs • Perform streaming experiments • See Chapter 2 for details	
Numeric view Press Num Setup.	
• View up to four sensors numerically in a meter • Perform selected events and events-with-entry experiments • See Chapter 3 for details	

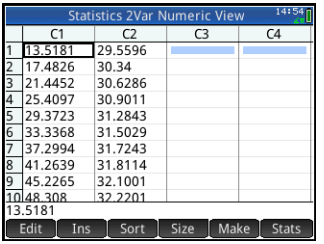
Table 1-2 DataStreamer app views

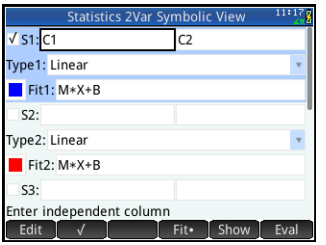
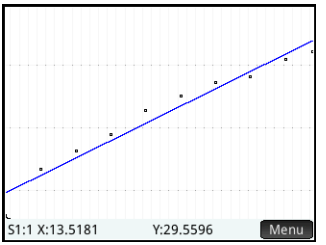
View	Display
Experiment Press View Copy, select **Experiment**, and tap OK. • Set up a data logging experiment with a set duration (in seconds) and set number of samples • The experiment then runs in the Plot view like a streaming experiment • See Chapter 2 for details	

The Statistics apps

After you have selected the data you want to analyze, you send it to either the Statistics 1Var or the Statistics 2Var app. The Statistics 1Var and Statistics 2Var apps can perform 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. Table 1-3 summarizes the main views of the Statistics 2Var app; the Statistics 1Var app has similar views for studying univariate data. See the *HP Prime Quick Start Guide* for details.

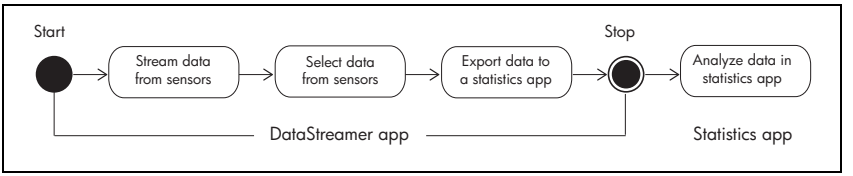
Table 1-3 Statistics 2Var app views

View	Display
Numeric view Press Apps Info and select **Statistics 2Var**. Press Num Setup to return to this view at any time. • View numerical data in columns • Calculate summary statistics for the data	

View	Display
Symbolic view Press Symb Setup. • Choose columns of data for analysis • Choose a fit type	
Plot view Press Plot Setup or Press View Copy and select **Autoscale**. • View and trace the scatter plot and the fit of your data	

2 Streaming Experiments

In streaming experiments, data is collected in real time in up to four separate streams. A streaming experiment is illustrated conceptually in the figure below.



As the data streams across the screen, you can modify how you view the stream(s). Since all four streams share the same horizontal time axis, you can speed the streams up or slow them down simultaneously. Since each stream has its own vertical axis, you can move each stream up or down separately and zoom in or out on each stream vertically. 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 discrete section of the stream(s) to examine more closely.

Streaming overview summarizes the flow of streaming experiments in a table. Each section of the table corresponds to one of the bubbles in the figure above. Use this table for quick reference. The sections after Table 2-1 elaborate on each step. Refer to these sections for more detailed information on streaming, selecting, exporting, and analyzing data.

Streaming overview

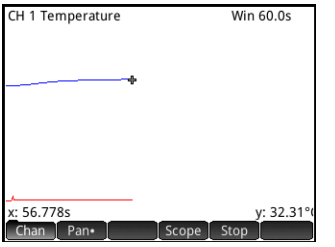
When you start the DataStreamer app, it opens in the Plot view, ready to start streaming data. Press Plot to return to Plot view at any time. Since the sensors are identified and the window is set for you automatically, all you need to do is tap Start.

Table 2-1 summarizes how to collect, export and analyze data.

Table 2-1 Streaming overview

View	Display
Plot view, streaming	Stream Data

Press Apps, select **Datastreamer**, and when DataStreamer opens, tap Start to begin streaming.



What you see:

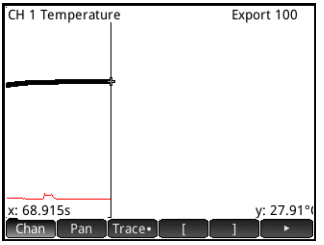
- Up to four data streams displayed graphically in real time
- Channel number, sensor type, and screen width expressed in seconds
- Cursor coordinates showing current sensor time and reading

Button	Description
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
Start / Stop	Stop stream flow or start a new stream

Tap Start to start streaming. When you see the data you want, tap Stop to stop streaming. Tap Export to select just the data you want.

View	Display
Plot view, page 1 of Export menu	Select Data

Tap Stop then Export.

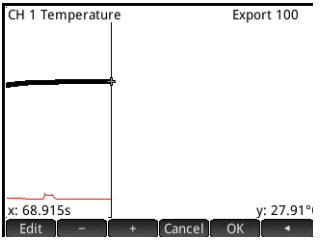


What you see:

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

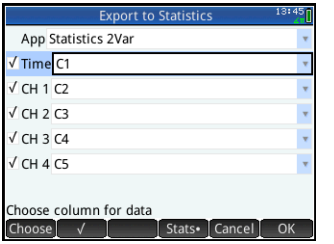
Button	Description
Zoom, Pan•, Trace•	Zoom, pan, and trace to navigate the data streams and find data of interest
[/]	Crop left and crop right
▸	(next page) to see more functions

Tap ▸.



Plot view, page 2 of Export menu

Button	Description
Edit	Choose a set number of samples between two chosen time values
Cancel	Return to the data streams without saving changes
OK	Export the current data set to one of the statistics apps
◂	(previous page) to return to page 1

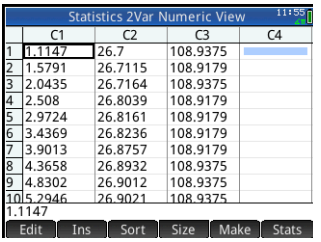
View	Display
Tap Trace• and trace to the area that contains your data. Use Zoom and Pan• to expand the data until it nearly fills the display. Use [and] to crop data from the left and the right. Once you have the data you want, tap OK to export the data for analysis.	
Export to Statistics view Tap OK from page 2 of the Export menu in Plot view.	Export Data 

What you see:

- Options for choosing the destination for the data you wish to export and analyze

Field	Description
App	Use Choose to select Statistics 1Var or Statistics 2Var as the app to which you will export your data
Time	Choose a destination column for the data timestamps
CH 1–CH 4	Choose columns for the data from channels 1–4 of the StreamSmart 410 and select or deselect each one for export

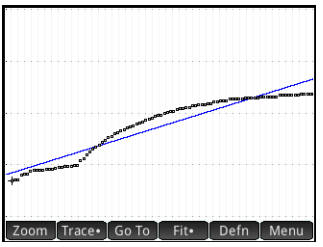
Button	Description
Choose	Choose destination columns for the data from each sensor
√	Select or deselect each channel for data export
Stats / Stats•	Choose between following your data to the selected statistics app or remaining in the DataStreamer app after data is exported
Cancel	Return to the original data set without saving changes
OK	Export the data to the selected statistics app

View	Display
Select the Statistics 1Var or Statistics 2Var app as the destination for your data. Choose the columns where your data and the timestamps will be stored. Tap OK to continue and you will see your data in the Numeric view of the selected statistics app.	
Statistics 2Var Numeric view Tap OK.	Analyze Data (numerically) 

What you see:

- Your data arranged in columns

Key or Button	Description
Stats	View summary statistics (tap OK to return to Numeric view from summary statistics)
Num Setup	Return to the Numeric view at any time

Statistics 2Var Plot view Press View Copy and select **Auto Scale**.	Analyze Data (graphically) 

What you see:

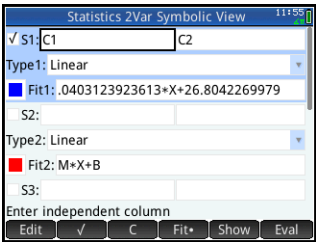
- Scatter plot of your data and your selected fit (if any)

Key or Button	Description
◀ ▶	Trace the scatter plot or the fit

View	Display
▲ ▼	Switch between the scatter plot and the fit
Menu	Open the Plot view menu for zooming, tracing, etc.
Plot	Return to the Plot view at any time

Statistics 2Var Symbolic view — Analyze Data

Press Symb.



What you see:

- Five 2-variable analyses, named S1–S5
- The default analysis defined in S1, with:
  - Independent data in C1
  - Dependent data in C2
  - Linear model chosen as the fit

Key or Button	Description
Edit	Open an edit box to enter column names for your data (C1–C9 and C0)
√	Select or deselect S1–S5 for plotting
C	A typing aid for entering the letter *C*
Fit•	Toggle plotting the fit on and off
Show	Display the fit equation in textbook format
Eval	Resolve references (in a user-defined fit)
Symb	Return to the Symbolic view at any time

See the *HP Prime Quick Start Guide* for more details on the Statistics 2Var and Statistics 1Var apps.

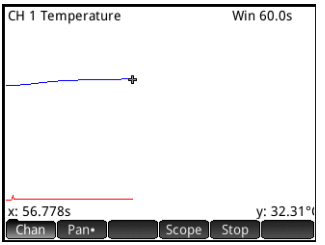
Stream data

Once you tap Start in the Plot view, the DataStreamer app 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. The time represented by the width of the display is shown in the upper right corner and changes as you zoom in and out horizontally. Because only one stream may be traced at a time, the display also identifies the current data stream channel, sensor and cursor coordinates.

The DataStreamer app first tries to identify the attached sensors and makes several decisions based on the characteristics of the sensors. The DataStreamer app sets the vertical scales for each data stream based on the units of the sensor and the initial readings. The DataStreamer app 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 while the data is streaming.

Since the DataStreamer app collects thousands of sample readings from the sensor(s) every second, each pixel in a data stream actually represents a set of data points. It is only when you zoom all the way in that each pixel represents exactly one data point. You can zoom in on the data stream to make each pixel represent a smaller data set or zoom out on the data stream to make each pixel represent a larger data set. By default, the DataStreamer app averages the readings in each pixel column data set to arrive at a y-value to plot for that column. Although the data are averaged for graphing purposes, you still have access to all the data.

The figures below illustrate the location and basic functions of the Plot view main menu during and just after streaming. Once you stop the stream, there are three additional touch buttons available: Trace•, Export, and ▸.



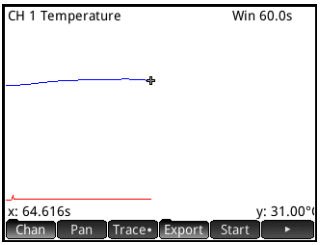


Table 2-2 below describes page 1 of the Plot view main menu during and just after streaming.

Table 2-2 Plot view main menu, page 1

Button	Description
Chan	This button 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. You can also use the calculator keys numbered 1 to 4 to select a channel.
Pan• / Zoom	This button is a toggle that determines how the direction keys function. Tap this button to toggle between *Pan* and *Zoom*. The active mode is indicated by a small white dot after the button name.
Pan•	When PAN is in active mode, use 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 stream. You can pan (scroll) the streams vertically to separate or superimpose them.
Zoom•	When ZOOM is in active mode, use the direction keys to zoom 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 stream. You can zoom in or out horizontally while data is streaming in, to control the speed of the data streams.
Scope	This button 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.
Export	This button replaces Scope after streaming is stopped. It opens the Export menu, where you can find the buttons for isolating and selecting a final data set to export to one of the statistics apps.
Start / Stop	This toggle starts and stops data streaming. Stopping the streams permits exploration of the data and selection of a final data set for export. Start deletes any current data set and starts a new set of streams.
Trace•	When TRACE is active, use the direction keys to trace along the selected data stream.
▸	This button takes you to page 2 of the Plot view main menu.

ZOOM, PAN, and TRACE are touch button toggles that work in conjunction with the direction keys (▲, ▼, ◀, and ▶). Only one function is active at a time. Active status is indicated by a small white dot after the function name. For example, Pan• means that panning (scrolling) is active and the direction keys will be used to scroll the stream(s) within the display.

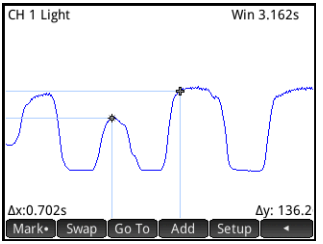
Table 2-3 below describes how these combinations function.

Table 2-3 Zoom, pan and trace

Button and Key		Description
Zoom•	◀ ▶	• Zoom in/out horizontally on all streams simultaneously • 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 toggle to Zoom• to zoom in or out. • Press ▶ to zoom in horizontally, decreasing the amount of time represented by the width of the display • Press ◀ to zoom out horizontally, increasing the amount of time represented by the width of the display
Zoom•	▲ ▼	• Zoom in/out vertically on the current stream • Press ▲ to zoom in and press ▼ to zoom out • Decrease/increase the vertical scale, in sensor units, of the current 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 stream up and down in the display • Separate or superimpose the streams for viewing purposes
Trace•	◀ ▶	• Move left or right from pixel to pixel in the current, selected data stream • Display timestamp and sensor data

Besides navigating and tracing the data set to find data of interest, DataStreamer also lets you compare any two points in a single stream and manually add a data point to a data set. These features are found on page 2 of the Plot view main menu, which is only accessible after 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 tap Mark, the DataStreamer app 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 DataStreamer app displays the change in both x and y between the mark and the current tracer location as shown in the figure below. Tap Swap to switch the tracer and mark locations.



ADD and SETUP are used together when you want to build your final data set point by point. For example, suppose a data stream represents a light flashing at different intensities. In this case, you may want to collect just the maxima of the intensities into a data set. Tap Setup to choose a statistics app and columns 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. Tap Add to add the data point to your data set in the statistics app you chose; DataStreamer briefly displays a icon indicating that your data point is being added to the data set. Continue in this fashion until you have collected all the points you want. Start your chosen statistics app to view and analyze your data.

Table 2-4 describes page 2 of the Plot view main menu.

Table 2-4 Plot view main menu, page 2

Button	Description
Mark	This button toggles MARK mode on and off, setting a mark at the current tracer position, or erasing the mark.
Swap	This button switches the positions of the mark and the tracer.
Go To	This button lets you to jump to a specific time along the current stream.
Add	This button adds the current tracer data point to your data set.

Table 2-4 Plot view main menu, page 2

Button	Description
Setup	This button takes you to the Export to Statistics dialog box, where you can set the destination columns for data you are adding.
◂	This button takes you back to page 1 of the Plot view main menu.

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 touch button opens the Export menu in the Plot view. 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 [and] to crop data off the left and right sides of the data set. You can also thin the data by subtracting points; if you change your mind, you can add them back.

The following tables describe the new touch buttons available on the two pages of the Export menu.

Table 2-5 Export menu, page 1

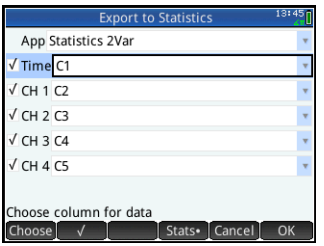
Button	Description
[	This button toggles left-cropping on and off. When there is a small white dot on this button ([•), use ▶ and ◀ to move the left-crop bar. Data to the left of the bar is excluded from the final data set.
]	This button toggles right-cropping on and off. When there is a small white dot on this button (]•), use ◀ and ▶ to move the right-crop bar. Data to the right of the bar is excluded from the final data set.
▸	This button takes you to page 2 of the Export menu.

Table 2-6 Export menu, page 2

Button	Description
Edit	This button opens a dialog box where you can select a specific number of data points between two time values for export to one of the statistics apps.
Cancel	This button closes the Export menu and returns to the Plot view main menu.
OK	This button exports the current data set to the selected statistics app and deletes all other data.
◂	This button takes you back to page 1 of the Export menu.

Export data

From the Export menu in Plot view, tap OK to open the Export to Statistics dialog box as shown in the figure below.



There are six fields in the Export to Statistics dialog box: one for the statistics app that is the destination for the data, one for the timestamp associated with each data point, and four for the StreamSmart 410 channels. The four channel fields, (**CH 1**, **CH 2**, **CH 3**, and **CH 4**) and the **Time** field are each preceded by a checkbox. The checkbox allows you to select or deselect the data from each channel for export. By default, all four channels and the time are selected for export. Tap √ to toggle between selecting and deselecting a channel. By default, data from each channel appears in a particular column in the selected statistics app. If you want to change the default column for data from a channel, select the channel then tap Choose to change to another of the columns available in the statistics apps. At any time, you can tap Cancel to cancel the changes you made and return to your data set, or tap OK to export the data. Once your data set is exported, all the other data from your experiment is deleted.

Table 2-7 summarizes the fields and touch buttons in the Export to Statistics dialog box

Table 2-7 The Export to Statistics dialog box

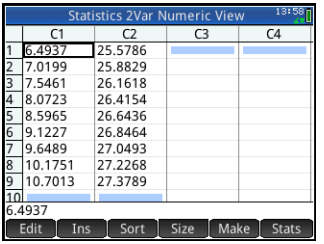
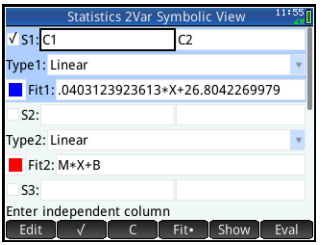
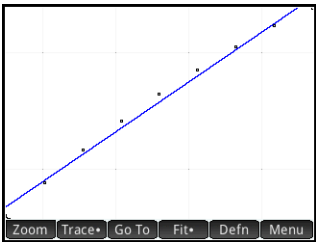
Field	Description
App	Choose to export your data to the Statistics 1Var or Statistics 2Var app, or to a saved app based on one of these apps.
Time	Choose a column for the data timestamps and select or deselect this data for export.
CH 1–CH 4	Choose columns for the data and select or deselect each data stream for export.
Button	**Description**
Choose	This button opens a drop-down box to make a choice for the selected field.
√	This button toggles between selecting and deselecting a field for export.
Stats•	This button toggles between remaining in the DataStreamer app and following your data into the selected statistics app. The white dot after STATS indicates that you wish to follow the data and launch the statistics app chosen in the **App** field.
Cancel	This button takes you back to the Plot view without saving any changes.
OK	This button saves all changes and exports the data as indicated.

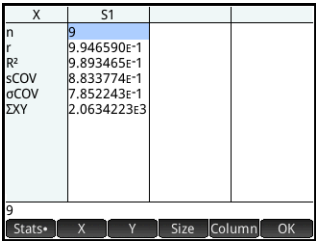
Analyze data

The DataStreamer app provides minimal facilities for examining and analyzing data, as most of this work is done in the Statistics 1Var and Statistics 2Var apps after the data is exported there. The Statistics 1Var and Statistics 2Var apps let 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 the *HP Prime Quick Start Guide*, so it is not repeated here. However, this section contains a brief summary of the views of the Statistics 1Var and Statistics 2Var apps.

Table 2-8 below uses the Statistics 2Var app to illustrate the views in the statistics apps.

Table 2-8 Views in the statistics apps

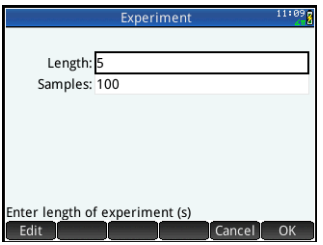
View	Display
Numeric view Press Num Setup.	
The Numeric view shows your columns of data arranged in a table. Although only four columns are displayed, there are actually ten columns available. Press ▶ and ◀ to move from column to column; press ▼ and ▲ to navigate through the data in a column. Tap Stats to view summary statistics for your data set.	
Symbolic view Press Symb Setup.	
In the Symbolic view you can define up to five statistical analyses to perform on data from particular columns. In the Statistics 2Var app (shown above), the analyses are named **S1** to **S5.** In the Statistics 1Var app, the analyses are named **H1** to **H5.**	
Plot view Press Plot Setup. or Press View Copy and select **Auto scale**.	

View	Display
The easiest way to get a good view of your data is to use the **Auto scale** option. Press ▶ and ◀ to trace the scatter plot and the fit. Press ▼ and ▲ to switch between the scatter plot and the fit. The Plot view in the Statistics 2Var app with a linear fit is shown above. In the Statistics 1Var app, the Plot view would show histograms, box-and-whisker plots, and other 1-variable statistical plots.	
Numeric view STATS Press Num then tap Stats.	
Press ▼ and ▲ to navigate the summary statistics. Tap OK to return to the Numeric view of the app. The Numeric view STATS in the Statistics 2Var app is shown above. In the Statistics 1Var app, this view would contain the 5-number summary of the data.	

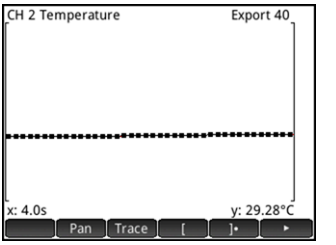
Data logging

Under certain circumstances, you might want to run an experiment for a particular duration and collect a particular number of samples. You can do this in the StreamSmart 410 with the **Experiment** option.

1. Press View, select **Experiment**, and tap OK to open the Experiment dialog box.



2. Select **Length**, tap Edit, change the experiment length to 4 seconds, then tap OK. Then select **Samples**, tap Edit, change the number of samples to 40, then tap OK. Tap OK to close the dialog box.
3. When the **Experiment** dialog box closes, you are returned to the Plot view. Tap Start to start logging data.



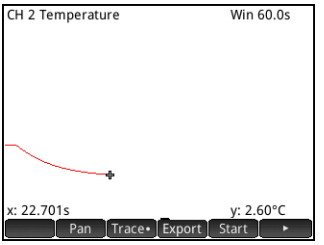
Data collected from each sensor is shown as a stream, just like a streaming experiment, but DataStreamer will only collect the specified number of points over the specified period. The figure above shows 40 data points have been collected (**Export: 40**) and the trace cursor readout at the far left of the screen shows that the elapsed time is approximately 4.0 seconds (**x:4.0s**). You can then select and export a final data set, just like you would in a streaming experiment. Refer to the section Select data in Chapter 2 for more details on selecting and exporting a data set.

Streaming experiment example

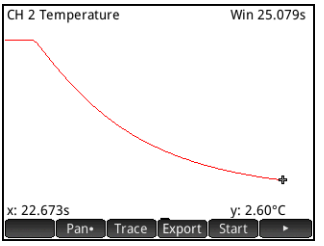
In the following experiment, a temperature sensor is placed in ice water. Connect the HP Prime, the temperature sensor and the StreamSmart 410 as shown in the figure on Page 2. There is an arrow on the plug for the temperature sensor. This arrow faces up when plugged into the StreamSmart 410.

1. Press Apps and select **DataStreamer**. The DataStreamer app opens in Plot view with the message "**Waiting to start…**"

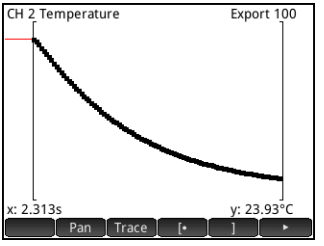
2. Tap Start to begin data streaming.
3. Once you see the data stream, place the temperature sensor in the glass of ice water and stir it constantly. Collect data until the temperature falls below 4°C, then tap Stop.



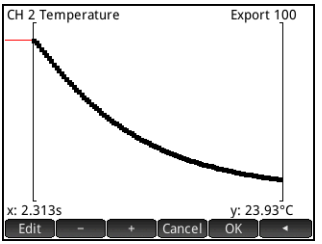
4. Toggle from Pan• to Zoom• and press ▶ and ▲ to zoom in until the data stream fills the display well.



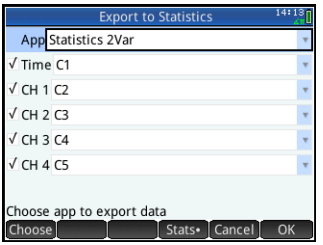
5. Tap Export then [. Press ▶ to move the left crop bar to the right to delete the data that corresponds to the time period before you placed the sensor in the ice water.



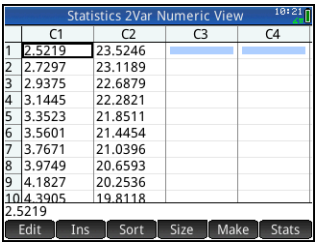
6. Tap ▶ to access page 2 of the Export menu. Tap OK to export your selected data.



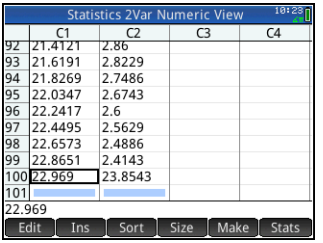
7. In the Export to Statistics dialog box, check to make sure that the **App** field is set to **Statistics 2Var**. If it is not, highlight the **App** field, tap Choose, select **Statistics 2Var** and tap OK. You can leave the rest of the fields with their default settings.

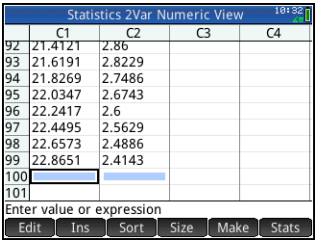


8. Tap OK. You will leave the Data Streamer app and open the Statistics 2Var app. The Statistics 2Var app opens in the Numeric view.

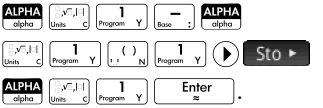


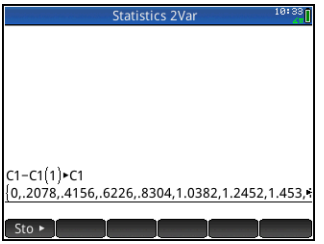
9. The last data point may be incorrect. Press Shift and ▼ to move to the last data point. Press Del to delete the value in column C2. Then press ◀ to move across to column C1 and press Del to delete the value there as well.



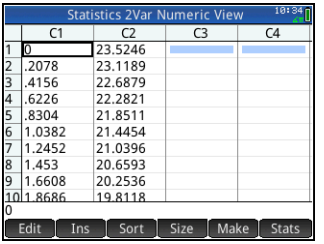


10. We want to reset the initial time value so that it is zero. Press Settings to enter the home view and enter C1–C1(1)►C1 by pressing the following:

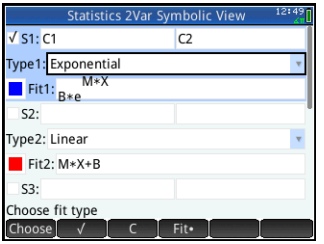




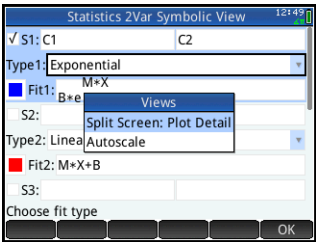
11. Press Num Setup to return to the Numeric view. **C1(1)** should now have a value of zero.



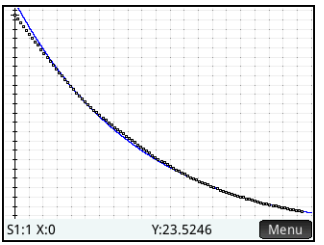
12. Press Symb Setup to enter the Symbolic view. Highlight the **Type1** field and change it to **Exponential**. Do this by pressing + Ans : to cycle through the options or tapping Choose and selecting **Exponential**.



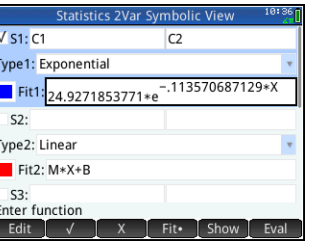
13. Press View Copy and select **Autoscale**.



14. The Plot view opens with both the scatter plot of our data and the exponential fit. Tap Menu to open the Plot view menu, with options to zoom, trace, etc.



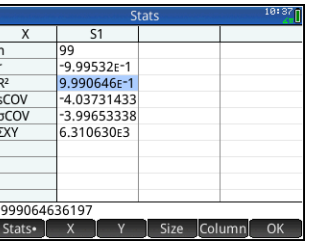
15. Press Symb Setup to return to the Symbolic view. Highlight **Fit1** and tap Show to see the equation of our fit in textbook format. Tap OK to return to the Symbolic view. The equation for our fit is of the form:



$$y = B \cdot e^{m \cdot x}$$

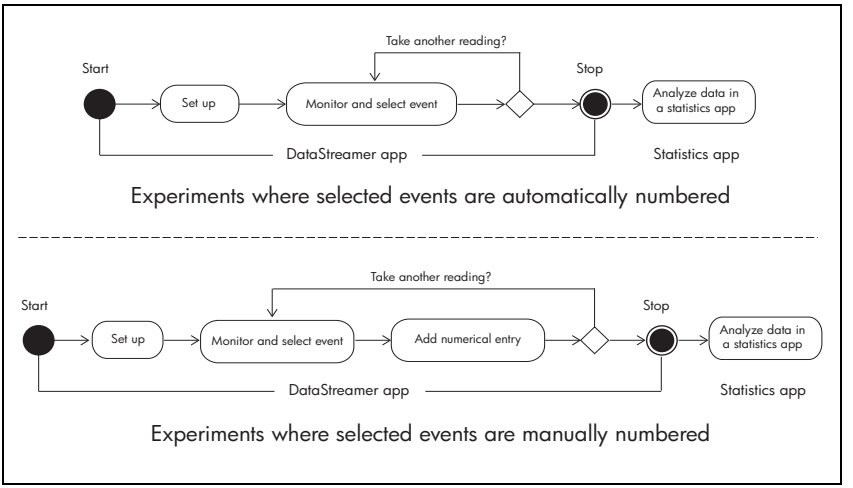
The value of B indicates the model's prediction of the temperature of the sensor just before it was submerged in the ice water. Your fit equation will differ from that shown in the figure above.

16. Press Num Setup to return to the Numeric view. Tap Stats to view the summary statistics for our data. The value of R^2 indicates the percentage of the variation in the data which can be explained by our fit. Your summary will have different values.



3 Selected Events Experiments

In this chapter, we show you how to take a few discrete sample readings from up to four sensors at a time and collect them into a data set for analysis. The DataStreamer app lets you capture data at any point in time and have the data point exported to a data set in one of the statistics apps. By default, the readings are auto-numbered in the order in which they are collected, but you can add a numerical entry to each reading when it is taken. The figure below summarizes the steps involved in these types of experiments.



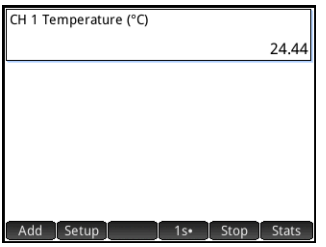
Selected Events Overview gives a brief summary, with each bubble explained in a section of Table 3-1. Pages 33–35 give more detailed information on each bubble. The chapter ends with a sample events-with-entry experiment.

Selected events overview

Whether you choose to auto-number your selected events or add a numerical entry to each event, experiments involving a series of distinct events usually start in the Numeric view of the DataStreamer app. To access the Numeric view with the DataStreamer app running, press Num. The Numeric view displays the current reading for each attached sensor. The readings are updated periodically.

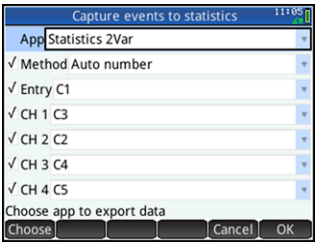
Table 3-1 illustrates the flow of a selected events experiment.

Table 3-1 Overview of selected events experiments

View	Display
Numeric view Press Num 1=Setup.	Start 

What you see:

Button	Description
Setup	Open the Capture Events to Statistics dialog box
1s	Toggle the sensor read-out refresh rate between 0.5, 1, and 1.5 seconds (after sensor read-out starts)
Start	Start reading sensor data
Stats	Leave the DataStreamer app and open the selected statistics app

Capture events to statistics dialog box Tap Setup.	Setup 

What you see:

- Options for choosing the destination for the data you wish to export and analyze

Field	Description
App	Use Choose to select Statistics 1Var or Statistics 2Var as the app to store your data for analysis
Method	Use Choose to select auto-numbering or adding a numerical entry to each data point

View	Display
Entry	Choose a column for the entry (or auto-numbering) and use √ to select or deselect it for export
CH 1–CH 4	Choose columns for the data from channels 1 to 4 of the StreamSmart 410 and select or deselect each one for export

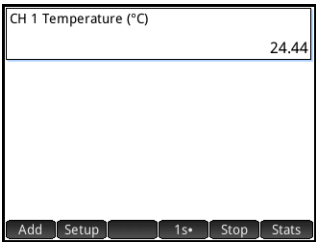
Button	Description
Choose	Open a drop-down box to make a selection
√	Select or deselect each channel for data export
Cancel	Return to the Numeric view without saving changes
OK	Save the setup changes and return to the Numeric view

When you have made your changes, tap OK to save the changes and return to the Numeric view or tap Cancel to return to the Numeric view without saving your changes.

Numeric view

Press Num then tap Start.

Monitor and Select Events



What you see:

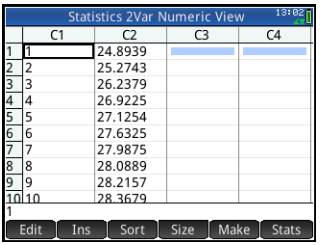
- Numeric read-out for each connected sensor

Button	Description
Add	Add the current sensor readings to your data set
Setup	Open the **Capture events to statistics** dialog box
1s	Toggle the refresh rate between 0.5, 1, and1.5 seconds
Stop	Stop reading sensor data
Stats	Leave the DataStreamer app and open the selected statistics app

Tap Add to keep adding current sensor readings to your data set until it is complete. Then tap Stats to analyze your completed data set in the selected statistics app.

View	Display
Statistics 2Var Numeric view	Analyze Data (numerically)

Tap Stats in the Numeric view of the DataStreamer app.



What you see:

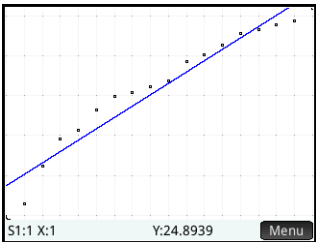
- Your data displayed in columns

Key or Button	Description
Stats	Display summary statistics for your data
Num ↵Setup	Return to the Numeric view at any time

Tap Stats in the Numeric view to view summary statistics for your data set.
Press OK to return to the Numeric view from summary statistics.

Statistics 2Var Plot view	Analyze Data (graphically)

Press View Copy and select **Autoscale**.



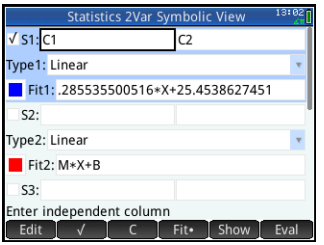
What you see:

- A scatter plot of your data with a linear fit

Key or Button	Description
◀ ▶	Trace the scatter plot or the fit
▲ ▼	Switch between the scatter plot and the fit
Menu	Open the Plot view menu for zooming, tracing, etc.

View	Display
Plot Setup	Return to the Plot view at any time
Statistics 2Var Symbolic view	Analyze Data

Press Symb Setup.



What you see:

- Five 2-variable analyses, named S1–S5
- The default analysis defined in S1, with:
  - Independent data in C1
  - Dependent data in C2
  - Linear model chosen as the fit

Key or Button	Description
Edit	Open an edit box to enter column names for your data (C1–C9 and C0)
√	Select or deselect S1 to S5 for plotting
C	A typing aid for entering the letter *C*
Fit•	Toggle plotting the fit on and off
Show	Display the fit equation in textbook format
Eval	Resolve references (in a user-defined fit)
Symb Setup	Return to the Symbolic view at any time

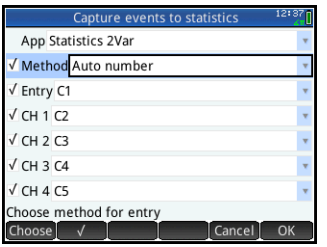
See the *HP Prime Quick Start Guide* for more details on the Statistics 2Var and Statistics 1Var apps.

Set up experiment

By default, tapping Add in the Numeric view will capture the current set of readings from sensors attached to channels 1 to 4 of the StreamSmart 410. The readings will be auto-numbered, and the auto-number will be stored in row 1 of

column **C1** in the Statistics 2Var app. The rest of the readings will be stored in row 1 of columns **C2** to **C5**, with the reading from the sensor in channel 1 stored in **C2**, the reading from the sensor in channel 2 stored in **C3**, and so on. The next time Add is tapped, the data will be stored in row 2 of these columns. This process can be continued indefinitely.

Tap Setup to enter the **Capture events to statistics** dialog box. From this dialog box you can set up where your data will be stored when you tap Add. You can choose to store it in either the Statistics 1Var app or the Statistics 2Var app, or any saved app based on one of these apps. You can also choose into which column in the selected statistics app the data from each channel is stored. In addition to choosing columns in which to store your data, you can also choose to add an entry to the data from each selected event. The figure below illustrates the **Capture events to statistics** dialog box.



In the figure above, data will be stored in the Statistics 2Var app, with the auto-number entries (1, 2, 3,…) stored in C1, the data from channel 1 (CH 1) stored in C2, and the data from channel 2 (CH 2) stored in C3. With **Method** highlighted as shown in the figure, you can tap Choose to change from **Auto number** to **With entry**, so you can add your own numerical entry to each selected event. You can also tap √ to deselect **Method** (and **Entry** as well) and omit sending the auto-number entries at all. Finally, you can tap OK to accept all changes and return to the Numeric view, or tap Cancel to close the dialog box without saving any changes.

Table 3-2 below describes each of the fields and touch buttons in the Capture events to statistics dialog box.

Table 3-2 **Capture events to statistics** dialog box

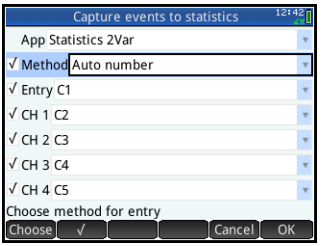
Field	Description
App	Choose the Statistics 1Var or Statistics 2Var app as the app to store your data for analysis.

Table 3-2 **Capture events to statistics** dialog box

Method	Choose to auto-number the data points or manually add a numerical entry to each data point.
Entry	Choose a column destination for the auto-numbered or user-supplied entries.
CH 1–CH 4	Choose column destinations for the data from channels 1 to 4 of the StreamSmart 410.
Button	**Description**
Choose	This button opens a choose box to make a selection. Use ▲ and ▼ to navigate the list, then tap OK to accept your selection and close the choose box.
√	This button selects and deselects a channel or entry for data export. Only channels (and entry) that are checked will have their data exported.
Cancel	This button closes the dialog box without making any changes and returns to the Numeric view.
OK	This button saves the changes, closes the dialog box, and returns 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. To capture an event's data in the Numeric view, tap Add. If you have selected to auto-number event data, you will see an icon that shows that your event data are being added to the current data set. If you have selected to add events to your entry, the Event to Statistics dialog box will appear as shown in the figure below, prompting you to add your numerical entry to the event just captured. Enter your numerical entry and tap OK. You will return to the Numeric view where you can continue adding data from subsequent events or tap Stats to open the selected statistics app to analyze your data.



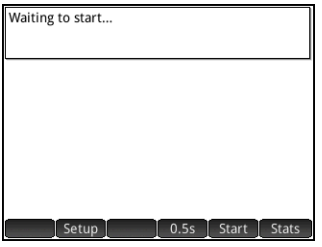
Analyze data

Once you have captured all your events, tap Stats to go to the statistics app where you selected to store your data. For a brief summary of the Statistics 2Var app, refer to the section titled, *Analyze data* in Chapter 2. For more complete information on both the Statistics 1Var and Statistics 2Var apps, please consult the *HP Prime Quick Start Guide*.

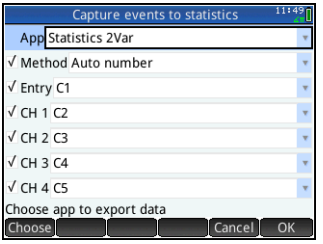
Selected events experiment example

In the following experiment, a temperature sensor is used to record the temperature in a room at various heights at 25 cm intervals. Connect the HP Prime, the temperature sensor and the StreamSmart 410 as shown in the figure on Page 2. There is an arrow on the plug for the temperature sensor. This arrow faces up when plugged into the StreamSmart 410.

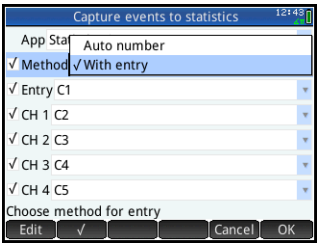
1. Press Apps and select **DataStreamer**. Press Num to enter the Numeric view. The Numeric view opens with the message "**Waiting to start…**"



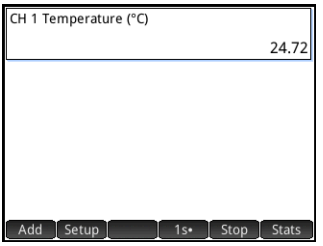
2. Tap Setup to open the Capture Events to Statistics dialog box. By default, our data will be stored in the Statistics 2Var app for analysis. Select the **Method** field.



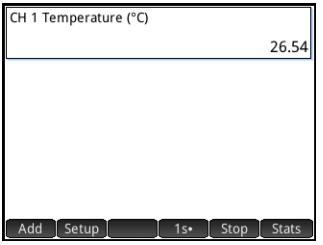
3. Since we want to enter the height in centimeters for each of our temperature readings, we will change the **Method** from **Auto number** to **With entry**. Select **Method**, tap Choose, select **With entry** and tap OK. Tap OK again to close the dialog box.

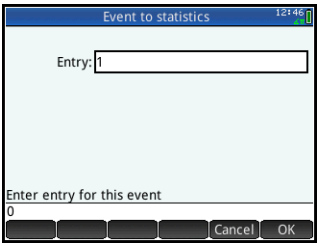


4. You will return to the Numeric view. Tap Start to start monitoring the current temperature. Press 1s• to toggle between taking readings every 0.5, 1.0, or 1.5 seconds.



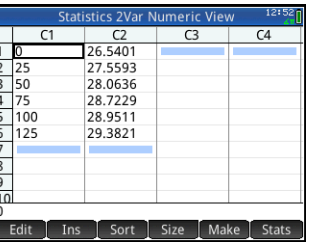
5. Place the sensor on the floor, wait until the reading stabilizes, and then tap Add. Since we chose to add an entry, the Event to Statistics dialog box opens. Enter 0 as the height of the sensor for the first reading and tap OK.



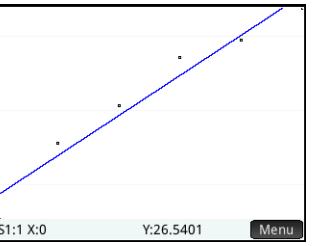


6. Repeat step 5 for sensor heights of 25, 50, 75, 100, and 125 cm.
7. Once you have recorded the 6 selected events, tap Stats to leave the DataStreamer app and open the Statistics 2Var app.

8. The Statistics 2Var app opens in the Numeric view, where we can see our six data points in a table. Use ◀, ▶, ▲, and ▼ to navigate the table. Tap Stats to see summary statistics for the bi-variate data in columns **C1** and **C2**. Tap OK when you are done.

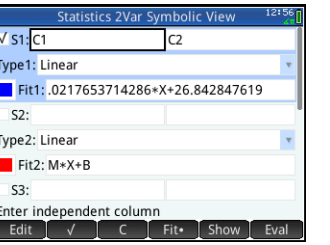


9. Press View Copy and select **Auto scale**. You will see a scatter plot of your data and the linear fit in the Plot view. Use ▶ and ◀ to trace the scatter plot or the fit. Use ▲ and ▼ to switch between the scatter plot and the fit.



10. Switch to tracing the linear fit. Suppose the ceiling of the room is at 3 m. What is our estimate of the temperature there? Tap Menu then Go To, enter 300, and tap OK. Tap Menu to read the predicted y-value of approximately 33.02°C. for x=300. Your value will differ from the one shown in the figure.

11. Press Symb Setup to enter the Symbolic view. Here you can see that the first analysis (**S1**) has been defined to use C1 as the independent data column and C2 as the dependent data column. Also, by default, a linear fit is used. The equation of the fit is shown as well.



The constant in the equation is the model's prediction of the floor temperature, while the slope is the model's estimate of the change in temperature per centimeter of height. Your values will differ from those shown. To choose a different fit type, select the **Type1** field, tap Choose, make a selection, and tap OK. When you return to the Plot view, you will see your new fit. When you return to the Symbolic view after this, you will see the equation of your new fit.

4 Troubleshooting

The table below lists solutions to frequently asked questions about the HP MCL and the DataStreamer app.

Table 4-1 FAQs

Question	Solutions
I connected the HP MCL as shown in the diagram on Page 2 and launched the DataStreamer app, but all I see is the message "**Streamer not connected…**". What should I do now?	1. First, check the cable connections from the HP Prime to the HP StreamSmart 410. 2. If checking the connections does not solve the problem, then disconnect the HP Prime from the StreamSmart 410. Wait until the green light on the HP StreamSmart 410 goes off, then reconnect. You must wait for the green light to go off before you can successfully reconnect the HP Prime and the HP StreamSmart 410.
I was using the HP MCL and was changing sensors or disconnecting and reconnecting the StreamSmart 410 when the DataStreamer app seemed to freeze up. Now the HP Prime does not respond to key presses. What should I do now?	1. First, insert the tip of a paper clip into the Reset hole on the back cover of the HP Prime. 2. If the simple reset does not work, then remove the batteries from the calculator and put them back in. 3. In either case, when you turn on the calculator, you may have to re-launch the DataStreamer app.

Table 4-1 FAQs

Question	Solutions
I am using the DataStreamer app and it seems to be running very slowly. What is wrong?	1. The DataStreamer app uses a lot of memory as it captures data in real time. As a result, it may slow down as the HP Prime memory fills up. To free up more memory for the app, delete large and unwanted items such as old notes, app data, and programs. 2. If you do not want to lose these large items, use the HP Connectivity Kit to transfer them to your PC first, then delete them on the HP Prime.
After I export my data to the Statistics 2Var app, I notice in the Numeric view that my last data point sometimes has a sensor reading that does not seem correct. What should I do?	1. Occasionally, the very last data point gets misread in a streaming experiment. If you suspect this is the case, then delete the last data point. This occurs only in certain streaming experiments and does not affect selected events and events with entry experiments.
I started the DataStreamer app with a sensor connected, but the DataStreamer app identifies it as some other sensor. What should I do?	1. Occasionally the DataStreamer app may identify a sensor incorrectly. In this case, tap Stop and then Start to force the app to try to identify the sensor again.

5 Regulatory 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! 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.

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 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.

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.

FCC operation notice

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, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

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- Low Voltage Directive 2006/95/EC
- EMC Directive 2004/108/EC
- Ecodesign Directive 2009/125/EC, where applicable
- RoHS Directive 2011/65/EU

CE compliance of this product is valid if powered with the correct CE-marked AC adapter provided by HP.

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Compliance is indicated by the CE-marking as shown below. Where applicable for telecommunications products a 4-digit notified body number may follow it as a suffix.

CE

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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VCCI-A

Korean Notice

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根据中国《电子信息产品污染控制管理办法》

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	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCA	X	O	O	O	O	O
外观景 /字键	O	O	O	O	O	O

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