TEXAS INSTRUMENTS

TI-*nspire*™

Data Collection and Analysis Guidebook

This guidebook applies to TI-Nspire™ software version 4.4. To obtain the latest version of the documentation, go to education.ti.com/guides.

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- Reorient or relocate the receiving antenna.
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- Consult the dealer or an experienced radio/TV technician for help.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

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Contents

Data Collection

The Vernier DataQuest™ application is built into the TI-Nspire™ software and the operating system (OS) for handhelds. The application lets you:

• Capture, view, and analyze real-world data using a TI-Nspire™ handheld, a Windows® computer, or a Mac® computer.

• Collect data from up to five connected sensors (three analog and two digital) using the TI-Nspire™ Lab Cradle.

  Important: The TI-Nspire™ CM-C Handheld is not compatible with the Lab Cradle and only supports the use of a single sensor at a time.

• Collect data either in the classroom or at remote locations using collection modes such as time-based or event-based.

• Collect several data runs for comparison.

• Create a graphical hypothesis using the Draw Prediction feature.

• Play back the data set to compare the outcome to the hypothesis.

• Analyze data using functions such as interpolation, tangential rate, or modeling.

• Send collected data to other TI-Nspire™ applications.

• Access sensor data from all connected sensor probes through your TI-Basic program.

Adding a Vernier DataQuest™ Page

Note: The application is launched automatically when you connect a sensor.

Starting a new document or problem for each new experiment ensures that the Vernier DataQuest™ application is set to its default values.

▶ To start a new document containing a data collection page:
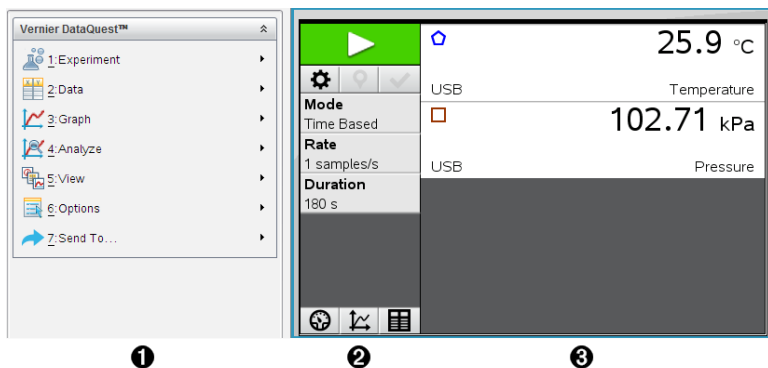
  From the main **File** menu, click **New Document**, and then click **Add Vernier DataQuest™**.

  Handheld: Press 〔🏠 on〕, and select **Vernier DataQuest™** 🧪.

▶ To insert a new problem with a data collection page into an existing document:

  From the toolbar, click **Insert > Problem>Vernier DataQuest™**.

  Handheld: Press 〔doc▾〕 and select **Insert > Problem > Vernier DataQuest™**.

❶   **Vernier DataQuest™ Menu.** Contains menu items for setup, collection, and analysis of sensor data.

❷   **Details view.** Contains buttons for starting data collection ▶, changing collection settings ⚙, marking collected data 📍, storing data sets ✔, and tabs for managing multiple data runs.

     View selection buttons let you choose from Meter view 🌐, Graph view 📈, or Table view ▦.

❸   **Data work area.** The information displayed here depends on the view.

     Meter. Displays a list of sensors that are currently connected or set up in advance.

     Graph. Displays collected data in a graphical representation, or displays the prediction before a data collection run.

     Table. Displays collected data in columns and rows.

What You Must Know

Basic Steps in Performing an Experiment

These basic steps are the same no matter which type of experiment you perform.

1. Start the Vernier DataQuest™ Application.
2. Connect sensors.
3. Modify sensor settings.
4. Select the collection mode and collection parameters.
5. Collect data.
6. Stop collecting data.
7. Store the data set.
8. Save the document to save all data sets in the experiment.
9. Analyze the data.

Sending Collected Data to Other TI-Nspire™ Applications

You can send collected data to the Graphs, Lists & Spreadsheet, and Data & Statistics applications.

▶ From the **Send To** menu, click the name of the application.

A new page showing the data is added to the current problem.

About Collection Devices

You can select from a variety of sensors and interfaces to collect data while running the Vernier DataQuest™ application with TI-Nspire™ software.

Multi-Channel Sensor Interfaces

Multi-channel sensor interfaces let you connect more than one sensor at a time.

Sensor Interface	Description
Texas Instruments TI-Nspire™ Lab Cradle	This sensor can be used with a handheld, a computer, or as a stand-alone sensor. The sensor interface allows you to connect and use one to five sensors at the same time. It can be used in the lab or at a remote collection location. The Lab Cradle supports two digital sensors and three analog sensors. The Lab Cradle also supports high-sample data collection sensors, such as a hand-grip heart rate or a blood pressure monitor. After using the Lab Cradle as a remote sensor, you can download data to either a handheld or computer.

Single-Channel Sensor Interfaces

Single-channel sensor interfaces can only connect to one sensor at a time. These sensors have either a mini-USB connector for a handheld or a standard USB connector for a computer. For a complete list of compatible sensors, see *Compatible Sensors*.

Sensor Interface	Description
Vernier EasyLink®	This sensor interface is used with handhelds. It has a mini-USB connector so it can be plugged directly into the handheld. Connect sensors to Vernier EasyLink® to: • Measure barometric pressure. • Measure the salinity of a solution. • Investigate the relationship between pressure and volume (Boyles' Law).
Vernier Go!Link®	This sensor interface is used with computers. It has a standard connector so it can be plugged into a Windows® or Mac® computer. Connect sensors to Vernier GoLink® to: • Measure the acidity or alkalinity of a solution. • Monitor greenhouse gases. • Measure sound level in decibels.

Types of Sensors

- **Analog sensors.** Temperature, light, pH, and voltage sensors are analog sensors and require a sensor interface.
- **Digital sensors.** Photogates, radiation monitors, and drop counters are digital sensors. These sensors can only be used with the TI-Nspire™ Lab Cradle.
- **Direct-connect USB sensors.** These sensors connect directly to a handheld or computer and do not require a sensor interface.

Sensors for Handhelds

The following lists some sensors you can use with a handheld.

Sensor	Description
Texas Instruments	This analog sensor connects directly to TI-Nspire™ handhelds through the mini-USB port. It is used to explore and graph motion. This sensor automatically launches the Vernier DataQuest™ application when you connect it to a handheld. Data collection begins when you select the Motion Match function. This sensor collects up to 200 samples per second. Use this sensor to: • Measure position and speed of a person or object.

Sensor	Description
CBR 2™	• Measure the acceleration of an object.

**Vernier EasyTemp®
temperature sensor** | This analog sensor connects directly to TI-Nspire™ handhelds through the mini-USB port and is used to collect temperature ranges. You can design experiments to:

• Collect weather data.

• Record temperature changes due to chemical reactions.

• Perform heat fusion studies. |

Sensors for Computers

The following table lists some sensors you can use with a computer.

Sensor	Description

**Vernier Go!Temp®
temperature sensor** | This analog sensor connects to the computer's USB port and is used to collect temperature ranges.

You can use this sensor to:

• Collect weather data.

• Record temperature changes due to chemical reactions.

• Perform heat fusion studies. |
|

**Vernier Go!Motion® motion
detector** | This analog sensor connects to the computer's USB port and is used to measure acceleration, speed, and velocity.

Use this sensor to:

• Measure position and speed of a person or object.

• Measure the acceleration of an object. |

Compatible Sensors

The following sensors can be used with the Vernier DataQuest™ application.

• 25-g Accelerometer

• 30-Volt Voltage Probe

- 3-Axis Accelerometer
- Low-g Accelerometer
- CBR 2™ - Connects directly to handheld USB port
- Go!Motion® - Connects directly to computer USB port
- Extra Long Temperature Probe
- Stainless Steel Temperature Probe
- Surface Temperature Sensor
- Ammonium Ion-Selective Electrode
- Anemometer
- Barometer
- Blood Pressure Sensor
- C02 Gas Sensor
- Calcium Ion-Selective Electrode
- Charge Sensor
- Chloride Ion-Selective Electrode
- Colorimeter
- Conductivity Probe
- High Current Sensor
- Current Probe
- Differential Voltage Probe
- Digital Radiation Monitor
- Dissolved Oxygen Sensor
- Dual-Range Force Sensor
- EasyTemp® - Connects directly to handheld USB port
- EKG Sensor
- Electrode Amplifier
- Flow Rate Sensor
- Force Plate
- Gas Pressure Sensor
- Go!Temp® - Connects directly to computer USB port
- Hand Dynamometer
- Hand-Grip Heart Rate Monitor
- Instrumentation Amplifier
- Light Sensor
- Magnetic Field Sensor

- Melt Station
- Microphone
- Nitrate Ion-Selective Electrode
- O2 Gas Sensor
- ORP Sensor
- pH Sensor
- Relative Humidity Sensor
- Respiration Monitor Belt (Requires Gas Pressure Sensor)
- Rotary Motion Sensor
- Salinity Sensor
- Soil Moisture Sensor
- Sound Level Meter
- Spirometer
- Thermocouple
- TI-Light - Sold only with the CBL 2™
- TI-Temp - Sold only with the CBL 2™
- TI-Voltage - Sold only with the CBL 2™
- Tris-Compatible Flat pH Sensor
- Turbidity Sensor
- UVA Sensor
- UVB Sensor
- Vernier Constant Current System
- Vernier Drop Counter
- Vernier Infrared Thermometer
- Vernier Motion Detector
- Vernier Photogate
- Voltage Probe
- Wide-Range Temperature Probe

Connecting Sensors

Direct-connect USB sensors, such as the Vernier Go!Temp® temperature sensor (for computers) or the Vernier EasyLink® temperature sensor (for handhelds), connect directly to the computer or handheld and do not need a sensor interface.

Other sensors require a sensor interface such as the TI-Nspire™ Lab Cradle.

Connecting Directly

▶ Attach the cable on the sensor directly to the computer's USB port or to an appropriate port on the handheld.

Connecting through a Sensor Interface

1. Attach the sensor to the sensor interface using either the mini-USB, USB, or BT connector and the appropriate cable.

2. Attach the interface to a computer or handheld using the appropriate connector and cable.

   Note: To attach a handheld to a TI-Nspire™ Lab Cradle, slide the handheld into the connector at the bottom of the Lab Cradle.

Setting Up an Offline Sensor

You can predefine meter settings for a sensor that is not currently attached to a computer or handheld.

You cannot use the sensor offline, but you can prepare the experiment for it and then attach it when ready to collect the data. This option makes it faster to share a sensor during a lesson or lab in which there are not enough sensors for everyone.

1. From the **Experiment** menu, select **Advanced Set Up > Configure Sensor > Add Offline Sensor**.

   The Select Sensor dialog box opens.
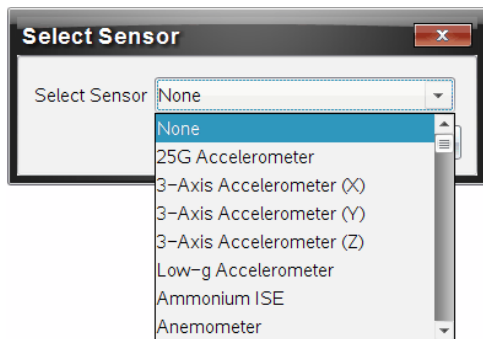
2. Select a sensor from the list.

3. Click the **Meter View** tab 🌀 .

4. Click the sensor you have added, and modify its settings.

   The settings will be applied when you attach the sensor.

Removing an offline sensor

1. From the **Experiment** menu, select **Advanced Setup > Configure Sensor**.

2. Select the name of the offline sensor to remove.

3. Click **Remove**.

Modifying Sensor Settings

You can modify how the sensor values are displayed and stored. For example, when using a temperature sensor, you can change the unit of measure from Centigrade to Fahrenheit.

Changing Sensor Measurement Units

Measurement units depend on the selected sensor. For example, units for the Vernier Go!Temp® Temperature sensor are Fahrenheit, Celsius, and Kelvin. Units for the Vernier Hand Dynamometer (a specialized force sensor) are Newton, Pound, and Kilogram.

You can change the units before or after you collect data. The collected data reflects the new measurement unit.

1. Click Meter view ⊙ to display the connected and offline sensors.

2. Click the sensor whose units you want to change.

3. In the Meter Settings dialog box, select the unit type from the **Measurement Units** menu.
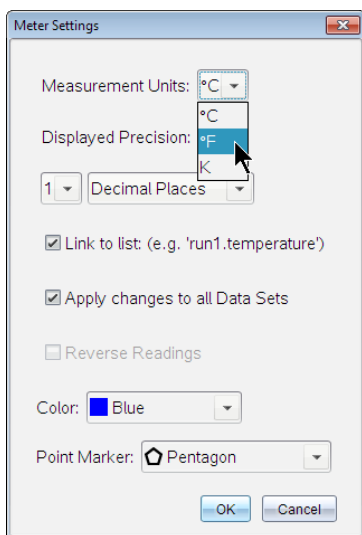
Calibrating a Sensor

When the software or handheld detects a sensor, the calibration for that sensor automatically loads. You can calibrate some sensors manually. Other sensors, such as the Colorimeter and the Dissolved Oxygen Sensor, must be calibrated to provide useful data.

There are three options for calibrating a sensor:

• Manual Entry

• Two Point

• Single Point

Refer to the sensor's documentation for specific calibration values and procedures.

Setting a Sensor to Zero

You can set the standing value of some sensors to zero. You cannot set sensors in which relative measurements such as force, motion, and pressure are common to zero. Sensors designed to measure specific environmental conditions, such as Temperature, pH, and CO_2 also cannot be set to zero.

1. Click Meter view ⊕ to display the connected and offline sensors.

2. Click the sensor that you want to set to zero.

3. In the Meter Settings dialog box, click **Zero**.

Reversing a Sensor's Readings

By default, pulling with a force sensor produces a positive force and pushing produces a negative force. Reversing the sensor allows you to display pushing as a positive force.

1. Click Meter view ⊕ to display the connected and offline sensors.

2. Click the sensor that you want to reverse.

3. In the Meter Settings dialog box, click **Reverse Readings**.

   The sensor display is now reversed. In Meter View, the reverse indicator ⇄ appears after the sensor name.

Collecting Data

Collecting Time-Based Data

The Time Based collection mode captures sensor data automatically at regular time intervals.

1. Connect the sensor or sensors.

    Sensor names are added to the sensor list automatically.

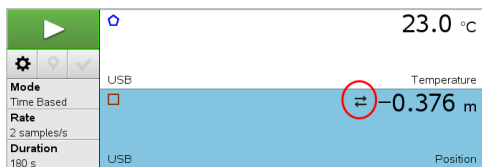2. From the **Experiment** menu, select **New Experiment**.

    This removes all data and restores all meter settings to their defaults.

3. From the **Experiment** menu, select **Collection Mode > Time Based**.

    a) Select **Rate** or **Interval** from the drop-down list, and then type the **Rate** (samples/second) or **Interval** (seconds/sample).

    b) Type the **Duration** of the collection.

        The Number of points is calculated and displayed, based on rate and duration. Note that collecting too many data points can slow system performance.

    c) Select **Strip Chart** if you want to collect samples continuously, retaining only the last *n* samples. (where "*n*" is the number shown in the Number of points field.)

4. Modify sensor settings as necessary.

5. Click **Start Collection** ▶.

6. After the data has been collected, click **Stop Collection** ■.

    The data set run is complete.

Collecting Selected Events

Use the Selected Events collection mode to capture samples manually. In this mode, each sample is automatically assigned an event number.

1. Connect the sensor or sensors.

Sensor names are added to the sensor list automatically.

2. From the **Experiment** menu, select **New Experiment**.

    This removes all data and restores all meter settings to their defaults.

3. From the **Experiment** menu, select **Collection Mode > Selected Events**.

    The Selected Events Setup dialog box opens.

    -   **Name**. This text is visible in the Meter View. Its first letter is displayed as the independent variable in the Graph view.
    -   **Units**. This text is displayed in Graph view alongside the Name.
    -   **Average over 10 s.** This option averages ten seconds of data for each point.

4. [Modify sensor settings](#) as necessary.

5. Click **Start Collection** ▶.

    The Keep Current Reading icon ⬤ becomes active. The current sensor value appears in the center of the graph.

6. Click **Keep Current Reading** ⬤ to capture each sample.

    The data point is plotted, and the current sensor value appears in the center of the graph.

    Note: If you selected the Averaging option, a countdown timer appears. When the counter reaches zero, the system plots the average.

7. Continue capturing until you collect all of the desired data points.

8. Click **Stop Collection** ⬛.

    The data set run is complete.

Collecting Events with Entry

Use the Events with Entry collection mode to capture samples manually. In this mode, you define the independent value for each point you collect.

1. Connect the sensor or sensors.

    Sensor names are added to the sensor list automatically.

2. From the **Experiment** menu, select **New Experiment**.

    This removes all data and restores all meter settings to their defaults.

3. From the **Experiment** menu, select **Collection Mode > Events with Entry**.

    The Events with Entry Setup dialog box opens.

    -   **Name.** This text is visible in the Meter View. Its first letter is displayed as the independent variable in the Graph view.
    -   **Units.** This text is displayed in Graph view alongside the Name.
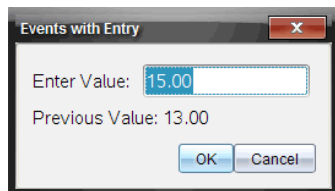   -   **Average over 10 s.** This option averages ten seconds of data for each point.

4. Modify sensor settings as necessary.

5. Click **Start Collection** .

    The Keep Current Reading icon becomes active. The current sensor value appears in the center of the graph.

6. Click **Keep Current Reading** to capture a sample.

    The Events with Entry dialog box opens.

7. Type a value for the independent variable.

8. Click **OK**.

    The data point is plotted, and the current sensor value appears in the center of the graph.

    Note: If you selected the Averaging option, a countdown timer appears. When the counter reaches zero, the system plots the average.

9. Repeat steps 6 through 8 until you collect all of the desired data points.

10. Click **Stop Collection** .

    The data set run is complete.

Collecting Photogate Timing Data

The Photogate Timing collection mode is available only when using the Vernier Photogate sensor. This sensor can time objects that pass through the gates or objects that pass outside of the gates.

1. Connect the Photogate sensor or sensors.

   Sensor names are added to the sensor list automatically.

2. From the **Experiment** menu, select **New Experiment**.

   This removes all data and restores all meter settings to their defaults.

3. From the **Experiment** menu, select **Collection Mode > Photogate Timing**.

4. Set the collection options.

5. Modify sensor settings as necessary.

6. Click **Start Collection** ▶.

7. After the data has been collected, click **Stop Collection** ■.

   The data set run is complete.

Collecting Drop Counter Data

The Drop Counting collection mode is available only when using the Vernier Drop Counter optical sensor. This sensor can count the number of drops or record the amount of liquid added during an experiment.

1. Connect the Drop Counter sensor or sensors.

   Sensor names are added to the sensor list automatically.

2. From the **Experiment** menu, select **New Experiment**.

   This removes all data and restores all meter settings to their defaults.

3. From the **Experiment** menu, select **Collection Mode > Drop Counting**.

4. Set the collection options.

5. Modify sensor settings as necessary.

6. Click **Start Collection** ▶.

7. After the data has been collected, click **Stop Collection** ■.

   The data set run is complete.

Using Data Markers to Annotate Data

Data markers give you a way to emphasize specific data points, such as when you change a condition. For example, you might mark a point at which a chemical is added to a solution or when heat is applied or removed. You can add a marker with or without a comment, and you can hide a comment.
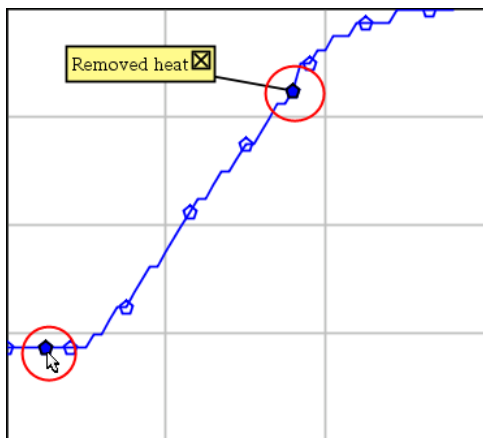
Two data markers, one with a comment displayed

Marker shown as red triangle in Table view

Adding a Marker During Data Collection

▶   Click **Add Data Marker** 📍 to place a marker at the current data point.

Adding a Marker After Collecting Data

1. In Graph or Table view, click the point at which you want a marker.

2. Click **Add Data Marker** 📍 .

3. Complete the items in the dialog box.

Adding a Comment to an Existing Marker

1. In the Detail view, click to expand the list of markers for the data set.
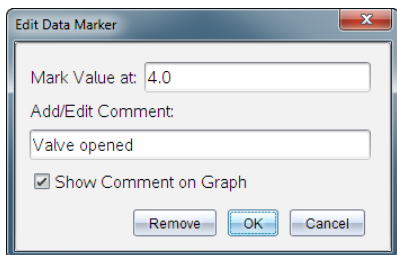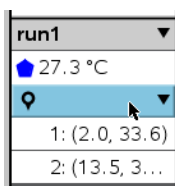

2. Click the entry for the marker that you want to change, and complete the items in the dialog box.

Repositioning a Data Marker

1. Click to expand the list of markers in the Detail view.

2. Click the entry for the marker that you want to change.

3. In the dialog box, type a new value for **Mark Value at**.

Moving a Data Marker's Comment in the Graph View

▶ Drag the comment to move it. The connecting line remains attached to the data point.

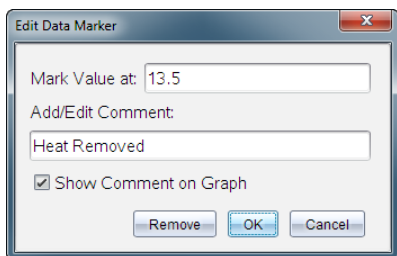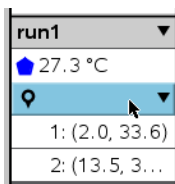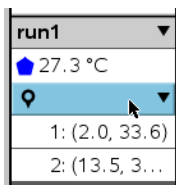**Hiding/Showing a Data Marker's Comment**

▶ Hide a comment by clicking the **X** at the end of the comment.

▶ To restore a hidden comment:

    a) Click to expand the list of markers in the Detail view.

run1	▼
● 27.3 °C	
●	▼
1: (2.0, 33.6)	
2: (13.5, 3…	

    b) Click the entry for the marker that you want to change, and check **Show Comment on Graph**.

Removing a Data Marker

1. Click to expand the list of markers in the Detail view.

run1	▼
● 27.3 °C	
●	▼
1: (2.0, 33.6)	
2: (13.5, 3…	
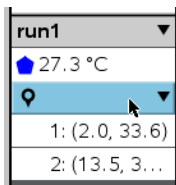
2. In the dialog box, click **Remove**.

Collecting Data Using a Remote Collection Unit

To collect information from a sensor while it is disconnected, you can set it up as a remote sensor. Only the TI-Nspire™ Lab Cradle, TI CBR 2™, and Vernier Go!Motion® support remote data collection.
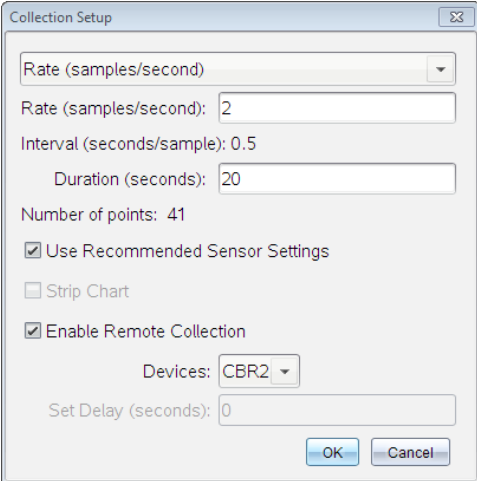
You can set up a remote collection unit to start collecting:

• When you press a manual trigger on the unit, as on the TI-Nspire™ Lab Cradle

• When a delay countdown expires on a unit that supports a delayed start

Setting Up for Remote Collection

1. Save and close any open documents, and start with a new document.

2. Connect the remote collection unit to the computer or handheld.

3. Modifying Sensor Settings.

4. Click the Collection Setup button ⚙.

5. On the Collection Setup screen, check **Enable Remote Collection**.

6. Select the remote collection unit from the **Devices** list.

7. Specify the method for starting the collection:

    • To start automatically after a specified delay (on supported units), type the delay value.

    • To start when you press the manual trigger (on supported units), type a delay value of **0**. When you use a delay, the manual trigger button on the TI-Nspire™ Lab Cradle has no effect on the start of the collection.

8. Click **OK**.

    A message confirms that the unit is ready.
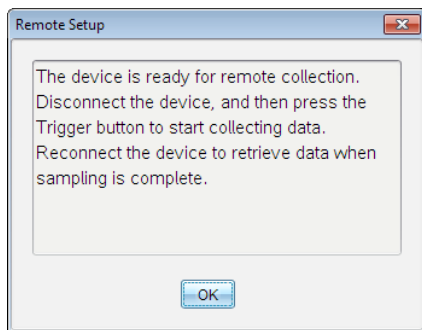
9. Disconnect the unit.

   Depending on the device, LED lights may indicate its status.

   Red. The system is not ready.

   Amber. The system is ready but not collecting data.

   Green. The system is collecting data.

10. If you are starting collection manually, press the trigger when ready. If you are starting based on a delay, the collection will start automatically when the countdown is complete.

Retrieving the Remote Data

After collecting data remotely, you transfer it to the computer or handheld for analysis.

1. Open the Vernier DataQuest™ application.
2. Attach the TI-Nspire™ Lab Cradle to the handheld or computer.

   The Remote Data Detected dialog box opens.
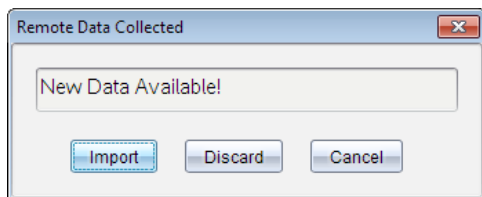
3. Click **Import**.

   The data transfers to the Vernier DataQuest™ application.

Setting Up a Sensor for Automatic Triggering

To start data collection automatically based on a specific sensor reading, the TI-Nspire™ Lab Cradle and sensor must be connected.

1. Connect the sensor.

2. Click **Experiment > Advanced Set up > Triggering > Set Up**.

    The Configure Trigger dialog box opens.

3. Select the sensor from the **Select the sensor to use as trigger** drop-down list.

    Note: The menu displays the sensors connected to the TI-Nspire™ Lab Cradle.

4. Select one of the following from the **Select the type of trigger to use** drop-down list.

    • **Increasing through threshold.** Use to trigger on increasing values.
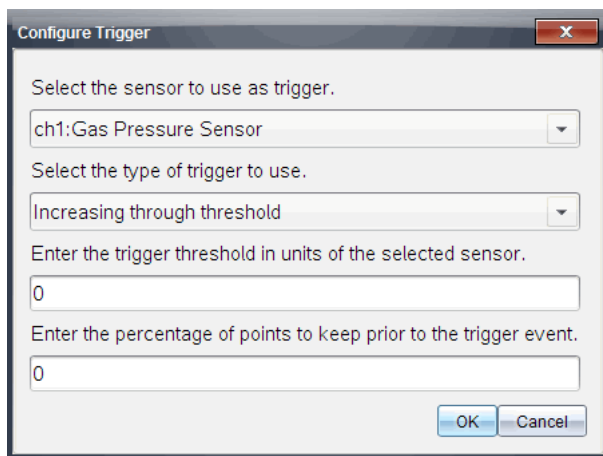   • **Decreasing through threshold.** Use to trigger on decreasing values.

5. Type the appropriate value in the **Enter the trigger threshold in units of the selected sensor** field.

    When entering the trigger value, enter a value within the range of the sensor.

    If you change the unit type after setting the threshold, the value automatically updates.

   For example, if you use the Vernier Gas Pressure sensor with the units set as atm and you later change the units to kPa, the settings are updated.

6. Type the number of data points to keep before the trigger value occurs.

7. Click **OK**.

    The trigger is now set and enabled if values were entered.

8. (Optional) Select **Experiment > Advanced Set up > Triggering** to verify the active indicator is set to Enabled.
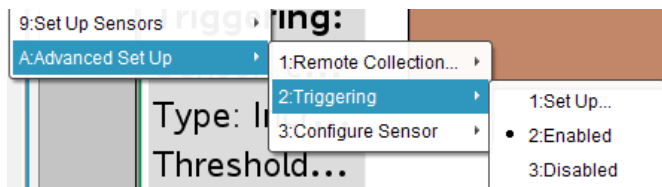
Important: When the trigger is enabled, it stays active until it is disabled or you start a new experiment.

Enabling a Disabled Trigger

If you set the trigger values in the current experiment, and then disable them, you can enable the triggers again.

To enable a trigger:

▶ Click **Experiment > Advanced Set Up > Triggering > Enable**.

Disabling an Enabled Trigger

To disable the active trigger.

▶ Click **Experiment > Advanced Set Up > Triggering > Disable**.

Collecting and Managing Data Sets

By default, the **Start Collection** button overwrites collected data with data from the next run. To preserve each run, you can store it as a data set. After collecting multiple data sets, you can superimpose any combination of them on the Graph View.

Important: Stored data sets are lost if you close the document without saving it. If you want stored data to be available later, make sure to save the document.

Storing Data as Sets

1. Collect the data from the first run. (See Collecting Data.)

2. Click the **Store Data Set** button .

The data is stored as **run1**. A new data set, **run2**, is created for collecting the next run.

3. Click **Start Collection** to collect data for **run2**.

Comparing Data Sets

1. Click the **Graph View** icon to show the graph.

2. Click the Data Set Selector (near the top of the Detail View) to expand the list of data sets.
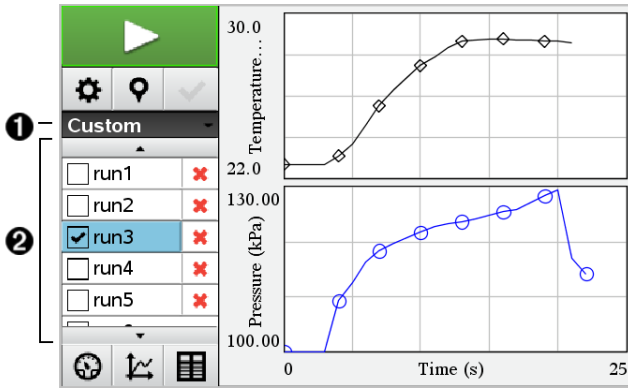
❶   Data Set Selector lets you expand or collapse the list.

❷   Expanded list shows available data sets. Scroll buttons appear as necessary to let you scroll the list.

3. Choose which data sets to view by selecting or clearing the check boxes.

    The graph is rescaled as necessary to show all selected data.
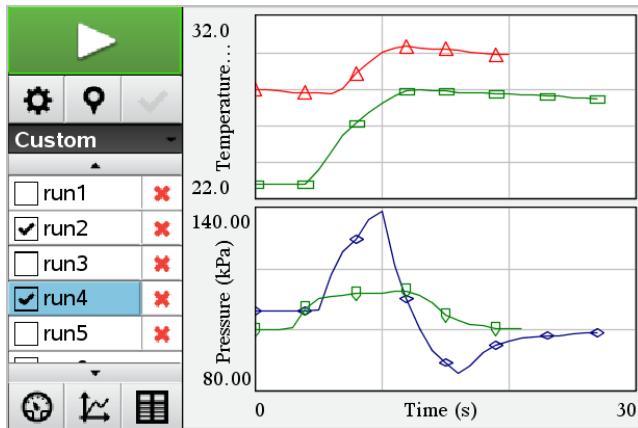
Tip: To quickly select a single data set, hold down **Shift** while clicking its name in the list. The graph shows only the selected set, and the list is collapsed automatically to help you view details of the data.

Renaming a Data Set

By default, data sets are named **run1**, **run2**, and so on. The name of each data set is displayed in the Table view.

1. Click the **Table View** icon ⊞ to show the table.

2. Display the context menu for the table view, and select **Data Set Options >** [*current name*].
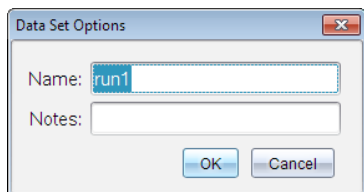
3. Type the new **Name**.

    Note: The maximum character limit is 30. The name cannot contain commas.

4. (Optional) Type **Notes** about the data.

Deleting a Data Set

1. Click the **Graph View** icon ⊯ to show the graph.

2. Click the Data Set Selector (near the top of the Detail View) to expand the list of data sets.

3. Scroll the list as necessary, and then click the Delete symbol (**X**) next to the name of the data set.
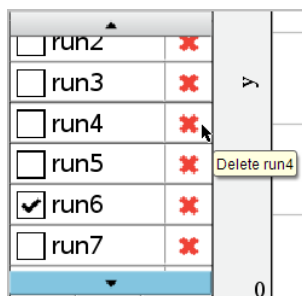
4. Click **OK** on the confirmation message.

Expanding the View Details Area

▸ Drag the boundary at the right edge of the Details area to increase or decrease its width.
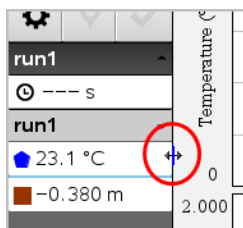
Using Sensor Data in ProgramsI

You can access sensor data from all connected sensor probes through your TI-Basic program by using this command:

RefreshProbeVars statusVar

• You must first launch the Vernier DataQuest™ application, or you will receive an error.

   Note: The Vernier DataQuest™ application will auto-launch when you connect a sensor or a lab cradle to the TI-Nspire™ software or handheld.

• The *RefreshProbeVars* command will be valid only when Vernier DataQuest™ is in 'meter' mode.

• *statusVar* is an optional parameter that indicates the status of the command. These are the *statusVar* values:

StatusVar Value	Status
statusVar =0	Normal (continue with the program)
statusVa r=1	The Vernier DataQuest™ application is in data collection mode. **Note:** The Vernier DataQuest™ application must be in meter mode for this command to work.
statusVar =2	The Vernier DataQuest™ application is not launched.

StatusVar Value	Status
statusVar =3	The Vernier DataQuest™ application is launched, but you have not connected any probes.

- Your TI-Basic program will read directly from Vernier DataQuest™ variables in the symbol table.

- The meter.time variable shows the last value of the variable; it does not update automatically. If no data collection has occurred, meter.time will be 0 (zero).

- Use of variable names without corresponding probes being physically attached will result in a "Variable not defined" error.

Collecting Sensor Data using RefreshProbeVars

1. Launch the Vernier DataQuest™ application.

2. Connect the sensor(s) you need to collect the data.

3. Run the program you wish to use to collect data in the calculator application.

4. Manipulate the sensors and collect the data.

Note: You may create a program to interact with the TI-Innovator Hub using menu **> Hub > Send**. (See Example 2, below.) This is optional.

Example 1

```
Define temp()=
Prgm
© Check if system is ready
RefreshProbeVars status
If status=0 Then
Disp "ready"
For n,1,50
RefreshProbeVars status
temperature:=meter.temperature
Disp "Temperature: ",temperature
If temperature>30 Then
Disp "Too hot"
EndIf
© Wait for 1 second between samples
Wait 1
EndFor
Else
Disp "Not ready. Try again later"
EndIf
EndPrgm
```

Example 2- with TI-Innovator™ Hub

```
Define tempwithhub()=
Prgm
© Check if system is ready
RefreshProbeVars status
```

```
If status=0 Then
Disp "ready"
For n,1,50
RefreshProbeVars status
temperature:=meter.temperature
Disp "Temperature: ",temperature
If temperature>30 Then
Disp "Too hot"
© Play a tone on the Hub
Send "SET SOUND 440 TIME 2"
EndIf
© Wait for 1 second between samples
Wait 1
EndFor
Else
Disp "Not ready. Try again later"
EndIf
EndPrgm
```

Analyzing Collected Data

In the Vernier DataQuest™ application, use Graph View to analyze data. Start by setting up graphs, and then use analysis tools such as integral, statistics, and curve fit to investigate the mathematical nature of the data.

Important: The Graph menu and Analyze menu items are only available when working in Graph View.

Finding the Area Under a Data Plot

Use Integral to determine the area under a data plot. You can find the area under all of the data or a selected region of the data.

To find the area under a data plot:

1. Leave the graph unselected to examine all the data, or select a range to examine a specific area.

2. Click **Analyze > Integral**.

3. Select the plotted column name if you have more than a single column.

   The data plot area is displayed in the View Details area.

Finding the Slope

Tangent displays a measure of the rate at which the data is changing at the point you are examining. The value is labeled "Slope."

To find the slope:

1. Click **Analyze > Tangent**.

   A check mark appears in the menu next to the option.

2. Click the graph.

   The examine indicator is drawn to the nearest data point.

   The values of the plotted data are shown in the View details area and the All Details for Graph dialog box.

   You can move the examine line by dragging, clicking another point, or using the arrow keys.

Interpolating the Value Between Two Data Points

Use Interpolate to estimate the value between two data points and to determine the value of a Curve Fit between and beyond these data points.

The examine line moves from data point to data point. When Interpolate is on, the examine line moves between and beyond data points.

To use Interpolate:

1. Click **Analyze > Interpolate**.

   A check mark appears in the menu next to the option.

2. Click the graph.

   The examine indicator is drawn to the nearest data point.

   The values of the plotted data are shown in the View Details area.

   You can shift the examine line by moving the cursor with the arrow keys or by clicking on another data point.

Generating Statistics

You can generate statistics (minimum, maximum, mean, standard deviation, and number of samples) for all the collected data or for a selected region. You can also generate a curve fit based on one of several standard models or on a model that you define.

1. Leave the graph unselected to examine all the data, or select a range to examine a specific area.

2. Click **Analyze > Statistics**.

3. Select the plotted column name if you have more than a single column. For example, run1.Pressure.

   The Stats dialog box opens.
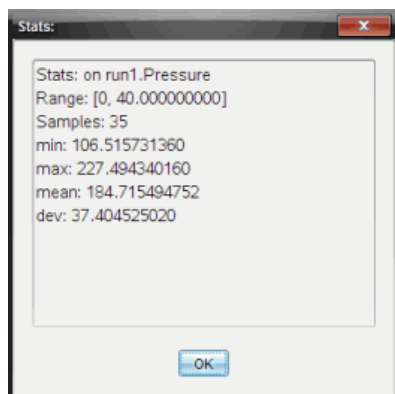
4. Review the data.
5. Click **OK**.

For information on clearing the Statistics analysis, see *Removing Analysis Options*.

Generating a Curve Fit

Use Curve Fit to find the best curve fit to match the data. Select all of the data or a selected region of data. The curve is drawn on the graph.

1. Leave the graph unselected to examine all the data, or select a range to examine a specific area.

2. Click **Analyze > Curve Fit**.

3. Select a curve fit option.

Curve Fit option	Calculated in the form:
Linear	y = m*x + b
Quadratic	y = a*x^2 + b*x + c
Cubic	y = a*x^3 + b*x^2 + c*x + d
Quartic	y = a*x^4 + b*x^3 + c*x^2 + d*x + e

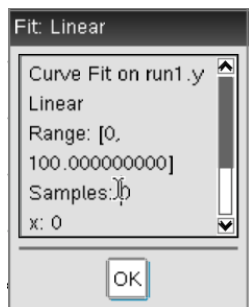| Curve Fit option	Calculated in the form:
Power (ax^b)	y = a*x^b
Exponential (ab^x)	y = a*b^x
Logarithmic	y = a + b*ln(x)
Sinusoidal	y = a*sin(b*x + c) + d
Logistic (d ≠ 0)	y = c/(1 + a*e^(-bx)) + d
Natural Exponential	y = a*e^(-c*x)
Proportional	y = a*x

The Fit Linear dialog box opens.

4. Click **OK**.

5. Review the data.

For information on clearing the Curve Fit analysis, see *Removing Analysis Options*.

Plotting a Standard or User-Defined Model

This option provides a manual method for plotting a function to fit data. Use one of the predefined models or enter your own.

You can also set the spin increment to use in the View Details dialog box. Spin increment is the value by which the coefficient changes when you click the spin buttons in the View Details dialog box.

For example, if you set m1=1 as the spin increment, when you click the up spin button the value changes to 1.1, 1.2, 1.3 and so on. If you click the down spin button, the value changes to 0.9, 0.8, 0.7, and so on.

1. Click **Analyze > Model**.

   The Model dialog box opens.
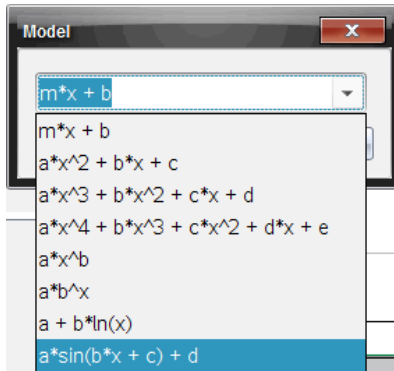
2. Type your own function.

   —or—

   Click to select a value from the drop-down list.

3. Click **OK**.

   The Set Coefficient Values dialog box opens.

Set Coefficient Values

f(x) = a*sin(b*x + c) + d

a: 1.000

Spin Increment: 0.100

b: 1.000

Spin Increment: 0.100

c: 1.000

Spin Increment: 0.100

d: 1.000

Spin Increment: 0.100

OK   Cancel

4. Type the value for the variables.

5. Type the change in value in the Spin Increment fields.

6. Click **OK**.

   Note: These values are the initial values. You can also adjust these values in the View Details area.

   The model is shown on the graph with adjustment options in the View Details area and in the All Details for Graph dialog box.

7. (Optional) Adjust the window setting for minimum and maximum axis values. For more information, see *Setting the Axis for One Graph*.

For information on clearing the Model analysis, see *Removing Analysis Options*.
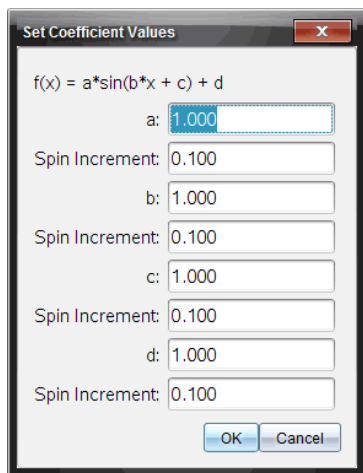
8. Click ▯ to make any desired adjustments to the coefficients.

   —or—

   Click the value in the View Details area.

This graphic is an example of a model with adjusted values.

Removing Analysis Options

1. Click **Analyze > Remove**.

2. Select the data display you want to remove.

The display you selected is removed from the graph and the View Details area.

Displaying Collected Data in Graph View

When you collect data, it is written in both the Graph and Table views. Use the Graph view to examine the plotted data.

Important: The Graph menu and Analyze menu items are only active when working in Graph View.

Selecting the Graph View

▶ Click the **Graph View** tab 🗠.

Viewing Multiple Graphs

Use the Show Graph menu to show separate graphs when using:

• A sensor that plots more than one column of data.

• Multiple sensors with different defined units at the same time.

In this example, two sensors (the Gas Pressure sensor and the Hand Dynamometer) were used in the same run. The following image shows the columns Time, Force, and Pressure in the Table view to illustrate why two graphs are shown.

Displaying One of Two Graphs

When two graphs are displayed, the top graph is Graph 1 and the bottom graph is Graph 2.

To display only Graph 1:

▶ Select **Graph > Show Graph > Graph 1**.

Only Graph1 is displayed.

To display only Graph 2:

▶ Select **Graph > Show Graph > Graph 2**.

Only Graph 2 is displayed.

Displaying Both Graphs

To display both Graph 1 and Graph 2 together:

▶ Select **Graph > Show Graph > Both**.

Graph1 and Graph 2 are displayed.

Displaying Graphs in the Page Layout View

Use the Page layout view when Show Graph is not the appropriate solution for showing more than one graph.

The Show Graph option is not applicable for:

• Multiple runs using a single sensor.

• Two or more of the same sensors.

• Multiple sensors that use the same column(s) of data.

To use Page Layout:

1. Open the original data set you want to see in two graph windows.

2. Click **Edit > Page Layout > Select Layout**.

3. Select the type of page layout you want to use.

4. Click **Click here to add an application**.

5. Select **Add Vernier DataQuest™**.

   The Vernier DataQuest™ application is added to the second view.

6. To see separate views, click the view you want to change, and then select **View > Table**.

   The new view is displayed.

7. To show the same view, click the view to change.

8. Click **View > Graph**.

   The new view is displayed.

Displaying Collected Data in Table View

Table view provides another way to sort and view collected data.

Selecting the Table View

▶   Click the **Table View** tab ▦ .
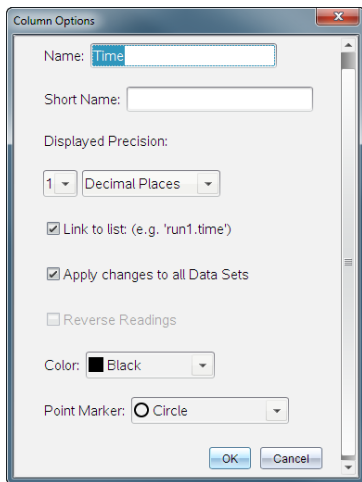
Defining Column Options

You can name columns and define the decimal points and the precision you want to use.

1. from the **Data** menu, select **Column Options**.

   Note: You can be in the Meter, Graph, or Table view and still click these menu options. The results will still be visible.

2. Click the name of the column you want to define.

   The Column Options dialog box opens.

3. Type the long name for the column in the **Name** field.

4. Type the abbreviated name in the **Short Name** field.

   Note: This name is displayed if the column cannot expand to display the full name.

5. Type the number of units in the **Units** field.

6. From the **Displayed Precision** drop-down list, select the precision value.

   Note: The default precision is related to the precision of the sensor.

7. Select **Link to list** to link to the symbol table and make this information available to other TI-Nspire™ applications.

   Note: Linking is the default for most sensors.

Important: Heart rate and blood pressure sensors require a tremendous amount of data to be useful, and the default for these sensors is to be unlinked to improve system performance.

8. Select **Apply changes to all Data Sets** to apply these settings to all data sets.
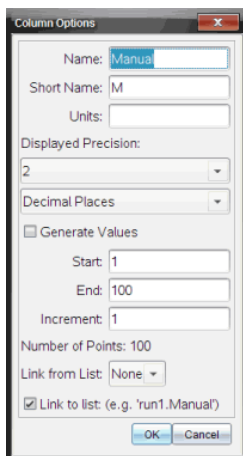
9. Click **OK**.

The column settings are now defined with the new values.

Creating a Column of Manually Entered Values

To enter data manually, add a new column. Sensor columns cannot be modified, but data entered manually can be edited.

1. Click **Data > New Manual Column**.

The Column Options dialog box opens.

2. Type the long name for the column in the **Name** field.

3. Type the abbreviated name in the **Short Name** field.

Note: This name is displayed if the column cannot expand to display the full name.

4. Type the units to be used.

5. From the **Displayed Precision** drop-down list, select the precision value.

Note: The default precision is related to the precision of the sensor.

6. (Optional) Select **Apply changes to all Data Sets** to apply these settings to all data sets.

7. (Optional) Select **Generate Values** to automatically populate the rows.

If you select this option, complete these steps:

a) Type a starting value in the **Start** field.

b) Type an ending value in the **End** field.

c) Type the increase in value in the **Increment** field.

The number of points is calculated and shown in the Number of Points field.

8. Select **Link from list** to link to data in another TI-Nspire™ application.

Note: This list only populates when data exists in the other application and includes a column label.

9. Select **Link to list** to link to the symbol table and make this information available to other TI-Nspire™ applications.

Note: Linking is the default for most sensors.

Important: Heart rate and blood pressure sensors require a tremendous amount of data to be useful, and the default for these sensors is to be unlinked to improve system performance.

10. Click **OK**.

A new column is added to the table. This column can be edited.

**Creating a Column of Calculated Values**

You can add an additional column to the data set in which the values are calculated from an expression using at least one of the existing columns.

Use a calculated column when finding the derivative for pH data. For more information, see *Adjusting Derivative Settings*.

1. Click **Data > New Calculated Column**.

The Column Options dialog box opens.
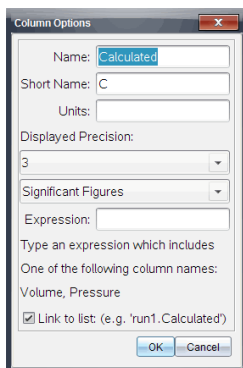
2. Type the long name for the column in the **Name** field.

3. Type the abbreviated name in the **Short Name** field.

    Note: This name is displayed if the column cannot expand to display the full name.

4. Type the units to be used.

5. From the **Displayed Precision** drop-down list, select the precision value.

    Note: The default precision is related to the precision of the sensor.

6. Type a calculation including one of the column names in the **Expression** field.

    Note: The system-provided column names are dependent on the sensor(s) selected and any changes made to the name field in Column Options.

    Important: The Expression field is case-sensitive. (Example: "Pressure" is not the same as "pressure.")

7. Select **Link to list** to link to the symbol table and make this information available to other TI-Nspire™ applications.

    Note: Linking is the default for most sensors.

    Important: Heart rate and blood pressure sensors require a tremendous amount of data to be useful, and the default for these sensors is to be unlinked to improve system performance.

8. Click **OK**.

    The new calculated column is created.

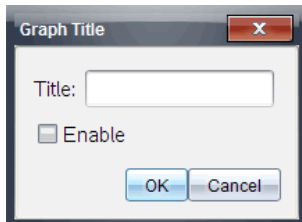## *Customizing the Graph of Collected Data*

You can customize the Graph view by adding a title, changing colors, and setting ranges for the axis.
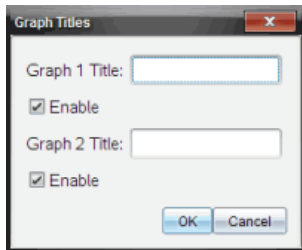
Adding a Title

When you add a title to a graph, the title is displayed in the View Details area. When you print the graph, the title prints on the graph.

1. Click **Graph > Graph Title**.

    The Graph Title dialog box opens.

    If there are two graphs in the work area, the dialog box has two title options.

2. Type the name of the graph in the Title field.

    —or—

    a) Type the name of the first graph in the Graph 1 field.

    b) Type the name of the second graph in the Graph 2 field.

3. Select **Enable** to show the title.

    Note: Use the Enable option to hide or show the graph title as needed.
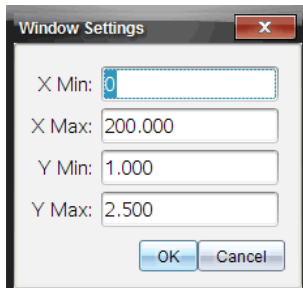
4. Click **OK**.

The title is shown.

Setting Axis Ranges

Setting Axis Ranges for One Graph

To modify the minimum and maximum range for the x and y axis:

1. Click **Graph > Window Settings**.

    The Window Settings dialog box opens.

2. Type the new values in one or more of these fields:

    -   X Min

    -   X Max

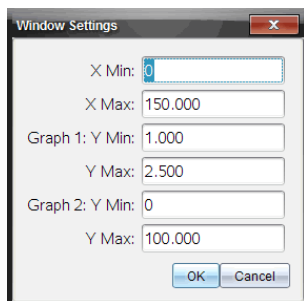   -   Y Min

    -   Y Max

3. Click **OK**.

    The application uses the new values for the graph visual range until you modify the range or change data sets.

Setting Axis Ranges for Two Graphs

When working with two graphs, enter two y axis minimum and maximum values, but only one set of minimum and maximum values for the x axis.

1. Click **Graph > Window Setting**.

    The Window Setting dialog box opens.

2. Type the new values in one or more of these fields:

   - X Min

   - X Max

   - Graph 1: Y Min
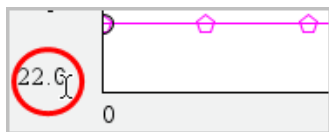
   - Y Max

   - Graph 2: Y Min

   - Y Max

3. Click **OK**.

   The application uses the new values for the graph visual range until you modify the range or change data sets.

Setting the Axis Range on the Graph Screen

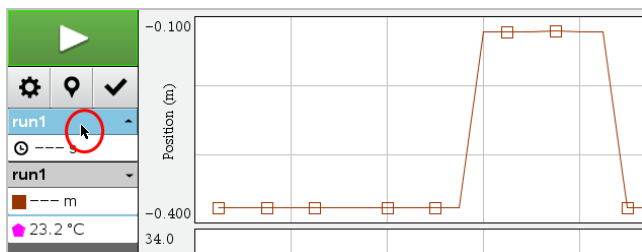You can modify the minimum and maximum range for the x and y axes directly on the graph screen.

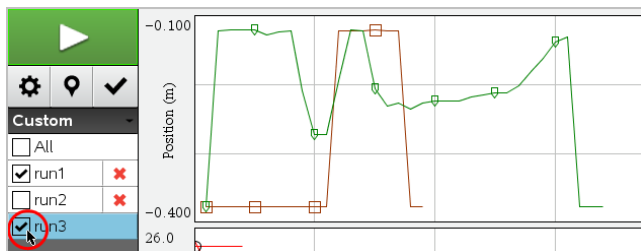▶ Select the axis value that you want to change, and type a new value.

The graph is redrawn to reflect the change.

Selecting which Data Sets to Plot

1. In the Detail view on the left, click the tab immediately below the view selection buttons.

2. The Detail view shows a list of available data sets.

3. Use the check boxes to select the data sets to plot.

Autoscaling a Graph

Use the autoscale option to show all the points plotted. Autoscale Now is useful after you change the x and y axis range or zoom in or out of a graph. You can also define the automatic autoscale setting to use during and after a collection.

Autoscale Now Using the Application Menu

▶ Click **Graph > Autoscale Now**.

The graph now displays all the points plotted.

Autoscale Now Using the Context Menu

1. Open the context menu in the graph area.
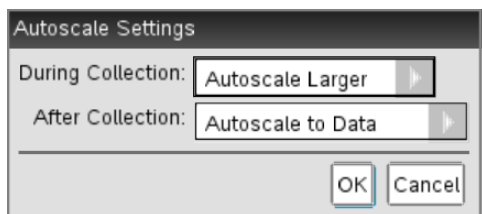
2. Click **Window/Zoom > Autoscale Now**.

The graph now displays all the points plotted.

Defining Autoscale During a Collection

There are two options for using the automatic autoscaling that occurs during a collection. To choose an option:

1. Click **Options > Autoscale Settings**.

   The Autoscale Settings dialog box opens.

2. Click ► to open the During Collection drop-down list.

3. Select one of these options:

   • **Autoscale Larger** - Expands the graph as needed to show all points as you collect them.

   • **Do Not Autoscale** - The graph is not changed during a collection.

4. Click **OK** to save the setting.

Defining Autoscale After a Collection

You have three options for setting the automatic autoscaling that occurs after a collection. To set your choice:

1. Click **Options > Autoscale Settings**.

   The Autoscale Settings dialog box opens.

2. Click ► to open the **After Collection** drop-down list.

3. Select one of these options:

   • **Autoscale to Data.** Expands the graph to show all data points. This option is the default mode.

   • **Autoscale From Zero.** Modifies the graph so all data points including the origin point are displayed.

   • **Do Not Autoscale.** The graph settings are not changed.

4. Click **OK** to save the setting.

Selecting a Range of Data

Selecting a range of data on the graph is useful in several situations, such as when zooming in or out, striking and unstriking data, and examining settings.

To select a range:

1. Drag across the graph.

   The selected area is indicated by gray shading.

2. Perform one of these actions.

   • Zoom in or out

   • Strike or unstrike data

   • Examine settings

To deselect a range:

▶ Press the **Esc** key as necessary to remove the shading and the vertical trace line.

Zooming In on a Graph

You can zoom in on a subset of the collected points. You can also zoom out from a previous zoom or expand the graph window beyond the data points collected.

To zoom in on a graph:

1. Select the area you want to zoom into, or use the current view.

2. Click **Graph > Zoom In**.

   The graph adjusts to display only the area you selected.

   The x range selected is used as the new x range. The y range autoscales to show all graphed data points in the selected range.

Zooming Out of a Graph

▶ Select **Graph > Zoom Out**.

   The graph is now expanded.

If a Zoom In precedes a Zoom Out, the graph displays the original settings prior to the Zoom In.
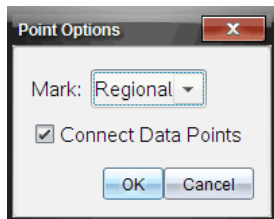
For example, if you Zoomed In twice, the first Zoom Out would display the window of the first Zoom In. To display the full graph with all data points from multiple zoom ins, use Autoscale Now.

Setting Point Options

To indicate how often marks show on the graph and whether to use a connecting line:

1. Click **Options > Point Options**.
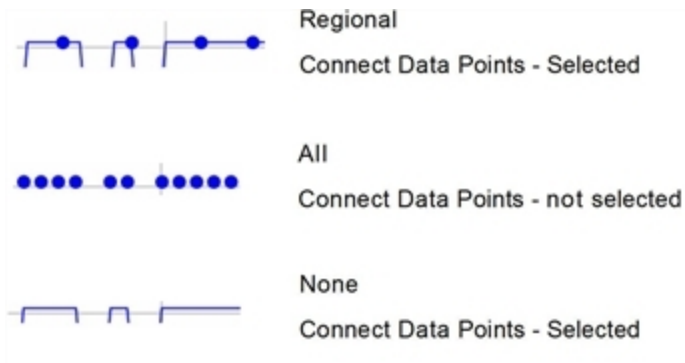
   The Point Options dialog box opens.

2. Select a **Mark** option from the drop-down list.

   - **None.** No point protectors.
   - **Regional.** Periodic point protectors.
   - **All.** Every data point as a point protector.

3. Select **Connect Data Points** to display a line between points.

   —or—

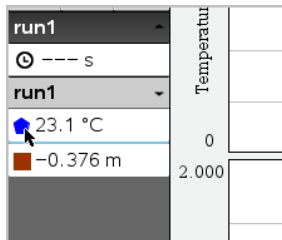   Clear **Connect Data Points** to remove the line between points.

The following graphics show examples of some of the Point Mark options.

Regional

Connect Data Points - Selected

All

Connect Data Points - not selected

None

Connect Data Points - Selected

Changing a Graph's Color

1. Click the point indicator for the graph whose color you want to change.

2. In the Column Options dialog box, select the new **Color**.

Selecting Point Markers

1. Right-click in the graph to open the menu.

2. Click **Point Marker**.

    Note: If there is only one dependent variable column, the Point Marker option is preceded by the data set name and column name. Otherwise, the Point Marker option has a menu.

3. Select the column variable to change.

4. Select the point marker to set.

    The Point Marker changes to the option selected.

Selecting an Independent Variable Column

Use the option Select X-axis Column to select the column used as the independent variable when graphing the data. This column is used for all graphs.

1. Click **Graph > Select X-axis Column**.

2. Select the variable you want to change.

    The x-axis label on the graph changes and the graph is reordered using the new independent variable for graphing the data.

Selecting a Dependent Variable Column

Use the option Select Y-axis Column to select which dependent variable columns to plot on the displayed graph(s).

1. Click **Graph > Select Y-axis Column**.

2. Select one of the following:

    •   A variable from the list. The list is a combination of dependent variables and the number of data sets.

    •   **More.** Selecting More opens the Select dialog box. Use this when you want to select a combination of data set variables to graph.
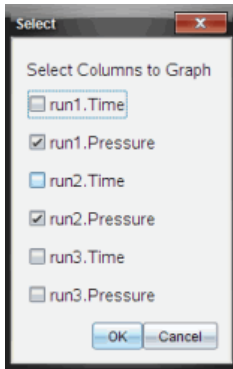
Showing and Hiding Details

You can hide or show the Details view on the left side of the screen.

▶   Click **Options > Hide Details** or **Options > Show Details**.

Striking and Restoring Data

Striking data omits it temporarily from the Graph view and from the analysis tools.

1. Open the data run that contains the data to be struck.
2. Click **Table View** ▦.
3. Select the region by dragging from the starting row to the ending point.

   The screen scrolls so you can see the selection.
4. Click **Data > Strike Data.**
5. Select one of the following:
   • **In Selected Region**. Strike the data from the area you selected.
   • **Outside Selected Region**. Strike all data except the area you selected.

   The selected data is marked as struck in the table and is removed from the graph view.

Restoring Struck Data

1. Select the range of data to restore or if restoring all struck data, start at step two.
2. Click **Data > Restore Data**.
3. Select one of the following:
   • **In Selected Region** - Restore data in the selected area.
   • **Outside Selected Region** - Restore data outside the selected area.
   • **All Data** - Restore all data. No data selection necessary.

   The data is restored.

Replaying the Data Collection

Use the Replay option to playback the data collection. This option lets you:

• Select the data set you want to replay.
• Pause the playback.
• Advance the playback by one point at a time.
• Adjust the playback rate.
• Repeat the playback.

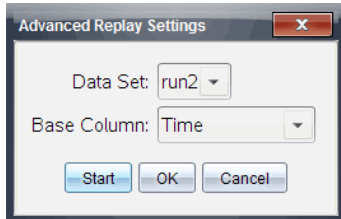#### Selecting the Data Set to Replay

You can replay one data set at a time. By default, the latest data set plays using the first column as the base column (example: time reference).

If you have multiple data sets, and want a different data set or base column than the default, you can select the data set to replay and the base column.

To select the data set to replay:

1. Click **Experiment > Replay > Advanced Settings**.

   The Advanced Replay Settings dialog box opens.

2. Select the data set to replay from the Data Set drop-down list.

   Note: Changing the run in the Data Set selection tool does not affect the playback choice. You must specify which data set in **Experiment > Replay > Advance Settings**.

3. (Optional) Select a new value from the Base Column drop-down list.

   The selected column acts as the "Time" column for the replay.

   Note: The base column should be a strictly increasing list of numbers.

4. Click **Start** to start the playback and save the settings.

   Note: Data Set and Base Column options are based on the number of stored runs and the sensor type used.

Starting and Controlling the Playback

▶ Select **Experiment > Replay > Start Playback**.

   Playback begins, and the Data Collection Control buttons change to:
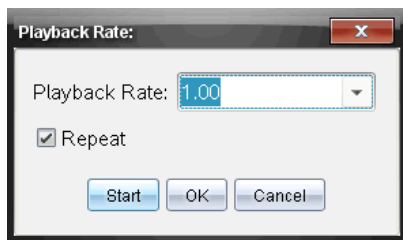
❙❙	Pause
▷	Resume
■	Stop
❙▶	Advance by One Point (enabled only during pause)

Adjusting the Playback Rate

To adjust the playback rate:

1. Select **Experiment > Replay > Playback Rate**.

    The Playback Rate dialog box opens.

2. In the Playback Rate field, click ▼ to open the drop-down list.

3. Select the rate at which the playback will play.

    Normal speed is 1.00. A higher value is faster, and a lower value is slower.

4. Select one of the following options:

    •   Click **Start** to start the playback and save the settings.

    •   Click **OK** to save the settings for use on the next playback.

Repeating the Playback

1. Select **Experiment > Replay > Start Playback**.

2. Click **Start** to start the playback and save the settings.

Adjusting Derivative Settings

Use this option to select the number of points to use in derivative calculations. This value affects the tangent tool, velocity, and acceleration values.

Find pH derivative settings using a calculated column.

The Vernier DataQuest™ application can determine a numeric derivative from a list of data with respect to another list of data. The data can be collected using sensors, input manually, or linked with other applications. The numerical derivative is found using a calculated column.

To determine the numerical 1st derivative of List B with respect to List A, enter the following expression in the Column Options dialog:

```
derivative(B,A,1,0) or derivative(B,A,1,1)
```

To determine the numerical 2nd derivative of List B with respect to List A, enter the following express:

```
derivative(B,A,2,0) or derivative (B,A,2,1)
```

The last parameter is either 0 or 1 depending on the method you are using. When it is 0, a weighted average is used. When it is 1, a time shifted derivative method is used.

Note: The first derivative calculation (weighted average) is what the Tangent tool uses to display the slope at a data point when examining data. (Analyze > Tangent).

Note: The derivative calculation is completely row based. It is recommended that your List A data be sorted in ascending order.

1. Click **Options > Derivative Settings**.

   The Settings dialog box opens.
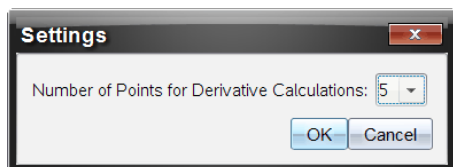
2. Select the number of points from the drop-down list.

3. Click **OK**.

Drawing a Predictive Plot

Use this option to add points to the graph to predict the outcome of an experiment.

1. Click the **Graph View** tab .

2. From the **Analyze** menu, select **Draw Prediction > Draw**.

3. Click each area in which you want to place a point.

4. Press **Esc** to release the drawing tool.
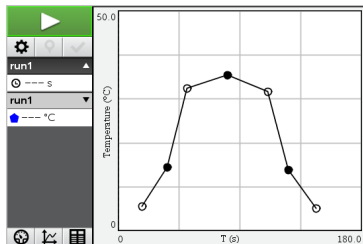
5. To clear the drawn prediction, click **Analyze > Draw Prediction > Clear**.

Using Motion Match

Use this option to create a randomly generated plot when creating position-versus-time or velocity-versus-time graphs.

This feature is only available when using a motion detector such as the CBR 2™ sensor or the Go!Motion® sensor.

Generating a Motion Match Plot

To generate a plot:

1. Attach the motion detector.

2. Click **View > Graph**.

3. Click **Analyze > Motion Match**.

4. Select one of the following options:

    • **New Position Match**. Generates a random position plot.

    • **New Velocity Match**. Generates a random velocity plot.

Note: Continue selecting a new position or a new velocity match to generate a new random plot without removing the existing plot.

Removing a Motion Match Plot

To remove the generated plot:

▶   Click **Analyze > Motion Match > Remove Match**.

Printing Collected Data

You can only print from the computer. You can print any single displayed active view, or with the Print All option:

• One data view.

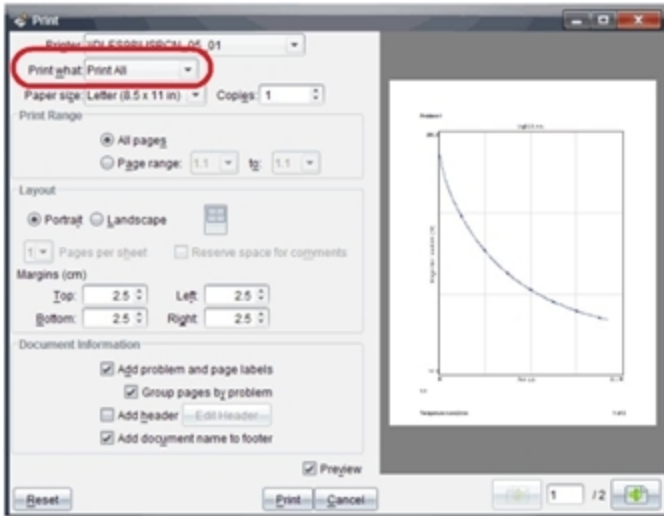• All of the data views.

• A combination of the data views.

The Print All option has no effect on applications outside of the Vernier DataQuest™ application.

Printing Data Views

To print a data view:

1. On the main menu (top of the window), click **File > Print**.

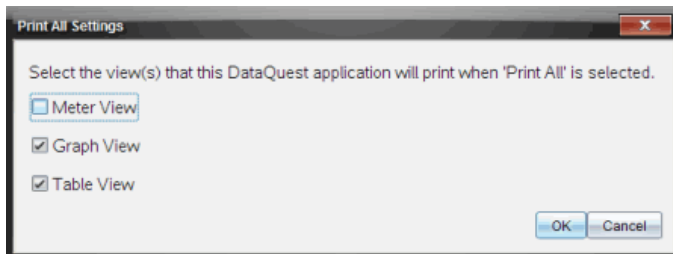   The Print dialog box opens.

2. Select **Print All** from the Print what drop-down list.

3. Select additional options, if needed.

4. Click **Print** to send the document to the printer.

Setting Options for the Print All Feature

1. Click **Options > Print All Settings**.

   The Print All Settings dialog box opens.

2. Select the views you want to print.

   • **Print Current View.** The current view is sent to the printer.

   • **Print All Views.** All three views (Meter, Graph, and Table) are sent to the printer.

   • **More.** Only the views you select are sent to the printer.

3. Click **OK**.

   The Print All Settings are now complete and can be used when printing.

TI-Nspire™ Lab Cradle

The TI-Nspire™ Lab Cradle is a device used with TI-Nspire™ handhelds, TI-Nspire™ software for computers, or as a stand-alone tool to collect data.

The Lab Cradle supports all TI sensors. It also supports more than 50 analog and digital Vernier DataQuest™ sensors, including motion detectors and photogate sensors. To see the full list of supported sensors, go to education.ti.com/education/nspire/sensors.

Important: The TI-Nspire™ CM-C Handheld is not compatible with the Lab Cradle and only supports the use of a single sensor at a time.

The Lab Cradle comes pre-loaded with its own operating system (OS). The TI-Nspire™ 3.0 operating system for handheld and computer software has been preset to recognize the Lab Cradle so you can start using it immediately.

Note: Any TI-Nspire™ OS earlier than 3.0 will not recognize the Lab Cradle. For more information about upgrading a handheld OS, see Getting Started with the TI-Nspire™ CX Handheld or Getting Started with the TI-Nspire™ Handheld.

Exploring the Lab Cradle

The following graphic shows the front and back of the Lab Cradle.
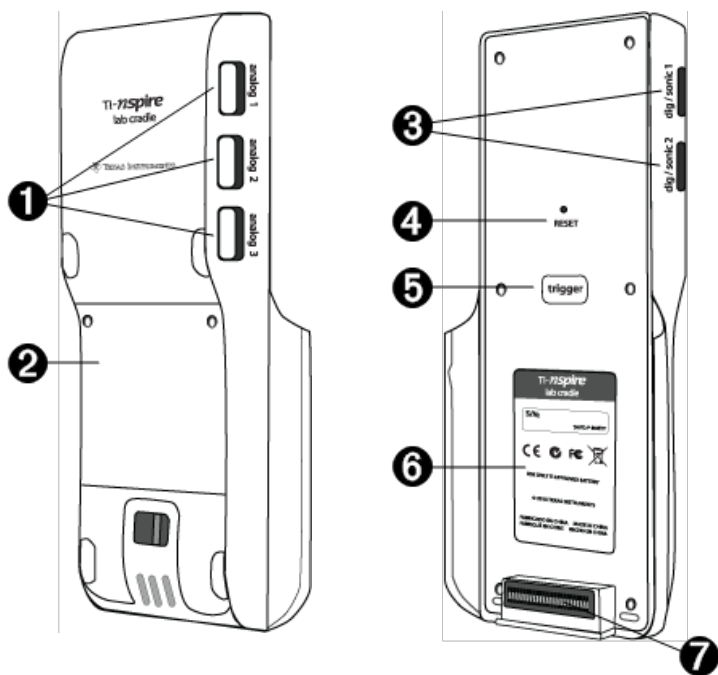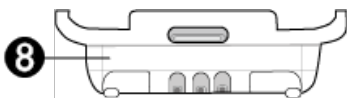
❶	**Analog ports.** The three BT analog ports used to connect analog sensors. The other side of the cradle has two digital ports for digital sensors.
❷	**Battery panel and compartment area**. The compartment is where the rechargeable battery is located. Two cross-slotted screws are used to secure the panel to the Lab Cradle.
❸	**Digital ports.** The two ports used to connect digital sensors.
❹	**Reset button.** Press to reboot the operating system if the Lab Cradle does not respond to commands. Data may be lost when the Lab Cradle reboots.
❺	**Trigger.** Lets you begin data collection manually when using the Lab Cradle as a stand-alone data collection tool.
❻	**Label.** Displays the serial number and other hardware information.
❼	**Handheld transfer connector.** Connects the handheld to the Lab Cradle for collecting or transferring data.
❽	**Locking latch.** Locks the Lab Cradle and handheld together.

Setting up the Lab Cradle for Data Collection

Before you can use the Lab Cradle to collect data, you must connect it to a handheld or computer to define the collection parameters.

Attaching the Lab Cradle

To attach a handheld to a Lab Cradle, slide the handheld into the connector at the bottom of the Lab Cradle. To lock the handheld to the Lab Cradle, push the lock up with the handheld facing up. Push the lock down to release the handheld.

You can also connect to a handheld by plugging the handheld's cable into the Lab Cradle's mini-USB port. This connection lets you transfer data from the Lab Cradle to the handheld when you have collected data in the stand-alone mode.

To connect the Lab Cradle to a computer, plug the cable's mini-USB connector into the Lab Cradle's mini-USB port. Then plug the cable's standard USB connector into the computer's standard USB port.

Defining Collection Parameters

You must have the TI-Nspire™ software loaded on the computer or handheld. Use the built-in Vernier DataQuest™ app to:

• Modify sensor settings.

- Set up data collection modes.
- Define triggering.

For more information, see the TI-Nspire™*Data Collection and Analysis Guidebook*.

Using the Lab Cradle

The Lab Cradle can be used in the classroom or remotely. Collect the data with the Lab Cradle, and then retrieve the data later. Store the data on the Lab Cradle until you return to the classroom, and then transfer it to a handheld or computer for analysis.

Using the Lab Cradle with a Handheld

You can connect the Lab Cradle to your handheld to collect or retrieve data.

Using the Lab Cradle with a Computer

The Lab Cradle works with all Windows® and Mac® operating systems currently supported by the TI-Nspire™ Teacher and Student computer software.

Using the Lab Cradle as a Stand-Alone Data Collection Tool

You can use the Lab Cradle in stand-alone mode to collect data either manually or automatically. Press the trigger button to manually start and stop data collection when in stand-alone mode.

Note: For long-term data collections TI recommends you use an AC adapter for a handheld or a remote collection device such as the Lab Cradle.

Before collecting data, set up the data collection parameters using the Vernier DataQuest™ app or use the sensor's default settings. If you do not change the parameters and use a single sensor, the Lab Cradle collects data using the sensor's default settings. If you use multiple sensors, the Lab Cradle collects samples beginning with the sensor that has the shortest collection time requirement.

You do not have to reconnect the Lab Cradle to the same computer or handheld to download the data. You can use any computer or handheld running a compatible OS and TI-Nspire™ software to download the data.

About the Lab Cradle

Portability

The Lab Cradle fits into the palm of most high school students' hands when connected to the TI-Nspire™ handheld.

The Lab Cradle features an attachment point for a lanyard. Students can attach a lanyard to wear the Lab Cradle around their neck. This feature lets students keep their hands free to steady themselves in rough terrain during remote data collection activities.

When collecting data for an experiment that subjects the Lab Cradle to intense movement, TI recommends that students wear a Vernier Data Vest or zip-up jacket with the sensor secured both around the student's neck as well as to the student's chest. For example, if a student is measuring speed or motion on a roller coaster, the Lab Cradle may bounce around due to the movement of the roller coaster. Wearing a zip-up jacket or Vernier Data Vest limits the movement of the Lab Cradle.

Durability

The Lab Cradle is durable enough to withstand extensive use in the classroom and in the field. It is designed to survive being dropped from a height of 36 inches, the height of a standard lab table.

Storing/Operating Temperature Ranges

The Lab Cradle storage temperature range is between -40°C (-40° F) to 70°C (158° F).

The Lab Cradle, when used as a stand-alone data collection tool, operates in temperatures from 10° C (50° F) to 45° C (113° F).

Triggering Methods

The Lab Cradle has two options for triggering data collection—automatic or manual.

To use automatic triggering, define the criteria in the Vernier DataQuest™ application to start data collection. The Lab Cradle can trigger on either an increasing or decreasing value.

Manual triggering is defined in the Vernier DataQuest™ app. By setting the trigger delay value to zero, you can start data collection by pressing the trigger button on the Lab Cradle when using it as a stand-alone data collection tool.

You can define a delay in triggering the data collection when using the Lab Cradle with a computer or handheld. The Vernier DataQuest™ app starts a countdown based on the time delay you define. When the countdown reaches zero, the Lab Cradle and its connected sensors begin collecting data.

Multi-Channel Data Collection

You can connect up to five sensors to the Lab Cradle. It provides three analog BT connectors and two digital BT connectors.

The Lab Cradle supports multi-channel data collection by allowing you to collect data through all five sensors at the same time. When using all five sensors at the same time, the time stamp is the same for all data collection streams.

Sampling Rate

The maximum sampling rate for a Lab Cradle using a single BT sensor is 100,000 samples per second. This sampling rate allows you to collect data for high-sample sensors, such as microphones, blood pressure monitors, and hand-grip heart rate monitors.

If using more than one sensor at the same time, the 100,000 samples per second rate is divided by the number of connected sensors. For example, when using:

- One sensor, data is collected at 100,000.

- Two sensors, data is collected at 50 kHz per sensor.

- Three sensors, data is collected at 33.3 kHz per sensor.

Some sensor's maximum sample rates are less than the maximum sample rate of the Lab Cradle. For example, with five sensors connected to the Lab Cradle, data may be collected at 20 kHz per sensor; however, temperature sensors may only be capable of collecting data at 1 kHz so it will only collect data at that rate.

Viewing Data Collection Status

The Lab Cradle has an LED light located on the top to indicate data collection status. This light will be red, green, or amber and use a variety of blink patterns.

TOP

Data collection
activity status

Red

- Red indicates that you need to wait until the system is ready.

- *Slow blink:* The Lab Cradle is updating experiment storage space. This is automatic behavior and does not impact active collections.

- *Fast blink:* Indicates one or more attached sensors are not warmed up. (You may still collect data during the warm-up period but you risk the data being less precise.)

Amber

- Amber indicates the system is ready but the collection has not yet started.

- *One blink per second:* The sensor is configured and set up for sampling.

- *Slow blink:* The LabCradle isconnected to a computer or handheld running TI-Nspire™ software but not set up for sampling.

- *Fast blink:* The Lab Cradle is ready for data collection when you press the trigger.

Green

- Green indicates the system is actively collecting data.

- *Slow blink:* Actively collecting data.

  Note: There may be a slight variation in the duration of the blink depending on the mode/rate of collection.

- *Fast blink:* Pre-storing data prior to a trigger.

Alternating Amber and Green

- The blinking pattern indicates the system is in trigger mode but has not yet reached the trigger event.

Managing Power

When managing the power for the Lab Cradle, you must consider the power source being used. The Lab Cradle can be powered by its rechargeable battery or a connected power cord.

Batteries

The Lab Cradle runs on a rechargeable battery that supports one full day of high-use, high-consumption sensor data collection before recharging. An example of high-use data collection is an experiment requiring 150 total minutes of continuous data collection with CO_2 (47 mA) and O_2 sensors at one sample every 15 seconds.

The battery recharges in less than 12 hours.

Viewing the Battery Status

There are two ways to view battery status: when attached to a handheld, or by looking at the LED light. When the Lab Cradle is attached to a TI-Nspire™ handheld, you can view the battery status for both. The first value is the handheld and the second value is the Lab Cradle.
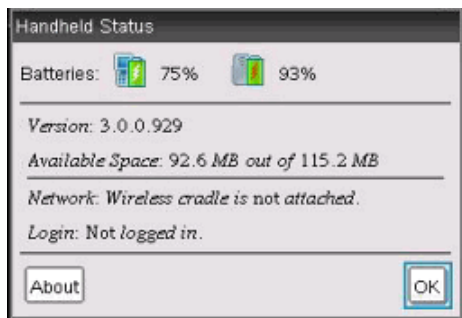
▶ Press 🏠on 5 (Settings) 4 (Status).

When you attach the Lab Cradle directly to a computer, you do not see a power indicator. Use the LED light on the top of the Lab Cradle to determine battery status.

TOP

Battery
status

When the Lab Cradle is connected to a USB power source (either wall charger or computer):

• Red - Slow blinking LED indicates the charge is low but charging.

• Amber - Slow blinking LED indicates the Lab Cradle is charging

• Green - Slow blinking LED indicates the Lab Cradle is fully charged.

When in the TI-Nspire™ Cradle Charging Bay:

• Red - Solid LED indicates the charge is low but is still charging.

• Amber - Solid LED indicates the Lab Cradle is charging.

• Green - Solid LED indicates the Lab Cradle is fully charged.

When running and not charging:

• Red - Blinking LED indicates the battery is below six percent.

• Amber - Blinking LED indicates the battery is below 30 percent.

• Green - Blinking LED indicates the battery is between 30 percent and 96 percent. Two green blinks per second indicates the battery is over 96 percent.

Managing Battery Power

When the battery power reaches 30 percent, a yellow LED indicates the Lab Cradle needs to be charged. The LED turns red when the battery power reaches five percent.

When managing battery power for the Lab Cradle, remember that some sensors need to warm up before use. You can collect data while the sensor is warming up; however, the data may not be as precise.

When you start a long-term or remote data collection, the system checks current power sources to determine if the sources are adequate to support the sensors from the beginning to the end of the experiment.

If the power is unable to support the experiment configuration, a warning indicates that the power available is insufficient for the experiment. You either need to charge the battery or plug the Lab Cradle into an external power source.

When using the wall charger, TI-Nspire™ Cradle Charging Bay, or USB cable plugged into a powered computer, the Lab Cradle can be fully charged from a dead state in less than 12 hours when not being used.

The battery is capable of supporting one full day of high-use, high-consumption sensor data collection or two full days of moderate to low consumption sensor data collection.

Charging the Lab Cradle

You can charge the Lab Cradle in a number of ways.

• Wall charger

- USB Cable connected to a computer
- TI-Nspire™ Navigator™ Cradle Charging Bay

Charging with an AC Wall Charger

Connect the plug to a standard AC wall outlet and the mini-B USB connector to the TI-Nspire™ Lab Cradle.

Charging with a USB Cable

The Lab Cradle can be charged using a standard USB cable. Attach the mini-B connector to the Lab Cradle and the USB type A connector into the computer.

The Lab Cradle will fully charge in less than 12 hours.
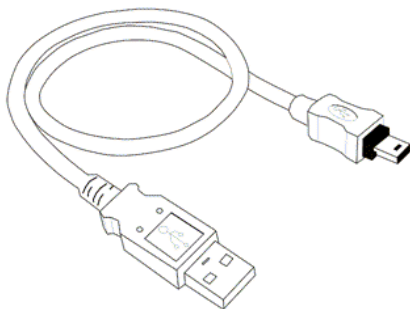
Charging with a Charging Bay

Use the TI-Nspire™ Navigator™ Cradle Charging Bay to charge five Lab Cradles at the same time. A full charging bay with dead Lab Cradle units fully charges those units in less than 12 hours.

You can leave the Lab Cradle in the charging bay even if fully charged. You can recharge at any time regardless of the current charge level.

The charging bay is only included in certain bundled packages. The charging bay works with Lab Cradles or with Lab Cradles connected to handhelds.

Upgrading the Operating System

Before You Begin

Before beginning an OS download, ensure that batteries are at least 25 percent charged. If attached to a handheld, remove the handheld before updating the Lab Cradle. You cannot update the OS with the handheld attached.

Finding Operating System Upgrades

For up-to-date information about available OS upgrades, check the Texas Instruments website at education.ti.com.

You can download an OS upgrade from the Texas Instruments website to a computer, and use a USB cable to install the OS on your TI-Nspire™ Lab Cradle. You will need an Internet connection and the appropriate USB cable to download the updates.

Checking for Lab Cradle OS Updates

When using TI-Nspire™ software, you can quickly determine if your Lab Cradle OS is up to date when the Lab Cradle is connected to a computer.

1. Open the TI-Nspire™ software and ensure the Lab Cradle is connected to your computer.

2. In the Documents Workspace, click 📂 to open Content Explorer.

3. In the Connected Handhelds/Lab Cradle pane, select a connected Lab Cradle.
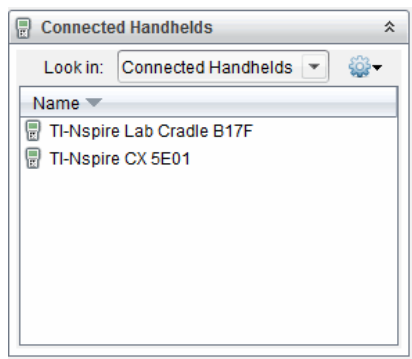
4. Select **Help > Check for Handheld/Lab Cradle OS Update**.

    •   If the operating system is current, the Check for Handheld OS dialog box opens indicating that the operating system on the Lab Cradle is up to date.
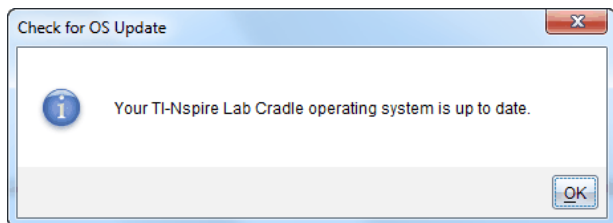
    •   If the operating system is not current, the dialog box contains a message indicating that a new version of the operating system is available.

5. Click **OK** to close the dialog box.

Upgrading the Operating System

In the TI-Nspire™ software, you can select to upgrade the operating system on a connected Lab Cradle from the following workspaces and menus:

- In all versions of the software, you can select **Help > Check for Handheld/Lab Cradle OS Update**. Select a connected Lab Cradle in the Content Explorer to activate this option. If the OS on the Lab Cradle is not current, the dialog box indicates that there is an updated version of the operating system. Follow the prompts to update the operating system.

- In all versions of the TI-Nspire™ software, you can use options available in the Documents Workspace:

    - Open Content Explorer, select the Lab Cradle name, and then click ⚙ and select **Install Handheld/Lab Cradle OS**.

        —or—

    - Select **Tools > Install Handheld/Lab Cradle OS**.

- Those using teacher versions of the TI-Nspire™ software can use options available in the Content Workspace:

    - In the Resources pane, right-click the name of a connected Lab Cradle, and then select **Install Handheld/Lab Cradle OS**.

        —or—

    - Select the Lab Cradle name in the Preview pane, click ⚙ in the Preview pane, and then select **Install Handheld/Lab Cradle OS**.

        —or—

    - Right-click the Lab Cradle name and select **Install Handheld/Lab Cradle OS**.

Completing the OS Upgrade

When you select to update the OS on a Lab Cradle, the Select Handheld/Lab Cradle OS File dialog box opens.
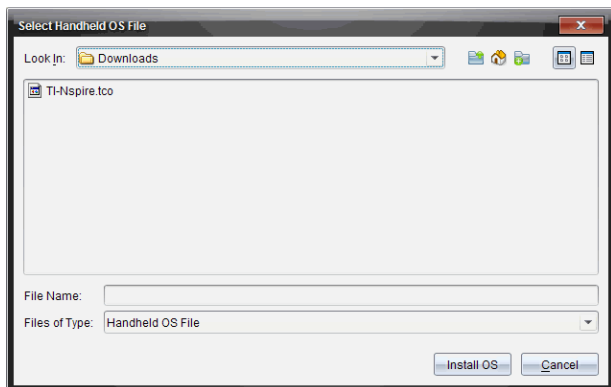
The file displayed for selection defaults to the file type required for the selected Lab Cradle.

1. Select the OS file TI-Nspire.tlo.

2. Click **Install OS** to download the OS and update the Lab Cradle. The confirmation message "*You are about to upgrade your handheld/Lab Cradle operating system. Any unsaved data will be lost. Do you want to continue*?" is displayed.

3. Click **Yes** to continue.

   The Installing OS dialog box opens indicating the progress of the download. Do not disconnect the Lab Cradle.

4. When the download is complete, the Information dialog box opens indicating that the OS file has been successfully transferred to the Lab Cradle. You can disconnect the Lab Cradle.
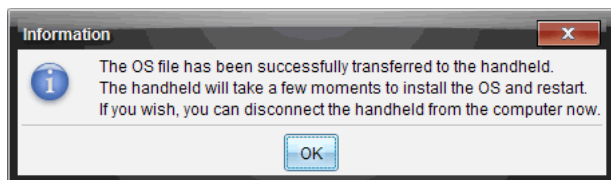
5. Click **OK**.

Updating the OS on Multiple Lab Cradles

1. To view connected lab cradles:

   • In the Content Workspace, view connected lab cradles in the Resources pane under the Connected Handhelds heading.

   • In the Documents Workspace, open the Content Explorer to view connected lab cradles.

2. Click **Tools > Install Handheld/Lab Cradle OS**.

   The Select Handheld OS File dialog box opens.
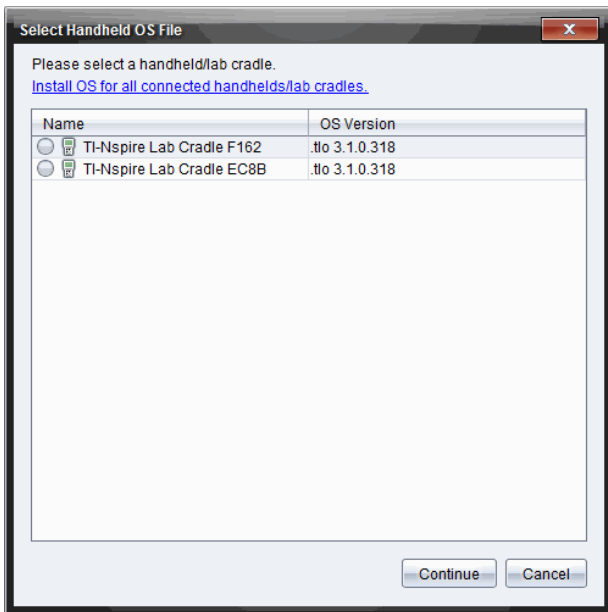
3. Click **Install OS for all connected handhelds/lab cradles**.

   Note: You can also update the OS on one lab cradle by clicking the radio button next to the handheld name, and then clicking **Continue**.

   The OS Installation dialog box opens.
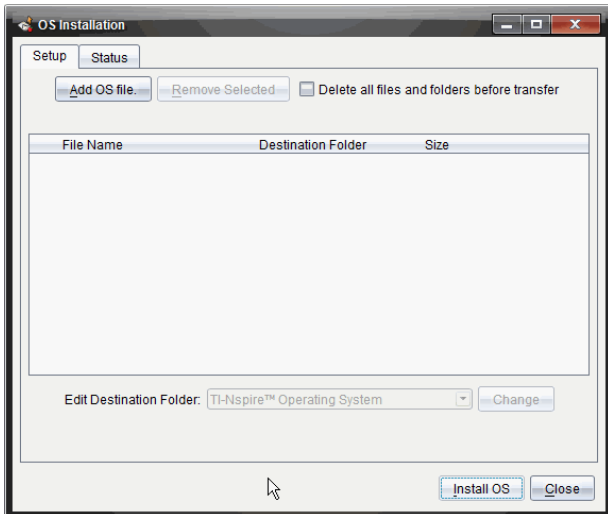
4. Click **Add OS File**.

   The Add to Transfer List dialog opens.
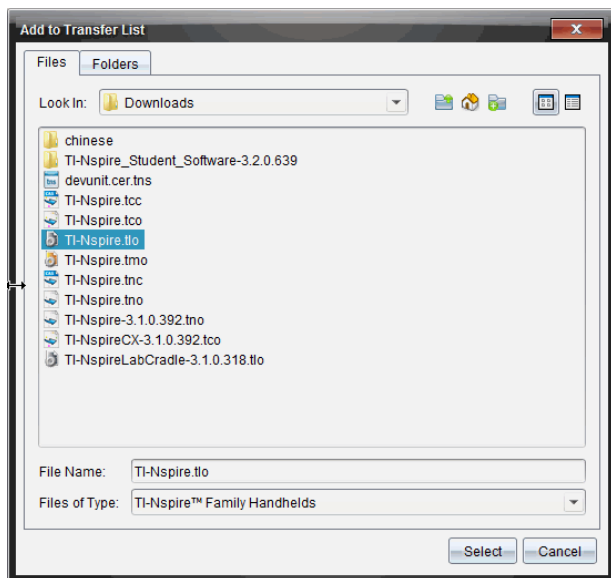
5. Navigate to the folder on your computer where the operating system file is located.

6. Select the TI-Nspire.tlo file.

7. Click **Select**.

   The OS Installation dialog box is redisplayed showing the selected file.

8. Click **Install OS**.

   The operating system is updated on the connected lab cradles. The status of the update is shown on the Status tab in the OS Installation dialog box.

9. When all lab cradles are updated, click **Stop Transfer**.

10. Click **Close** to close the OS Installation dialog box.

General Information

Texas Instruments Support and Service

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