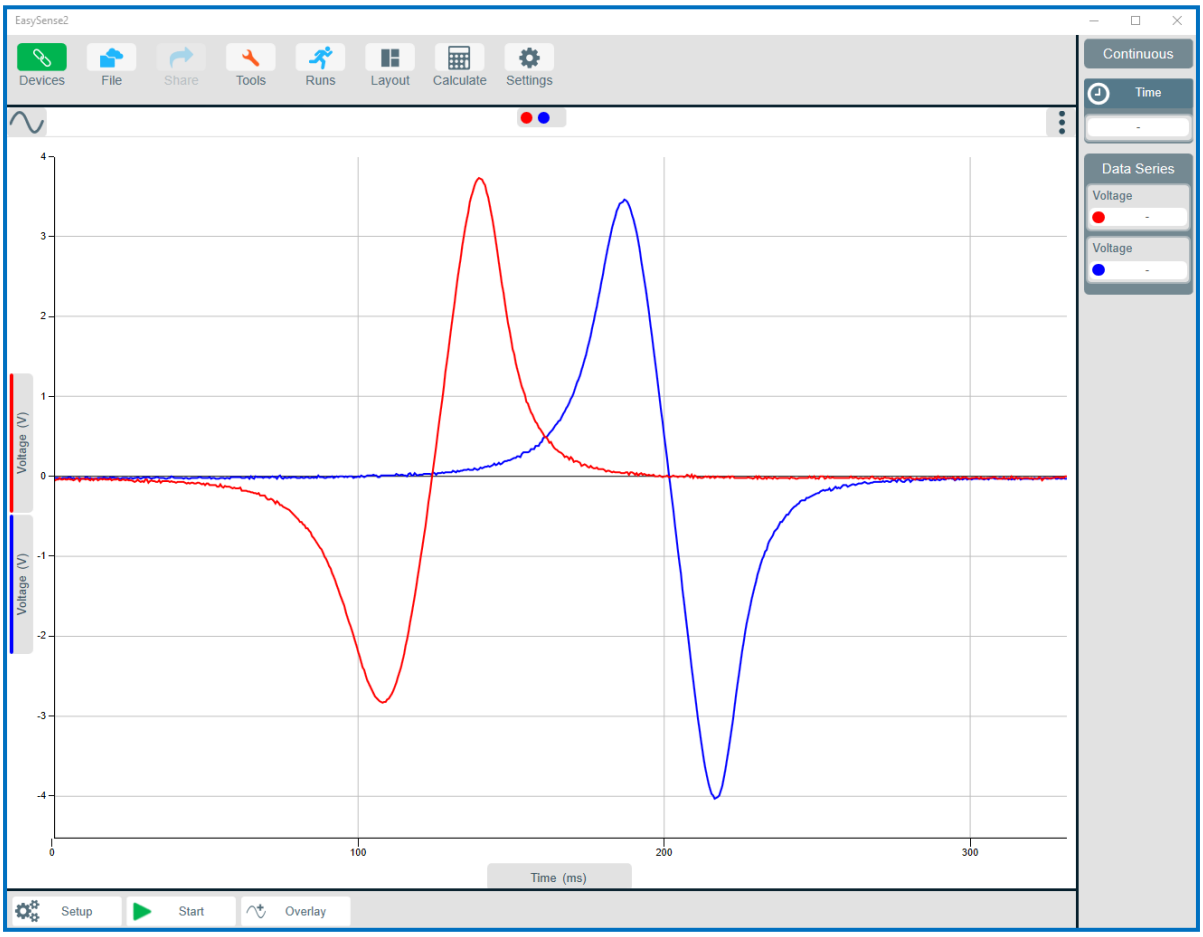
EasySense2 manual



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Document No: **DO277**
Issue 2

Contents

System minimum requirements

Microsoft Windows (Direct download via the Data Harvest website)	**Microsoft Windows** (Download from Windows 10 Store)	**Apple Mac**	**Google Chromebook**	**Apple iOS**	**Android** (Tablet & SmartPhones)
Windows 7 SP1, 8.1* & 10 Requires minimum Internet Explorer 11 plus .Net 4.5.2. *Not suitable for Windows 8	Windows 10 (Version 1703 Creators Edition or later)	OS X 10.10 64 bit processor	Chrome OS 57	iOS 10	OS 6

Methods of connection

Windows	**OS X or macOS**	**Chromebook**	**iOS devices**	**Android devices**
USB Bluetooth low energy (BLE)*	USB Bluetooth low energy (BLE)*	USB Wi-Fi Bluetooth low energy (BLE)*	Bluetooth low energy (BLE) (iPad 3 or later) Wi- Fi	Bluetooth low energy (BLE) Wi- Fi

***Note:** Only computers or devices with Bluetooth® low energy (BLE), also known as Smart or 4 are suitable.
To check Bluetooth compatibility:

Windows 10	**macOS**
Right click Start button, Device Manager, Bluetooth, look for the Bluetooth heading, check for Bluetooth LE Enumerator (Classic is not suitable).	Select Apple menu, About this Mac, More Info, System Report, Hardware, look for the Bluetooth heading, check to see if BLE is supported.

BLE connection can be added by use of the Bluetooth USB Adaptor (Product No. 2070 or 2071).

Supported devices

			
VISION Firmware V **4.6** or higher	**V-Log** Firmware V **2.1** or higher	**V-Hub** Firmware V **1.4** or higher	**Vu+** Firmware V **1.6** or higher
USB, Wi-Fi or Bluetooth* *Bluetooth requires a Bluetooth USB Adaptor	USB, Bluetooth or Wi-Fi	USB, Bluetooth or Wi-Fi	USB or Bluetooth
			
Vu (legacy product) Firmware V **1.4** or higher	**Wireless sensors** Firmware V0 or higher. Android users require Firmware V2 or higher.		
USB	USB or Bluetooth		

Installing the EasySense2 app

EasySense2 is available as a download from the app store for your device, links are available from the Data Harvest website (www.data-harvest.co.uk).

Note: The Windows direct download that is available from our website will not update automatically.

Connecting a V-series data logger or Smart wireless sensor

Note: V-series data logger refers to VISION, V-Log, V-Hub, Vu+ or Vu data loggers.

USB connection

The first time a V-series logger or wireless sensor is connected to a USB port on the computer its device drivers will automatically be installed. Plug in the data logger or sensor before opening the EasySense2 app.

Bluetooth™ connection:

Use the instructions provided for the data logger, wireless sensor or the Bluetooth USB adaptor. Check on the computer or tablet that Bluetooth is On. **Do NOT pair the devices**.

Wi-Fi connection:

Use the instructions provided for the data logger. For example on the iPad or Android tablet:

Access point users: Check in Settings that Wi-Fi is On, select the loggers name from the list of available networks. Wait for confirmation that the network has been joined e.g. a tick or it shows as Connected.

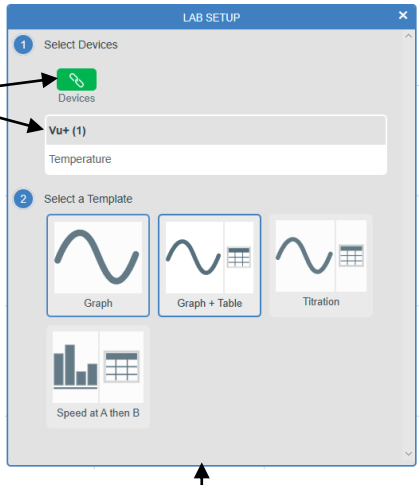
Infrastructure users: Connect the iPad or Android device to the schools network.

The start

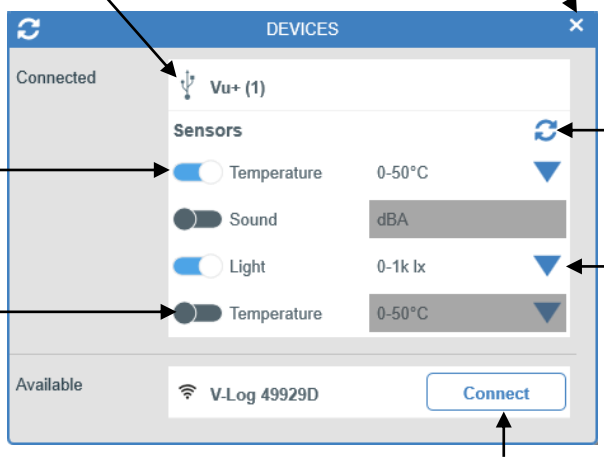
Start the EasySense2 app.

USB users: The Devices icon will automatically turn from Red (no interface detected) to Green with the interface detected and its sensors shown below.

Internal sensors are off by default, to switch on or change the range of the sensors select the Devices icon.



Note: This window is also available as New Lab from the File menu



Refresh

Slide switch indicates this sensor is On.

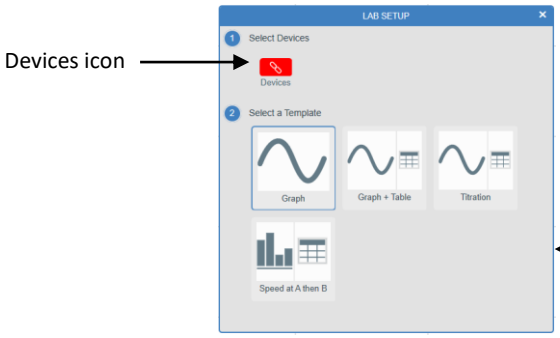
To change the range of the sensor tap or click the down arrow and select from the list

Slide switch grey indicates the sensor is Off (so no readings will be taken from this sensor). Tap or click to switch On.

Tap or click to connect another Bluetooth data logger or Smart wireless sensor

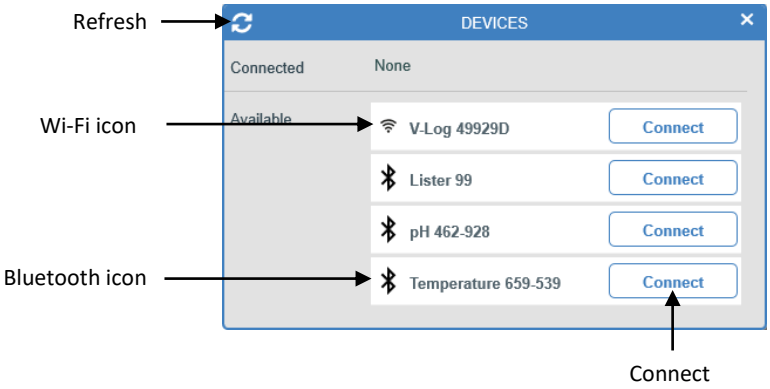
Bluetooth or Wi-Fi users:

1. Select the red Devices icon.

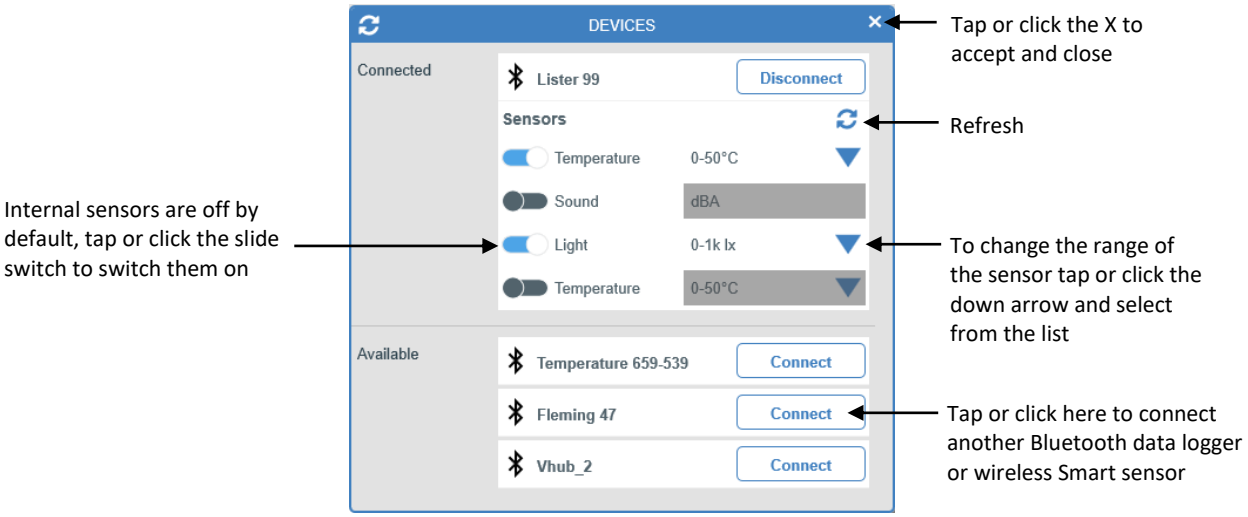


2. Select the data logger or wireless sensor from the list of available devices.

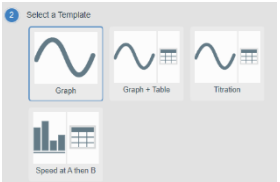
   Note: This list is also available from the Devices icon on the main screen.



3. Select **Connect**.



Templates



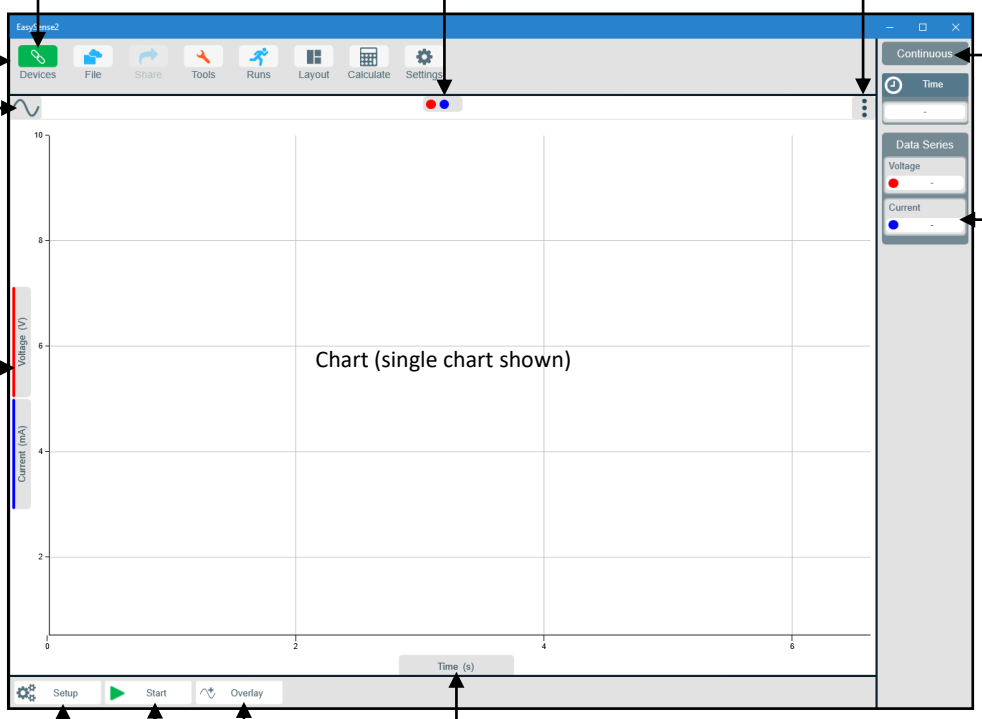
There are a choice of pre-set templates available from Lab Setup (or via File -> New Lab).

For example a template of:

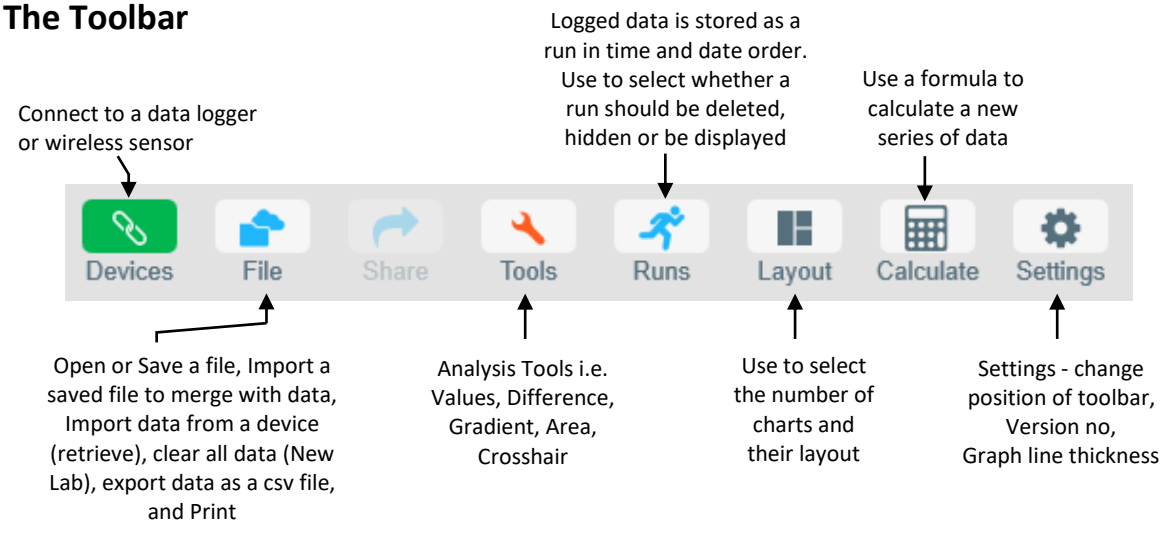
- Graph - fills the whole chart area with a line graph display
- Graph + Table - a two chart template, 66% showing a line Graph display and 33% showing a Table.
- A Titration set up. A line graph and table display, in Snapshot mode with an 'Enter Volume' function. Each time you click in Take Sample to record the value, an enter value box will appear for you to type in a number from your keyboard. Enter the TOTAL volume added so far.
- A Speed at A then B setup. A bar graph and table display, in Timing mode to record Speed at A (u), Speed at B (v) and Time from A to B (t). The apparatus set is a single interrupt card 120 mm in length. Created for students to calculate Acceleration (the change in velocity over time) using the Dynamics system apparatus.

$$a = \frac{(v-u)}{t}$$

The EasySense2 main screen



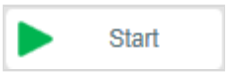
The Toolbar



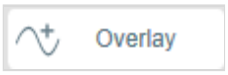
Recording data

To begin recording click on the **Start** icon.

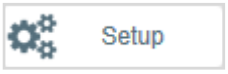
During logging the icon will alter to **Stop** and show a red square. Click on this icon to stop data being recorded.



If you want to clear the recorded data and repeat the last experiment (with all of the settings the same) simply click on the **Start** icon again.

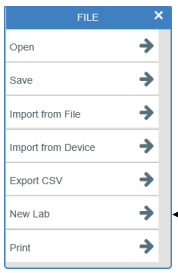


If you want to collect data, without the previous set of data being erased, select **Overlay** before you click on Start. The new data will be superimposed on the data already on the graph.



To set up a new investigation e.g. to identify a change of sensor or change a sensor's range, alter the mode of logging, start or stop conditions, select the **Setup** icon.

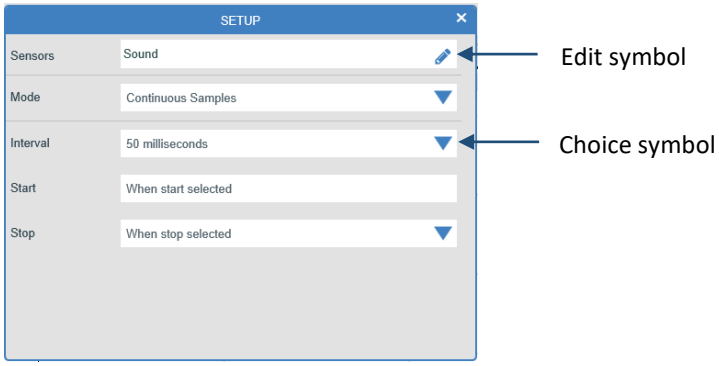
The logged data will clear from the chart and be stored as a run which can be accessed or deleted via the **Run** icon.



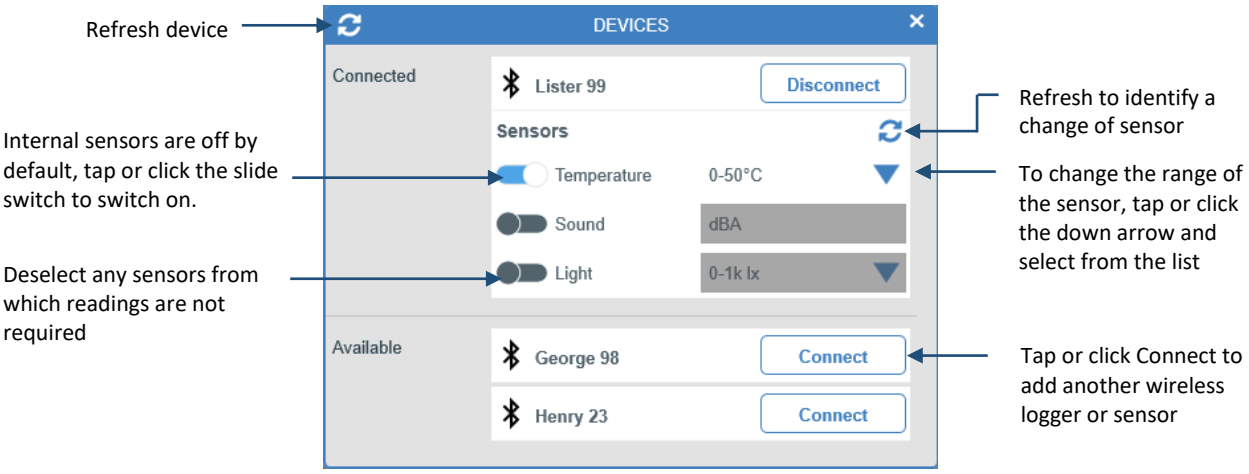
Select New Lab from the File menu to re-start from the beginning i.e. open a new template, clear the collected data, delete stored runs of data but retain the chart display and settings opted for in Setup.

Experiment Setup

Select the Setup icon (bottom left of screen).

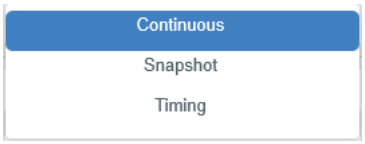


Sensors: (selection and or alter sensor's range). Select the edit symbol.



Mode: Select the choice symbol and choose your mode of logging.

Continuous samples



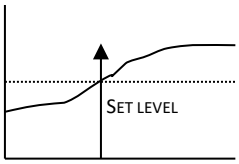
Pre-set to record sensor values **continuously** as a line graph until the stop condition is reached.

- Select Continuous as the mode.
- Select the interval between samples being taken (spans from 20 µs to 7 days).

  Notes: The fastest logging speed of the Vu+ data logger and the Bluetooth wireless pH and Temperature sensors is 50 samples per second so intervals shorter than 20 ms will not be available to select.

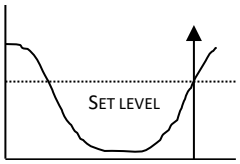
  If intervals are less than 20 ms with a V-series data logger connected, recording will done be in FAST mode (log + retrieve), when no data is displayed until the recording ends.
- Select the condition required for the recording to start. The choice of start conditions and triggers available will depend on the type of logger and the recording time selected.
  - When start is selected. To begin recording as soon as you click on the Start icon. 

  - Trigger when the value from the sensor selected is:



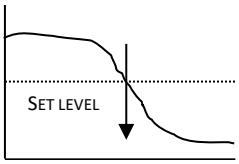
Higher than

To start recording when the value from a sensor is above the set level.



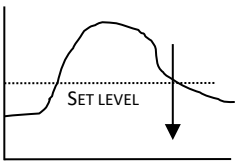
Value rises above

Logging will not start until the value from a sensor rises up above the set level.



Lower than

To start recording when the value from a sensor is below the set level.



Value falls below

Logging will not start until the value from a sensor falls below the set level.

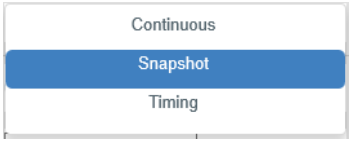
- Select any pre-trigger requirements.

  Note: This option is available for Smart Wireless Bluetooth sensors if a trigger on level condition is selected.

  Pre-trigger stores samples prior to the trigger condition being met and then displays the results. For example, to capture an entire induced voltage event you will require data to be recorded prior to the voltage rising up to the value set for the triggered start e.g. record data for 500 ms before the voltage rises above 0.04 V.
- Select the stop condition
  - When stop is selected (only available if an interval higher than 20 ms is selected).
  - After a duration. The number of samples will automatically alter as the duration is being selected.
  - After a specified number of samples. Tap or click in the Sample Count box and type in the number required.

Once ▶ Start is selected logging will begin when the start condition you have selected is met.

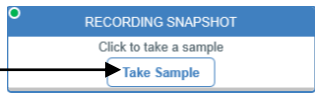
Snapshot (manual sampling)

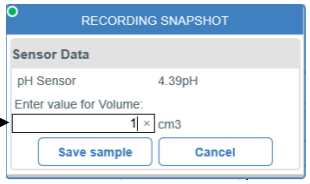


The graph will open pre-set to record sensor values on demand.

- Select Snapshot as the mode.
- Manual entry - if selected each time you take a sample a dialog box will appear for you to enter a number, these entries will create a set of data. Enter a name and the units for this data series.
- Select the stop condition (when stop is selected, after a duration, or after a specified number of samples).

Select ▶ Start and tap or click on Take Sample.

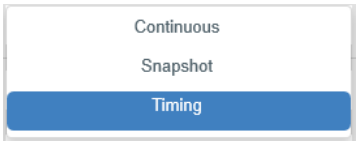




If manual entry was selected type in the value and select Save sample.

Logging will continue until the stop condition is met.

Timing

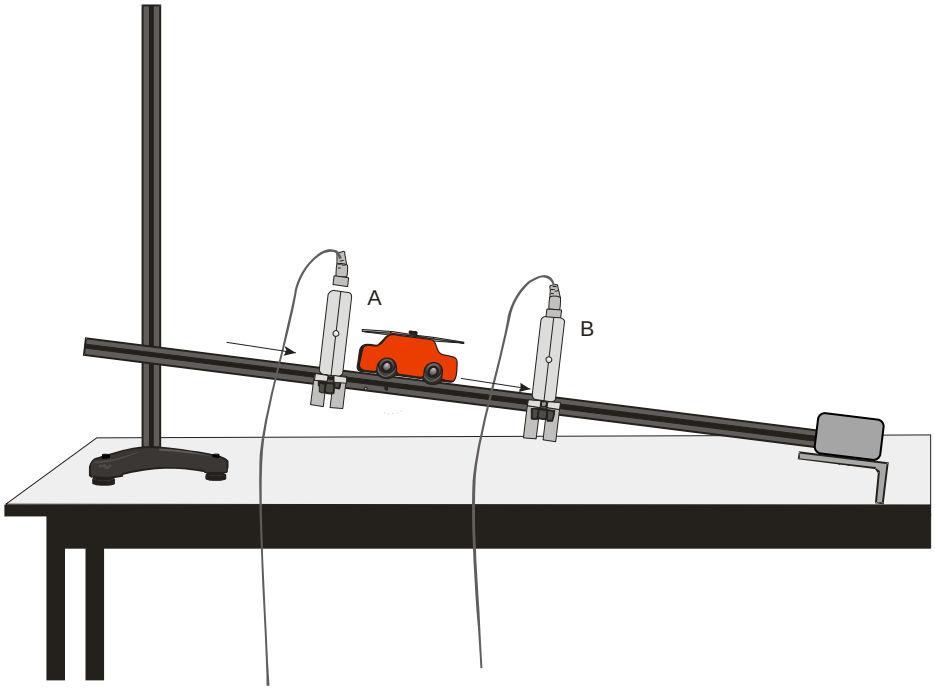


Timing is used to allow students to study Time, Velocity, Acceleration, Momentum and Kinetic Energy relationships using switch-type (digital) sensors such as Light gates which only have two states, ON or OFF.

Connect the digital sensors being used to the interface, measurements can be taken from either a single sensor connected to Input **A**, or from two sensors connected to both Input **A** and **B**. The graph will be pre-set to record as a bar graph display against reading number.

- Select the mode as Timing.
- Select
    1. What you would like to measure e.g. Time, Speed/Velocity, Acceleration, Distance, Momentum and Kinetic Energy, Raw data.
    2. Select whether you want to measure at A, at A or B, from A to B, at A then B, from A to A, Pendulum.
    3. Select the type of apparatus being used and the measurement required by the calculation e.g. to calculate speed from A to B, enter the distance between the two digital sensors connected to A and B.
    4. If required select to display any of the data sets used in the calculation.
    5. Select the stop condition (when stop is selected, after a duration, or after a chosen number of samples).

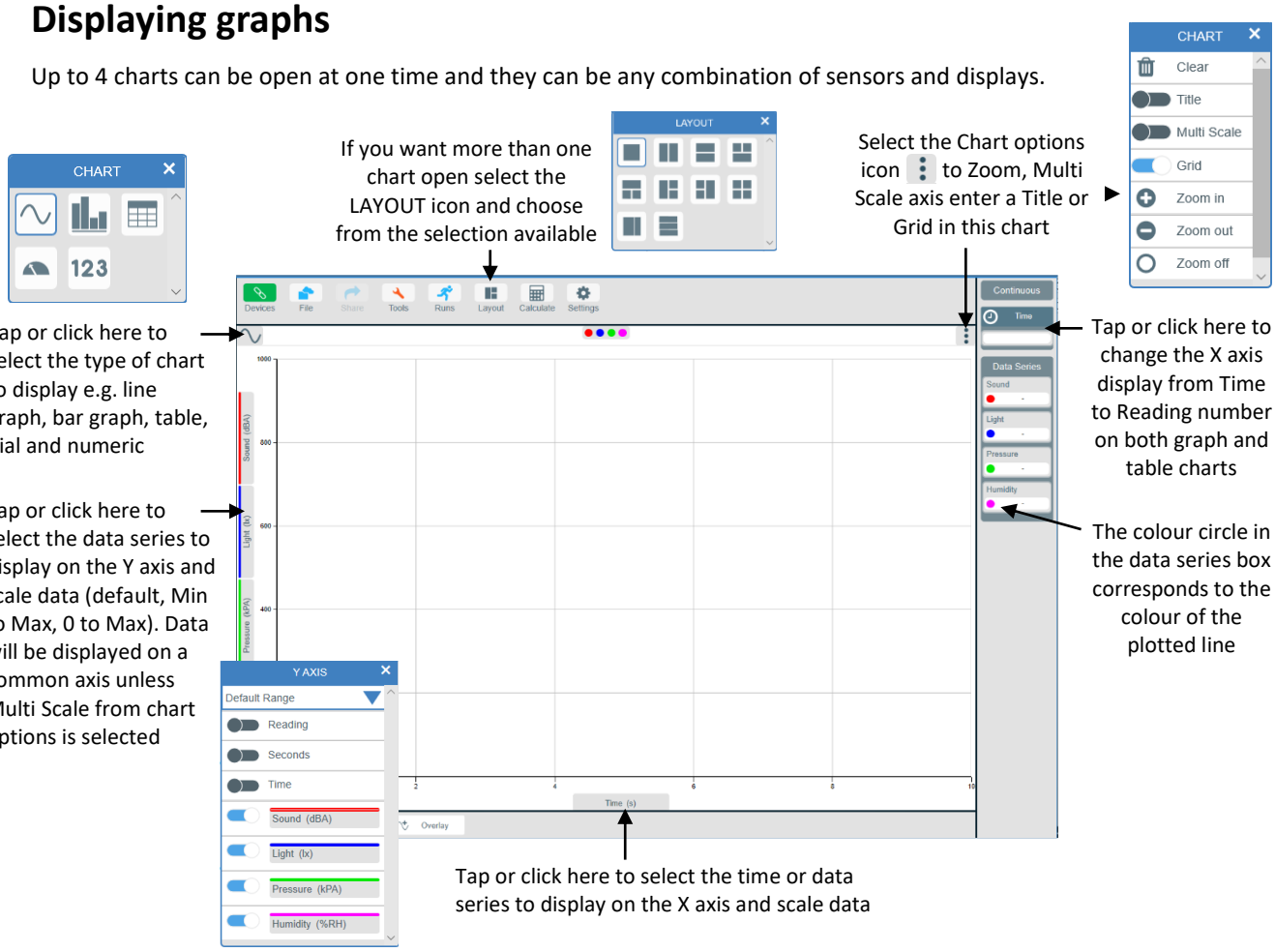
Select ▶ Start. When a signal change from the digital sensor/sensors is received, the timing measurement will automatically be entered. The vertical axis scale automatically adjusts to match the largest value collected. See page 23 for further information.

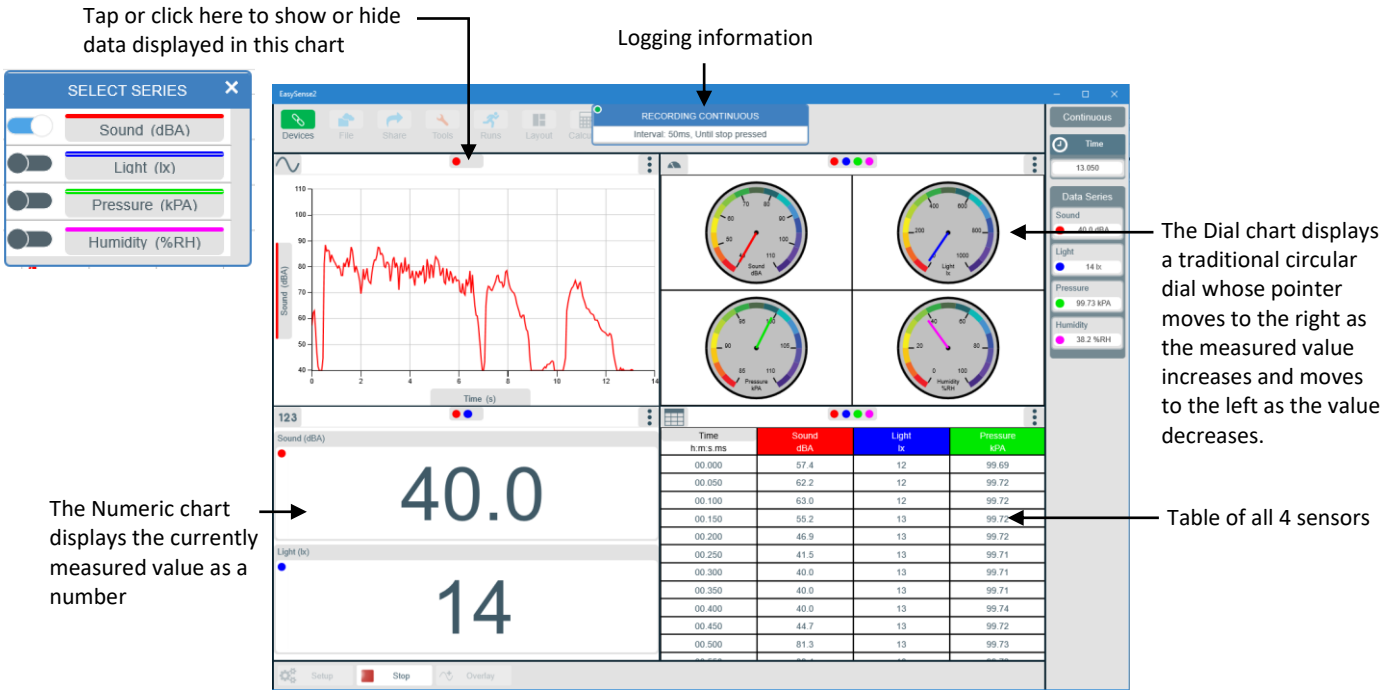


This diagram shows a typical apparatus set up for use with Timing. Light gates are connected to Input A and B on data logger and are used to monitor the movement of a cart down a track. An interrupt card is fixed to the top of the cart and this card will cut through the Light gate's infrared beam.

Displaying graphs

Up to 4 charts can be open at one time and they can be any combination of sensors and displays.

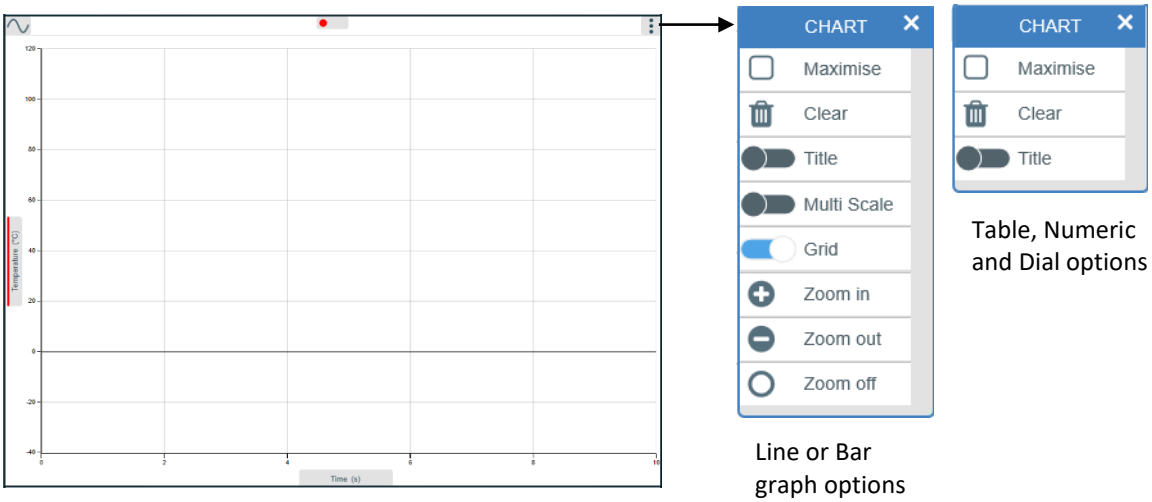




For example a 4 chart display, chart 1 = Line graph with just the Sound sensor displayed, chart 2 = dials of all 4 sensors, chart 3 = numeric display of 2 of the sensors, chart 4 = table of all 4 sensors.

Chart options

Some display options are applied on an individual chart basis rather than to all charts. Select the chart options icon ⋮ top right of the chart you want to alter. The options available will depend on the chart type selected.



Line or Bar graph options

Table, Numeric and Dial options

Maximise

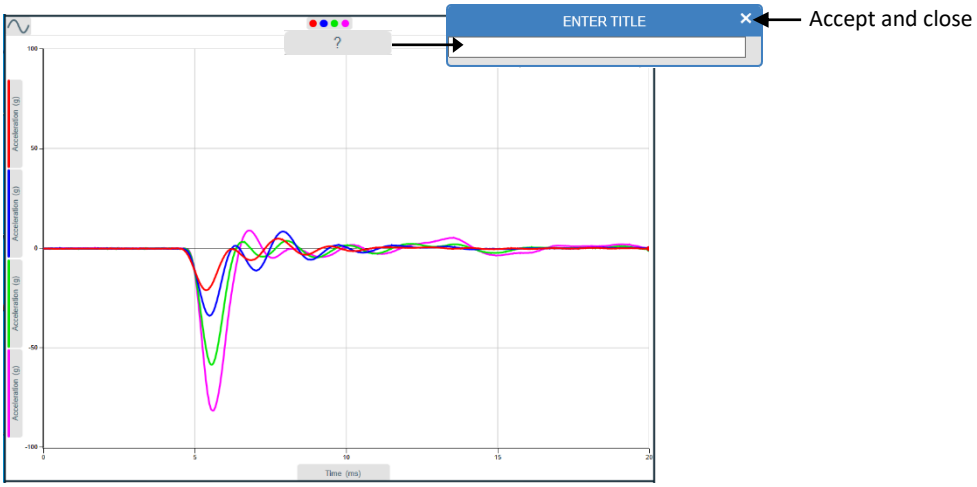
A chart can be maximized to fill the whole area by selecting Maximize from the chart options icon. Select Restore to return to original screen size.

Clear

Use to clear empty a chart of all data and deselect the chart type. Data is not deleted, use Runs to re-plot the data.

Title

Select Title. Tap or click on the grey Enter Title text above the chart. Type in the text for the title and select X to accept & close.



To edit click on the title text and alter as required. To hide deselect Title.

Multi Scale

By default data is displayed on a common axis (all sensors share the same axis scale), so the maximum and minimum value will be dependent on the highest and lowest limits combined of all sensors connected. Select Multi Scale from chart options to change so that each sensor uses its own axis label and numeric scale markings. Tap or click on the sensor's name to select which sensor to display on the Y-axis.

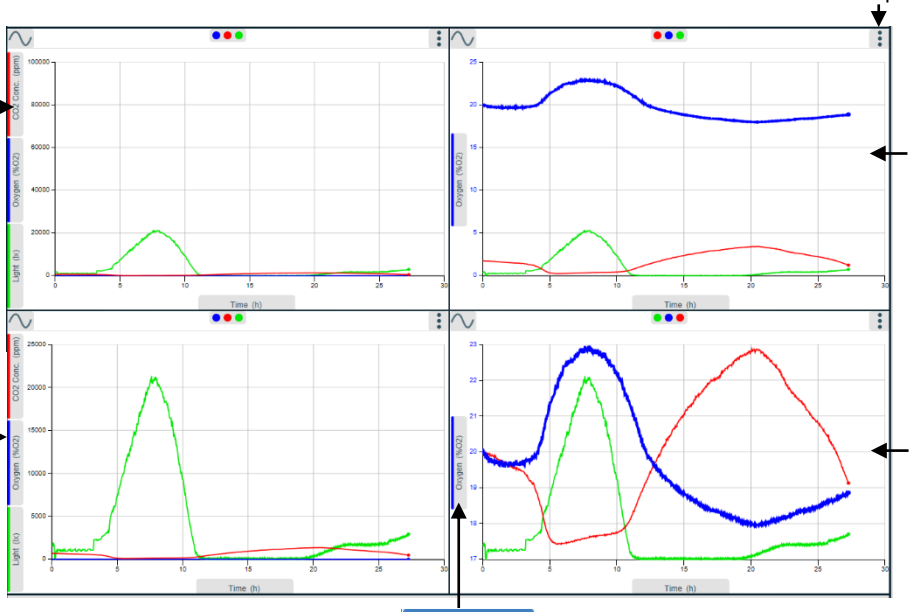
See the next page for an example of 4 charts, each showing the same data but displayed in different formats.

Chart Options

Data from all 3 sensors displayed on a common axis (default)

Light's range = 0 to 100,000,
Carbon Dioxide = 0 to 10,000,
Oxygen = 0 to 25%,

∴ Axis minimum is 0 and maximum of 100000



Multi Scale from Chart Options selected

Light's range = 0 to 100,000,
Carbon Dioxide = 0 to 10,000,
Oxygen = 0 to 25%,

Scale is that of the sensor chosen to be displayed on the Y axis i.e. Oxygen

All 3 sensors on common axis, Min to Max scale applied

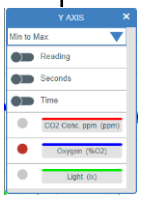
Light values = 0 to 20,000
CO_2 = 98 to 1,370 ppm
Oxygen = 18 to 22.8%

∴ Axis minimum is 0 and maximum of 25,000

Multi Scale selected

Auto scale Min to Max applied.

The scale for each sensor is re set to the min – max of the recorded data.



Y Axis choices (axis to display and auto scale Min to Max or Zero to Max)

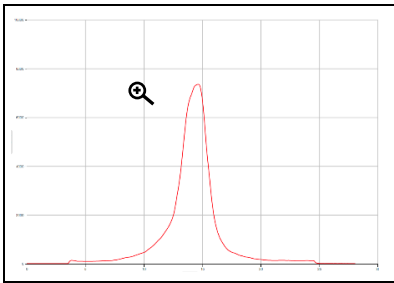
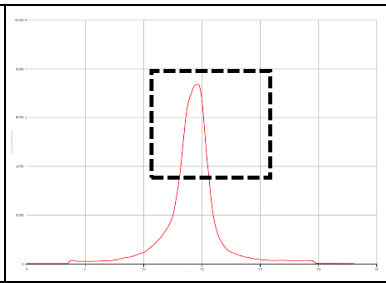
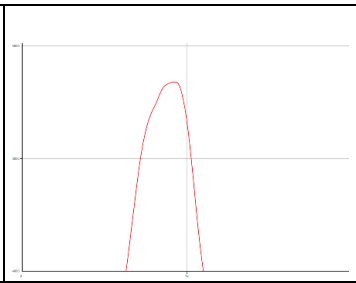
Grid

Select whether a Grid should be On or Off the graph. If a grid is selected then a faint grating is marked on the graph.

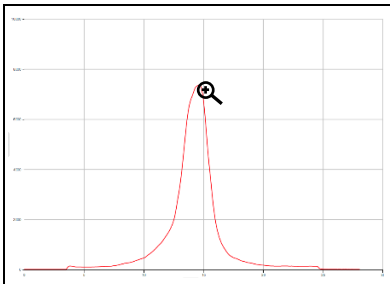
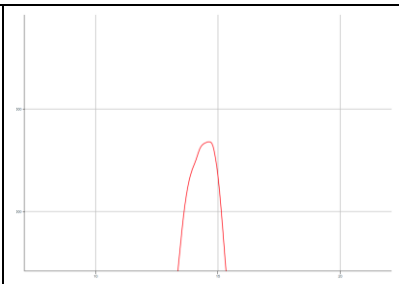
Zoom

An area of the graph can be magnified so that a particular area can be seen in greater detail.

Click and drag method:

		
Select **Zoom in**. Position your finger or the mouse pointer at the top corner of the area to be magnified.	Click or tap, hold down and drag the rectangular box over the area to be magnified.	Release to show the magnified area.

Point method:

	
Select **Zoom in.** Position the mouse pointer or tap on the screen at the area to be magnified.	The area will magnify and redraw automatically

To expand this magnified area further select **Zoom in** and repeat the above.

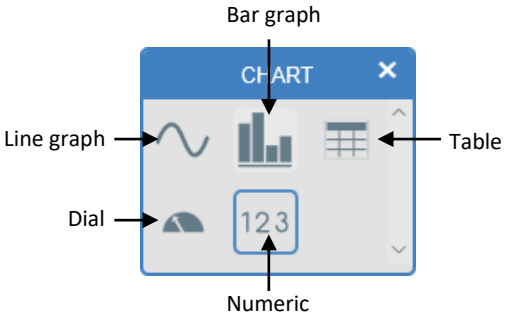
Select **Zoom Out** to zoom out by one step.

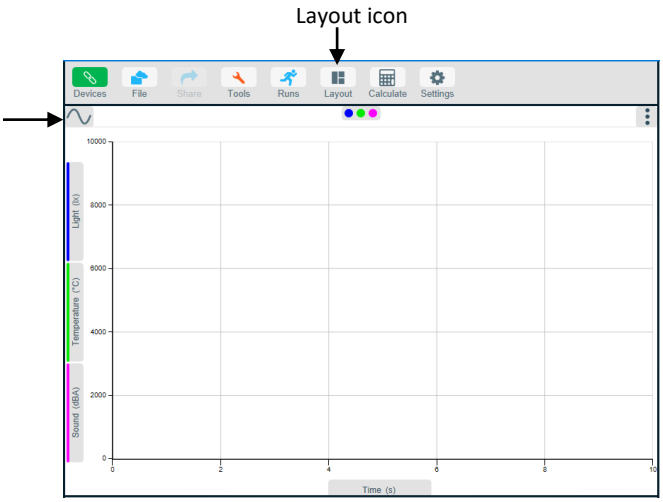
Select **Zoom Off** to return to the original graph.

Chart Layouts

To change the number of charts or their orientation select the Layout icon.

To alter the type of chart displayed e.g. from graph to table, select from the chart icon (top left of the chart).



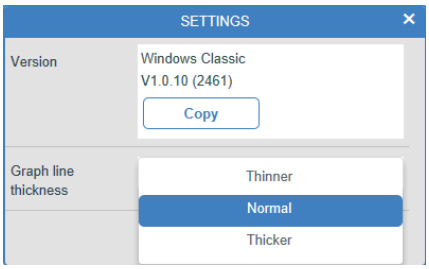


Bar or Line Graph

Select line or bar graph from the chart icon top left of a chart.

With a **Line Graph** individual readings are by default joined by a line. There is a choice of three different thickness of line available from the Settings menu.

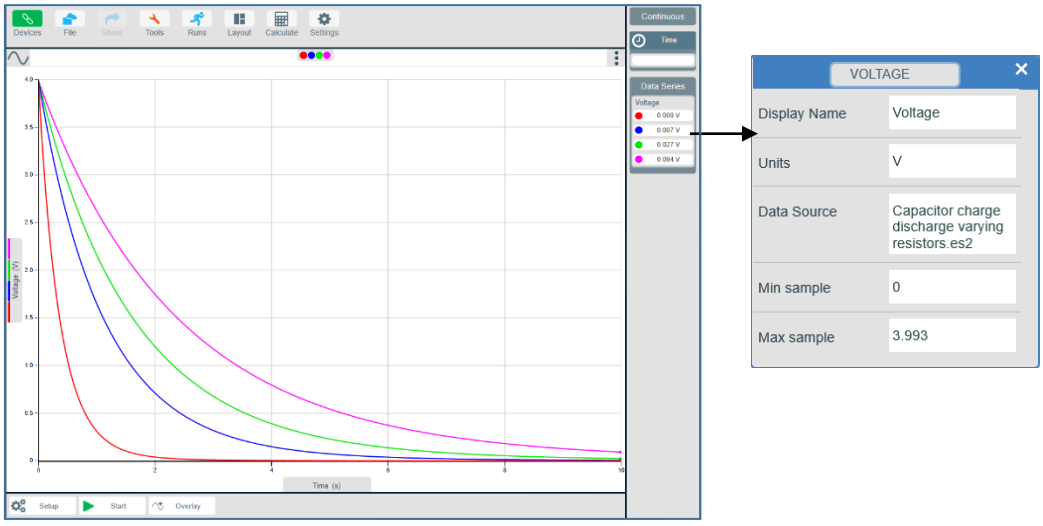
With a **Bar Graph** readings will be shown as bars of colour.



Data Series

The colour circle in a data series box corresponds to the colour of the plotted line.

Tap or click on a box to view information about the data collected from a sensor or derived data e.g. name, units, the source of the data (e.g. data logger's name, file name, etc.) and the highest or lowest value sample recorded.

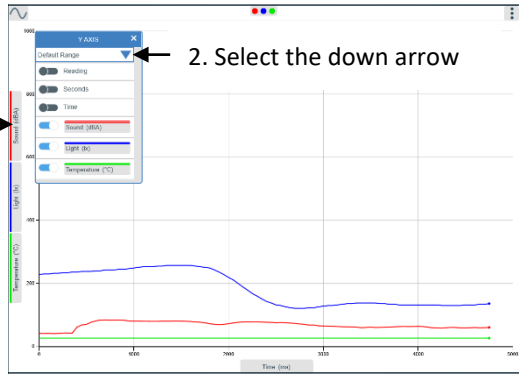


Autoscale

Normally the full scale of all sensors are displayed on a common axis. If Multi Scale from chart options is selected then each sensor will be displayed using its own axis label and scale markings. The data from Wireless Bluetooth sensors will scale automatically as data is collected.

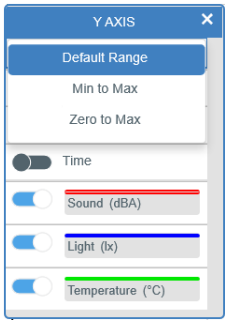
If the scale of an axis is too large the axis can be scaled using the values of the data collected.

1. Tap or click on the axis label



3. Choose between

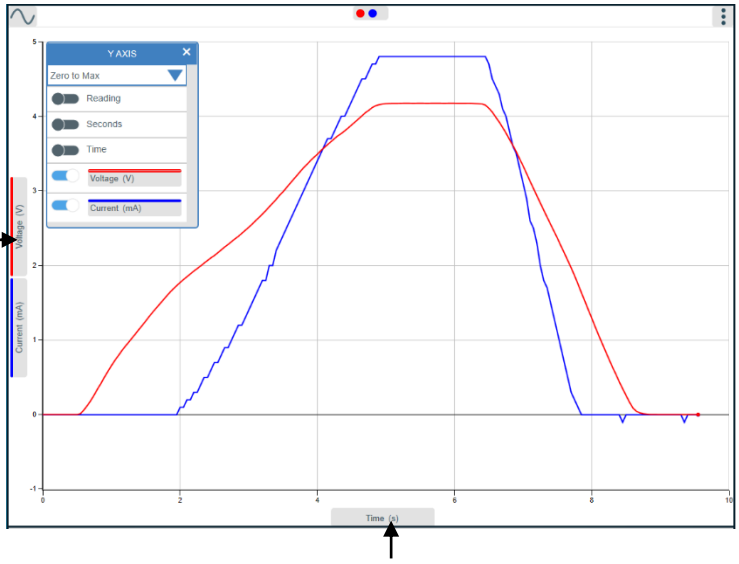
- **Default**: Restore the limits to the full scale of the sensors.
- **Min to Max**: Rescale the Y-axis to the maximum and minimum limits of the data
- **Zero to Max**: Rescale the Y axis using a minimum of zero to the maximum of the data



Axis options

Tap or click on the axis label (grey area round the axis name) to open the options for the X-Axis or Y-Axis.

Tap or click in this area for Y Axis options



Tap or click in this area for X Axis options

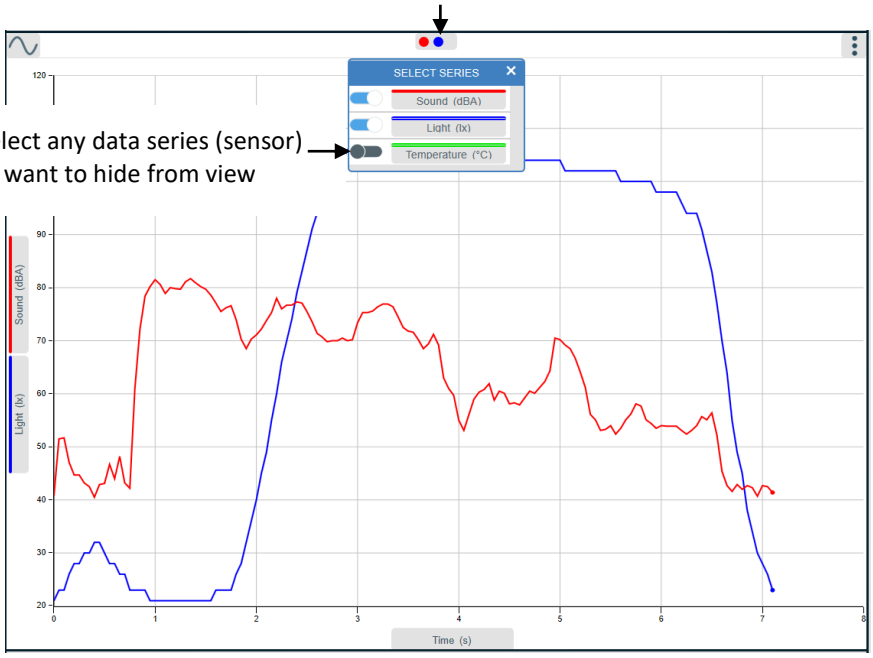
Select whether you would like Time, Reading Number or a Data Series (e.g. sensor) displayed on the axis.

- **Reading** - set to the number of single readings taken, without any regular time interval between them. This axis is often used for Snapshot data.
- **Seconds -** time axis as seconds [Time (s)].
- **Time** - elapsed time in days, hours, minutes and seconds [Time (d:h:m:s.ms)].
- **Data Series** e.g. Sensors.

Show or Hide data

(1) Tap or click on the colour swatch at the top of the chart area (grey area with coloured circles)

(2) Deselect any data series (sensor) that you want to hide from view



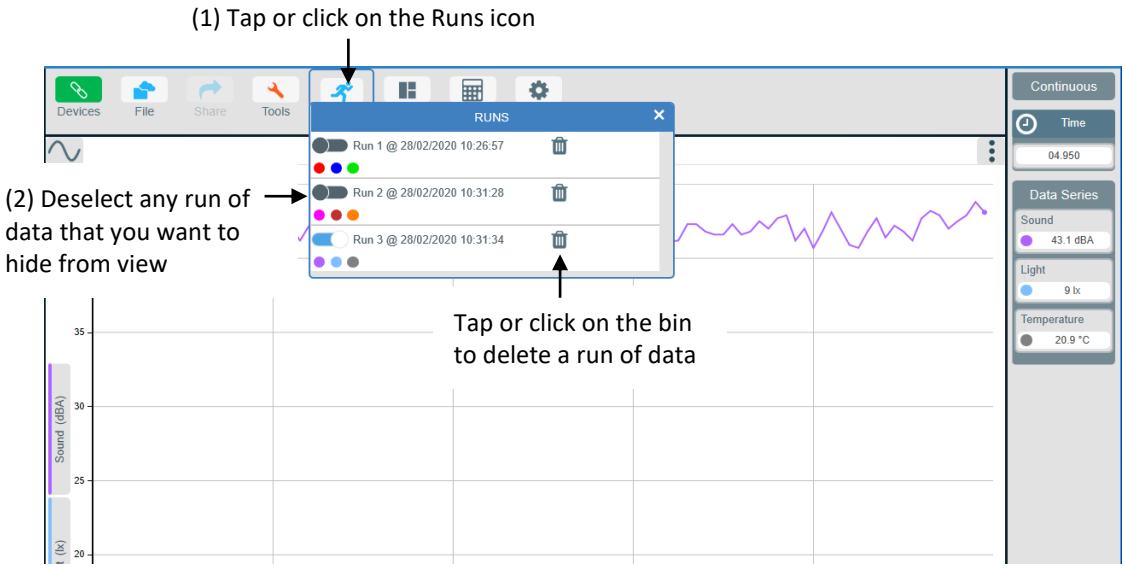
Runs

When data has been logged it is stored as a 'run' of data from all active sensors. If you select Start again the graph will clear and a new run of data will be created. Multiple runs of data can be collected for comparison. Select the Runs icon and select the ones you want to view, runs are listed in time and date order.

(1) Tap or click on the Runs icon

(2) Deselect any run of data that you want to hide from view

Tap or click on the bin to delete a run of data



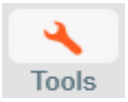
Delete data

To delete individual runs of data select the Runs icon and the bin image to delete. 

Select New Lab from the File menu to clear the collected data and delete all stored runs of data.

Analysing captured data

There are a number of tools available to allow the analysis of captured data. Select Tools from the menu bar to open the analysis menu.

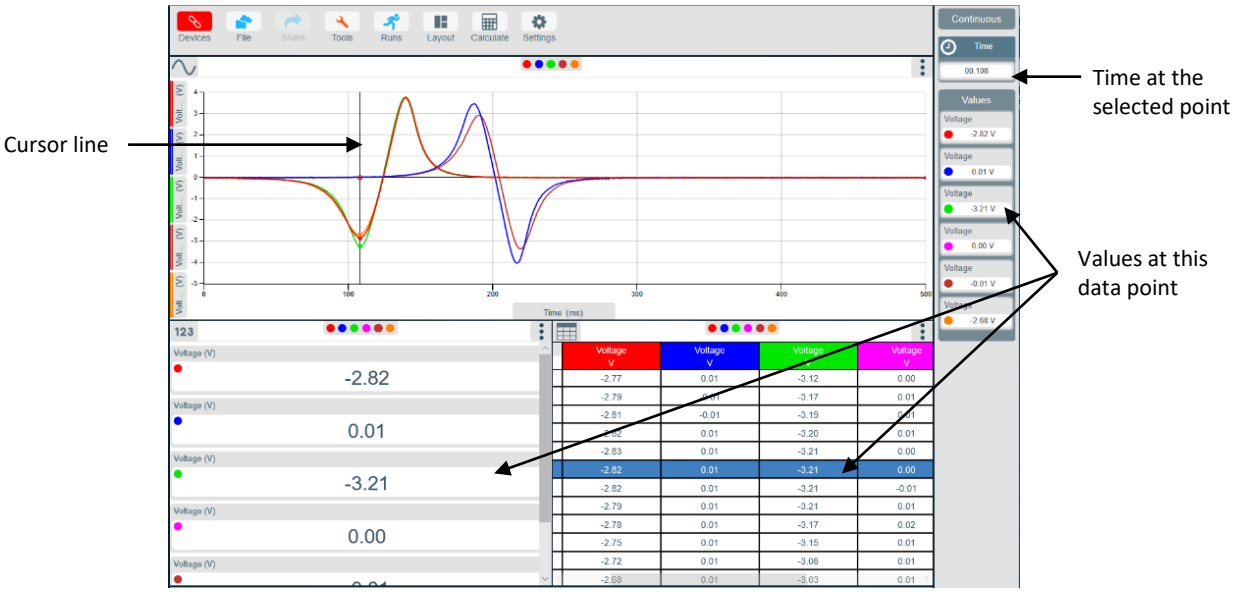


Values

Tap or click the slide switch to select **Values**. Tap or click in the graph or table chart at the point where information is needed. A cursor line will appear on the graph at the nearest data point and highlight in a table. Values at that point will be shown in the values box or numeric chart. The display mode box will indicate the time or reading number of that data point. The cursor can be dragged to any point.

To deselect select the Tools icon and tap or click on Values.

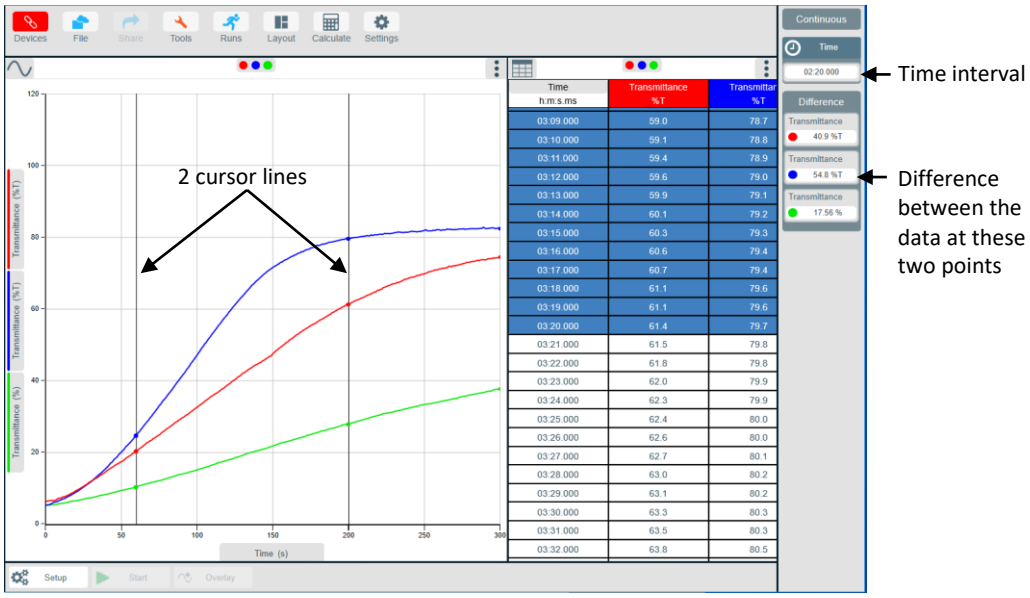
Note: If the X-axis is a sensor, select Crosshair instead of Values to indicate what the value from the sensors would be if they crossed at the cursor point.



Difference and Interval

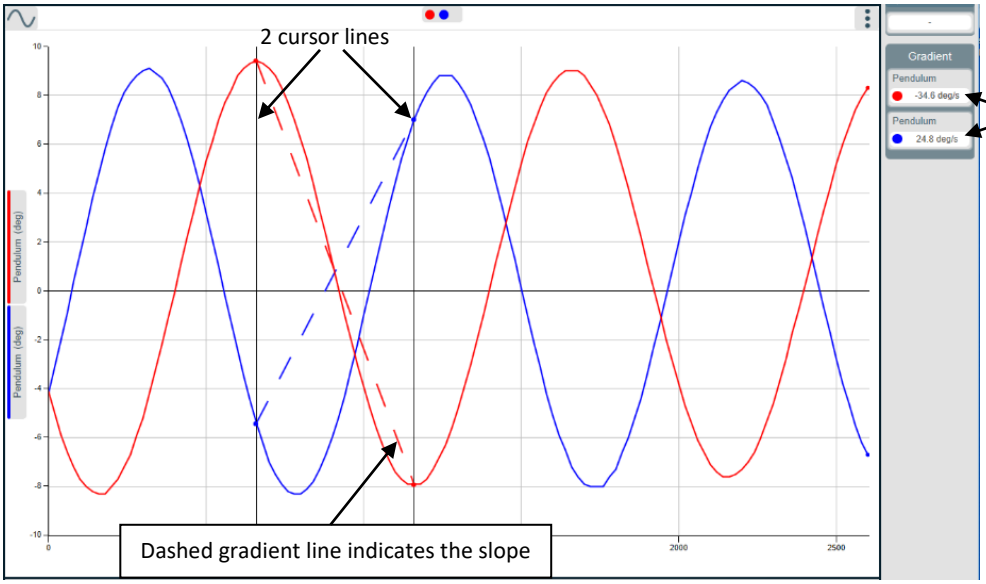
Select **Difference**, two cursor lines will appear in the graph area. Move one cursor line to the first reading to be used in the comparison and the other line to the second point. The data in between will be highlighted in the table and the values in the data series box will be the difference between the data at those two points. The display mode box will indicate the time interval between the two selected points.

The cursors can be dragged to any point. To deselect select the Tools icon and tap or click on Difference.



Gradient

This feature calculates the rate of change of data in the vicinity of the cursor. When the graph line is horizontal the gradient is zero and values are not changing. A positive gradient shows that values are increasing – the larger the gradient, the faster the change. Select **Gradient**, move the two vertical cursors to the position from which information is required, a dashed line will indicate the slope of the graph for each data series. The gradient value between the two cursors will be shown in the data series boxes.

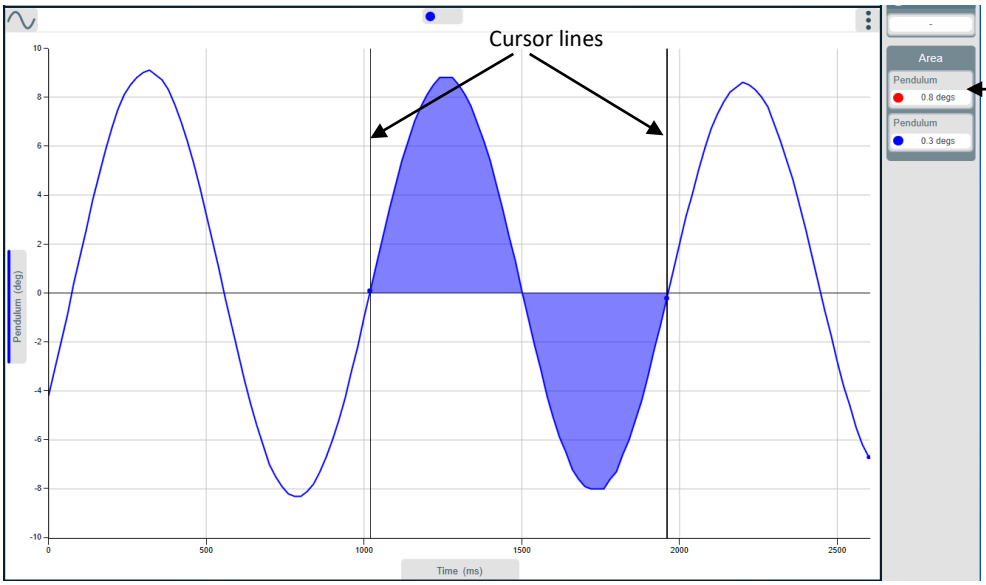


To deselect select the Tools icon and tap or click on Gradient again.

Area

This feature is used to calculate and display the area under a chosen section of the graph. The calculation for area is performed on the data from all channels. The units correspond to the product of the Y and X-axis.

From the Tools icon select **Area**, move the two vertical cursor lines to the start and end point. Shading lines will mark the section under the graph for each data series. The values for area will be shown in the data series boxes.

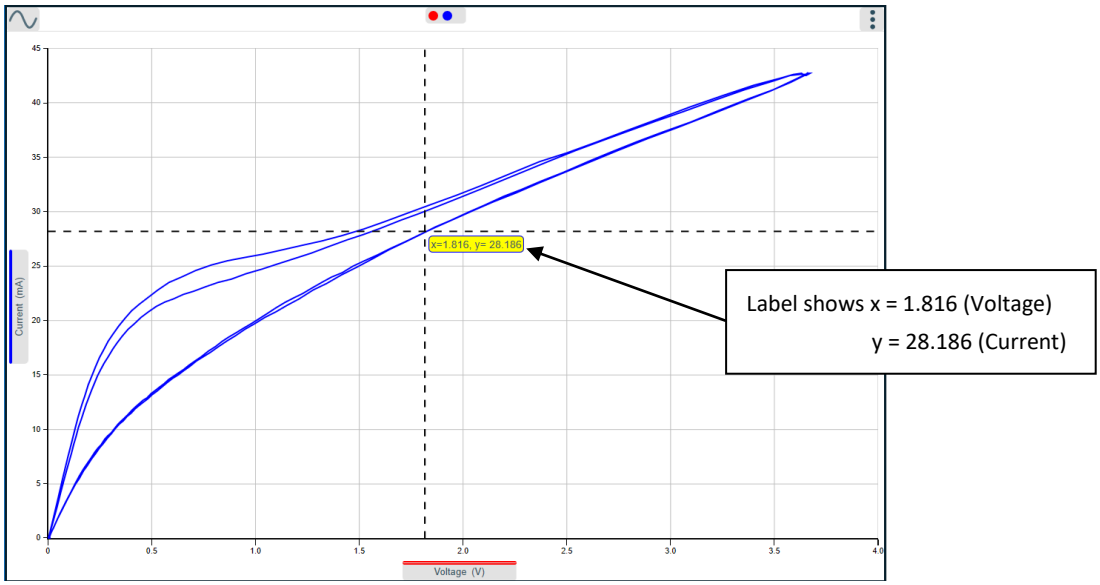


To deselect select the Tools icon and tap or click on Area again.

Crosshair

This feature shows the value at the point that a vertical and horizontal line cross.

Select **Crosshair**, click and drag the point of the crossover to the position from which information is required. The label will show the value of the X and Y axis at that data point. Use to interpolate data.

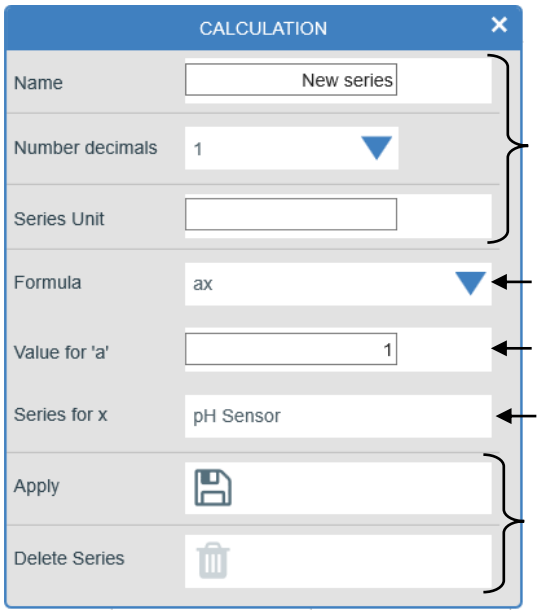


Calculate function

Calculate is for mathematical operations that can be applied to data. These can be applied to data as it is being collected or after the data has been collected.

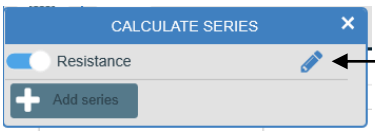
1. Select the Calculate icon from the toolbar. 

2. Select Add series. 



3. Enter a name for the series, the number of decimal places to be displayed and the units for the new data. Decimals should at least equal the sensor's resolution.
4. Click on the down arrow to view the formulae available and select from the list (see notes).
5. Enter any parameters required by the formula for 'a' and/or 'b'. E.g. type in a multiplier, constant or scaler. Numbers can be negative or positive (make sure there isn't a space between the + or – sign and the number).
6. Select the data channel(s) to be used as the source of x and/or y if required by the formula. Click on the arrow to reveal the list of sensors connected. The list will include any derived data channels.
7. Select Apply and the calculated data will appear on the graph, if a mistake has been made select Delete Series.

You can delete or change a calculated series after it has been applied by selecting the Calculate icon and then the edit symbol for the series.



If you are applying a calculation prior to logging, click on the Start icon. Data will be calculated and displayed on the graph and table.

Notes:

Formulae available are:

a	ax	a/x
ax + b	ax + by	sin(ax)
cos(ax)	axy	axy/b
ax/by	dx/dt	Moving average

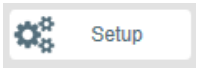
- The data channel(s) list is presented in the order of the connected sensor ports.
- A negative number multiplied by a positive number creates a negative.
- A negative number multiplied by a negative number creates a positive.
- Any number multiplied by zero = 0. A number multiplied by 1 gives the same number.
- To remove part of a function set the constant's (a or b) number to zero. E.g. To multiplying a data set by a constant would require an *ax* function. The function *ax + by* can be altered to *ax* by setting *b* to 0 (0 multiplied by *y* = 0).
- To leave the value of a data set unchanged by a calculation then the value of *a* or *b* should be set as 1. E.g. when adding two data sets there is no function *x + y* but there is *ax + by*. By setting both *a* and *b* to 1 makes the function *ax +by* = 1*x* +1*y* = *x + y*.
- When calculating moving average ensure the decimal places are set to at least the resolution of the sensor e.g. Voltage recorded to three decimal places (4.174 V) so set decimals to a minimum of 3.

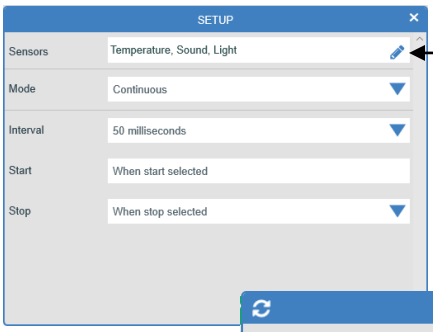
Changing Settings

Changing a sensor's range

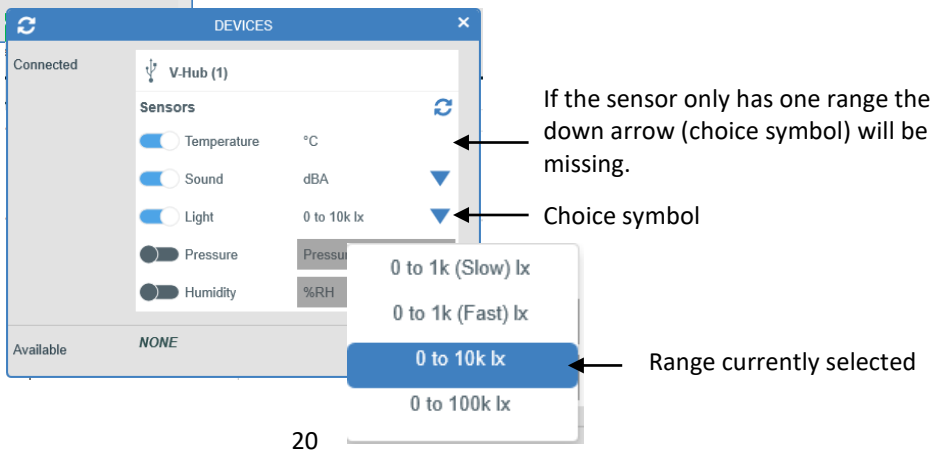
Some sensors have multiple ranges e.g. a Light Level Sensor. The places from which you can change a sensor's range to one suitable for an experiment are:

1. From the Devices icon (top left of screen) or Lab Setup. 

2. Setup (bottom left of screen) 



From the sensors row select the edit symbol



If the sensor only has one range the down arrow (choice symbol) will be missing.

Choice symbol

Range currently selected

- From the sensors row select the edit symbol.
- Select the choice symbol ▼ for the sensor in question and a drop-down list of ranges will open.
- The range currently selected will be highlighted. Select the required range

The sensor range setting will be retained until changed by the user.

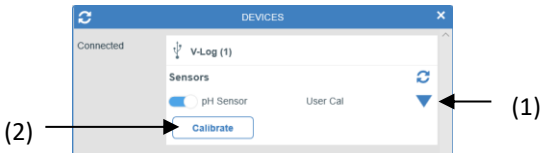
Calibrating a sensor

The stored calibration for a pH Sensor is the **Default** calibration. If required the calibration constants of a pH electrode can be adjusted. The settings for an electrode will be stored in the Adaptor as the **User** calibration.

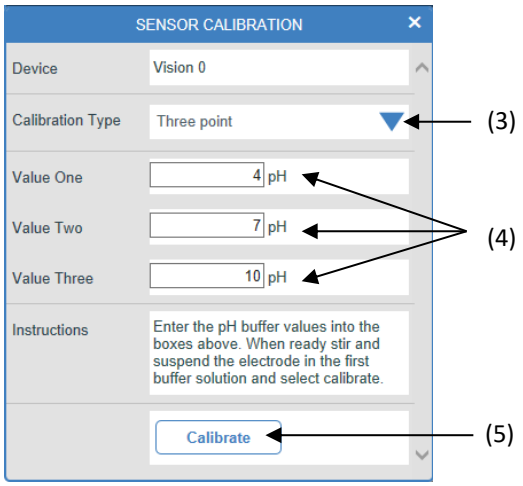
Note: *Mark the pH electrode and adaptor combination so they are used as a pair.*

How to calibrate

1. Change the sensor's range to User Cal.
2. Select the Calibrate button.



3. If only two samples of buffers are being used select the choice symbol ▼ for Calibration Type, then Two point from the list.
4. Type in the **value of all the buffers** being used to set points into the appropriate boxes.
5. Rinse the electrode in distilled water. Wipe off the excess and suspend the electrode in the value one buffer solution, stir and select Calibrate.
6. After the 20 second count rinse the electrode in distilled water, wipe off excess, suspend in the value two buffer, stir and select Next.
7. After the next count down rinse the electrode in distilled water, wipe off excess and suspend in the value 3 buffer, stir and select Next.



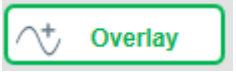
8. After the next count a message will say 'Your sensor has been calibrated ……' Select Finish. Unplug and re-plug the pH sensor into the data logger.

Note: *Mark the pH electrode and adaptor combination so they are used as a pair.*

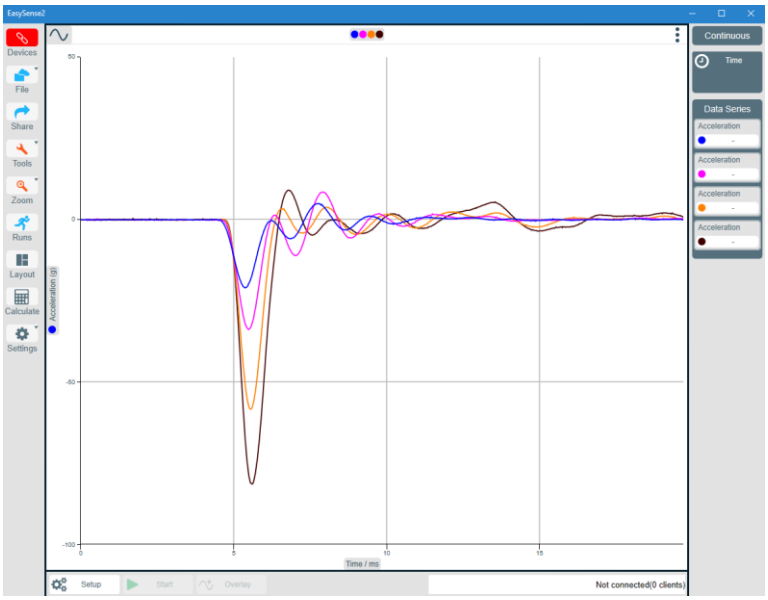
The User calibration values will be stored in the Adaptor and will be retained until reconfigured by the user.

Overlay

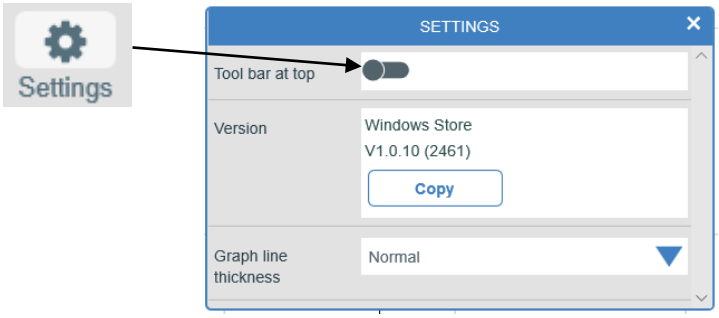
Select the **Overlay** icon from the bottom toolbar to add a new set of data to the graph without the previous set of data being erased - useful for repeating an experiment to compare data. The icon will 'green' up to show it is selected.



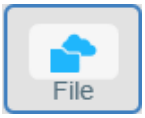
Toolbar

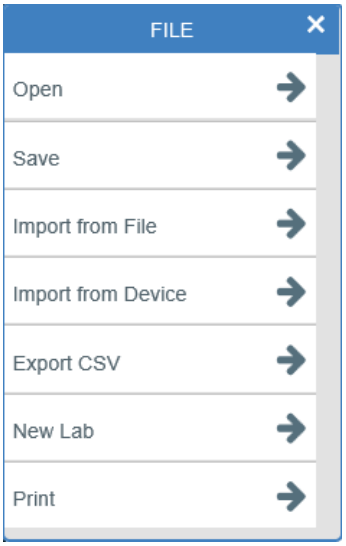


To move the Toolbar from the top to the left of the screen select the Settings icon and deselect Toolbar at top.



File menu options





Open File

Use to load a previously saved EasySense2 or an original EasySense file (*.es2 or *.ssl file type).

Save

A dialog box will open to allow the captured data to be saved as an EasySense2 file using a filename of your choice. Saved as *.es2 type file.

Manage (iOS version and Android)

Select your file then either use Share to email your data file as an attachment or Delete to permanently erase the file.

Import from File

Use to merge the current data with a saved *.es2 or *.ssl file. The data has to be logged using the same mode of logging. [Mode being either Continuous, Snapshot or Timing].

Import from Device

Use this option to retrieve a data set stored in your data logger or devices memory (remotely captured data). Retrieved data can be used in the same way as real-time data i.e. it can be analysed, saved and printed.

A dialog box will open showing a list of the data sets presently stored in the data logger in order of the date and time recorded (as set by the data logger). Select the required set of data

Export CSV

Use to export (save) the collected data in a .CSV file format. Files saved in CSV format (comma-separated values) are a simple text format suitable for database/spreadsheet systems e.g. Microsoft Excel.

New Lab

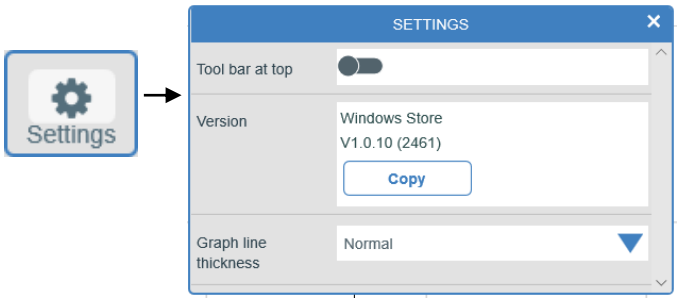
Use to clear the collected data, delete data stored as runs, open a new template, but retain the chart display and settings opted for in Setup.

Print

To print out a copy of the current screen display.

App's version number

The version of the EasySense app can be found by select the Settings icon.



- **Windows Store** - installed via the Microsoft Windows 10 Store and updates automatically (recommended method), ensures the software is always up to date.
- **Windows Classic** – a more traditional version installed from a direct download from the Data Harvest's website, comes with an .msi installer. This version does not update automatically.

Timing mode information

Measure	Where
Time	at A
	at A or B
	from A to B
	at A then B
	from A to A e.g. Stopwatch
	Pendulum (period at A)

[1]

Measure	Where	Apparatus	Measurement
Speed or Velocity	at A	Single interrupt card	Length of card (mm)
		Double interrupt card	Segment length (mm)
		Picket fence	Fence pitch (mm) Calculation increment

		Pulley	-
	at A or B	Single interrupt card	Length of card (mm)
	from A to B	-	Distance from A to B (m)
	at A then B	Single interrupt card	Length of card (mm)

Distance	at A	Picket fence	Fence pitch (mm), Calculation increment
		Pulley	-

Acceleration	at A	Double interrupt card	Segment length (mm)
		Picket fence	Fence pitch (mm) Calculation increment
		Pulley	-
	at A or B	Double interrupt card	Segment length (mm)
	from A to B	Single interrupt card	Length of card (mm)
	at A then B	Double interrupt card	Segment length (mm)
	change from A to B	Double interrupt card	Segment length (mm)

Momentum and Kinetic Energy	at A	Single interrupt card	Length of card (mm) Mass of object passing through A (kg)
		Double interrupt card	Segment length (mm) Mass of object passing through A (kg)
		Picket fence	Fence pitch (mm) Calculation increment Mass of object passing through A (kg)
		Pulley	Mass of object passing through A (kg)
Measure	**Where**	**Apparatus**	**Measurement**
	at A or B	Single interrupt card	Length of card (mm) Mass of object passing through A (kg) Mass of object passing through B (kg)
	from A to B		Distance from A to B (m) Mass of object passing through A (kg)
	at A then B	Single interrupt card	Length of card (mm) Mass of object passing through A (kg) Mass of object passing through B (kg)
	at A then A	Single interrupt card	Length of card (mm) Mass of object passing through A (kg)
	Stopwatch (change from A to A)	Single interrupt card	Length of card (mm) Mass of object passing through A (kg)
	change from A to B	Single interrupt card	Length of card (mm) Mass of object passing through A (kg) Mass of object passing through B (kg)

Measure	**Where**
Raw data (interrupt edge times)	at A
	at A or B

Timing measurements

Measurement at A

Uses one digital sensor connected to Input A. Timing starts when the signal from Input A changes (ON) and stops when the signal reverts back (OFF).

- If Light Gates are used with a single interrupt card, the time measured is for how long the card took to pass through the sensor.
- For a Push Switch it will be the length of time that the switch is kept depressed.
- For Timing mats it will be the length of time someone stands on the mat.

Measurement at A or B

Uses two sensors connected to Input A and B. A measurement will be taken from whichever sensor detects the change in signal level. The measurement will be the time to pass through either sensor A or sensor B.

Measurement from A to B

Uses two sensors connected to Input A and B. A measurement is taken for the time an object takes to travel from the sensor at Input A to the sensor at Input B. Timing will start when the signal change at Input A is detected and stops when the signal at Input B changes.

Measurement at A then B

Uses two sensors connected to Input A and B. Three measurements are recorded of an object travelling from the sensor at Input A to the sensor at Input B. The measurements are:

1. Time to pass through Sensor A
2. Time to pass through Sensor B
3. Time to travel from A to B

Measurement at A then A

Uses one digital sensor connected to Input A. Time will be measured for a single interrupt card passing through a Light Gate (A1), and then returning back through (A2). E.g. for rebound collisions.

Measurement from A to A

E.g. stopwatch

Uses one digital sensor connected to Input A.

Timing will start when the signal at input A changes (ON) and will continue until the signal at A goes OFF and then ON again.

Change from A to A

Uses one digital sensor connected to Input A. The measurement will be for the change in value from A2 to A1 e.g. for a single interrupt card passing through a Light Gate and returning back through.

Change from A to B

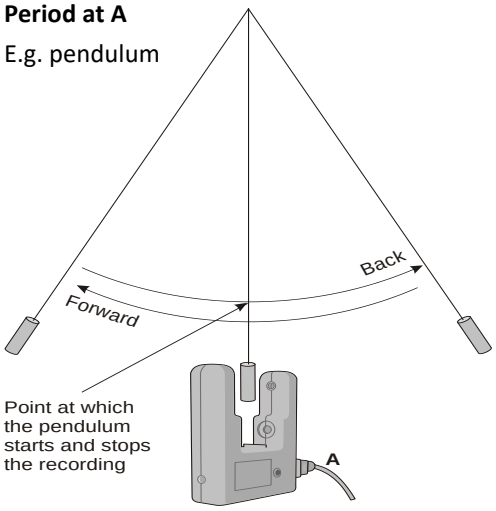
Uses two sensors connected to Input A and B. A double interrupt card is used to measure the acceleration at A and then at B. The measurement shown will be the change in acceleration (Acceleration at B – Acceleration at A).

Distance at A

Use the Picket fence or Pulley, with a Light Gate connected to Input A, to measure the distance moved. Distance is calculated using the step size of the Data Harvest Pulley, or the pitch length of the Picket fence. Each time a new gap in the Pulley or the pitch of the Picket fence is reached; the distance moved is known.

Period at A

E.g. pendulum

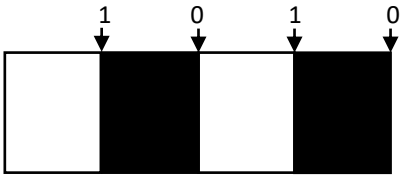


Start the pendulum swinging, when it is moving freely click on the **Start** icon.

Timing will start when the pendulum first passes through the Light Gate. When the pendulum passes back through, it will ignore the second signal change and will stop at the third change (when the pendulum arrives back at the Light Gate). The time shown will be for a complete period.

Raw Times

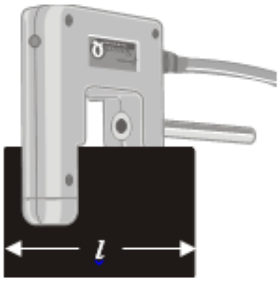
Timing is usually started when the solid black part of an interrupt card blocks the infrared beam on a Light Gate and changes the logic level from 0 to 1. When the clear part of the card is reached, the infrared beam is restored and its logic state changes back to 0 and the event time is taken. Raw times show the logic levels as 0 and 1 values with the time of the event.



Timing apparatus

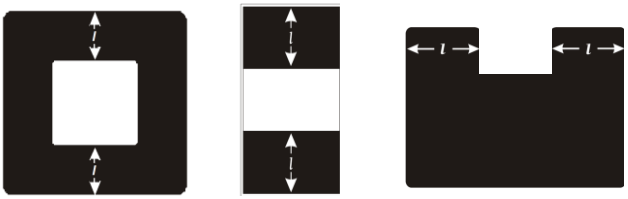
Single Interrupt card

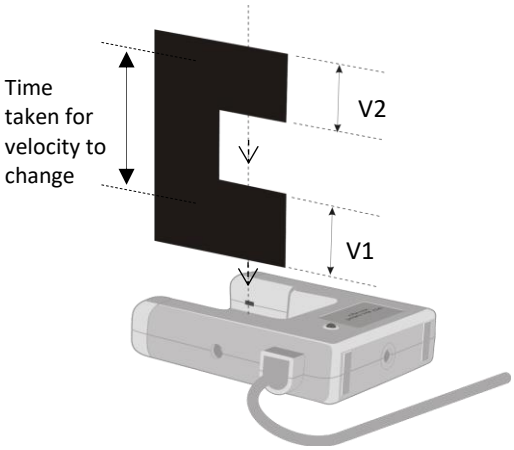
Measure the solid part of the card that will pass through the Light Gate (mm). **Speed** is calculated using the length of the interrupt card divided by the time taken for the card to pass



Double Interrupt card

The two segments of a double interrupt card must be equal in width. Measure the solid part of the card that will pass through the Light Gate (mm).





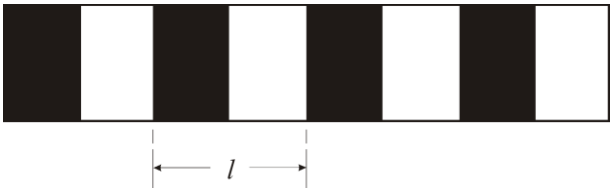
E.g. Average acceleration can be measured using a single Light Gate with a double interrupt card. Acceleration is calculated using the length of the segments on the double interrupt card.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time taken}} = \frac{V_2\left(\frac{\text{Length of segment}}{\text{Time}}\right) - V_1\left(\frac{\text{Length of segment}}{\text{Time}}\right)}{\text{Time taken}}$$

Picket fence

The picket fence is a multi-segmented interrupt card so a sequence of measurements will be taken.

To improve the accuracy of readings, a calculation increment can be applied to average the times over fewer pitches.



Measure from the start of one black edge to the start of the next black edge.

Note: A calculation increment (of more than 1) will result in fewer measurements than the number of pitches on a fence might indicate.

Pitch length (*l*)	**Suggested calculation increment**
60 mm or more	1
50 mm	2
40 mm	2
30 mm	3
20 mm	4
*10 mm	5 - 8

***Note:** If a picket fence with a pitch length of 10 mm is used with buggy type investigations (which produce slower times than gravity investigations), the times can be averaged over less pitches so the calculation increment could be reduced to 5.

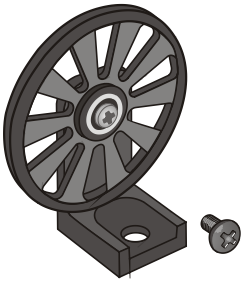
When a Picket fence is used to measure speed or acceleration, the measurements shown are for instantaneous values i.e. it took this amount of time to travel this distance and the acceleration was.

Spoked Pulley

The measurements for the Data Harvest Spoked Pulley are pre-defined.

The spokes on the pulley can easily interrupt the Light Gates beam to create false results. Wait until all is ready before you click on the **Start** icon.

When a Spoked Pulley is used to measure speed or acceleration, the measurements shown are for instantaneous values i.e. at this distance, the speed was.



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