DATA HARVEST

VISION's EasySense software

Document No: **DO234 (3)**

Contents

Any updates to this manual will be available at www.data-harvest.co.uk.

This manual may be freely copied for use with the **EASYSENSE** software.

The EasySense program

Select a User level
The first time VISION is used a 'Select Program Level' window will automatically open. Select a suitable user level and select OK.

- Level 1 is aimed at 'start' level (e.g. up to 9 years old)
- Level 2 is aimed at 'mid' level (e.g. 9 – 15 years old)
- Level 3 is aimed at 'exam' level (e.g.15 years plus)

Note: The program level can be altered by selecting **Level** from the **Settings** menu.

The Home window

Home is the main navigation window, which contains the icons for all logging options.
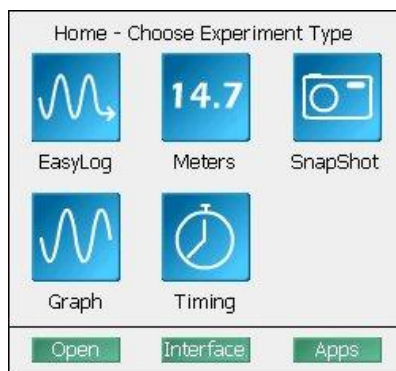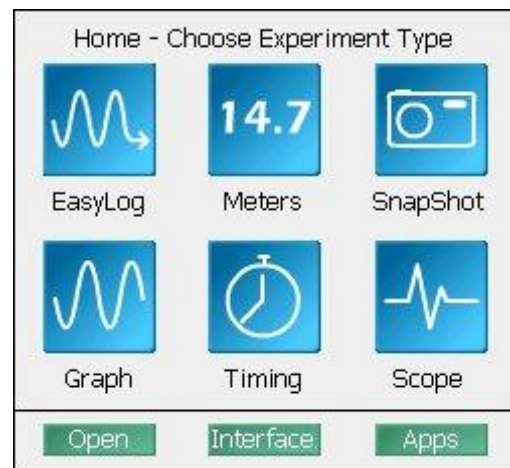
Home at Level 1   Home at Level 2 and 3

The appearance of the Home screen and the complexity of the toolbars and functions in the experiment options are altered by the user level selected.

EasyLog
Select EasyLog and the graph window will open pre-set to record sensor values **continuously** as a line graph until stopped.

See page 8.
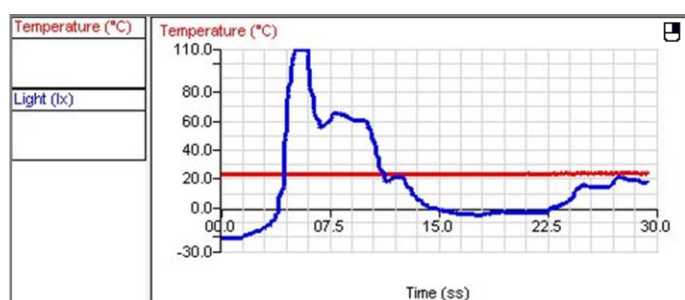
Meters
The Meters window gives an introduction to sensors and how they respond to change.
Up to four section displays can be open at any one time and they can be any combination of sensors and displays.

See page 6.
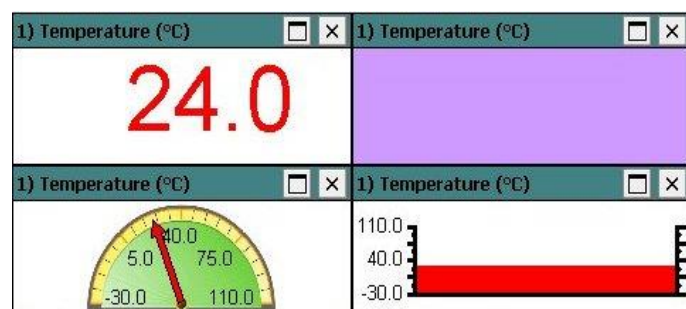
Snapshot

The Graph window will open pre-set to record sensor values on demand (**manual sampling**) with a bar graph display.

See page 8.
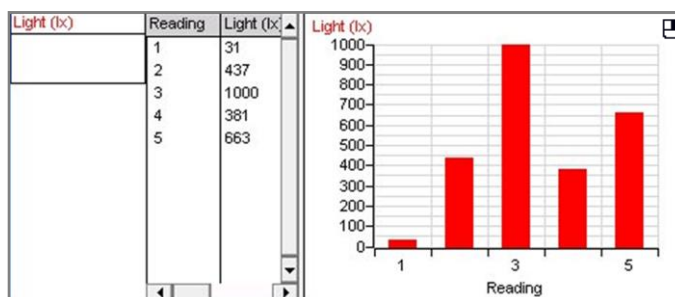
Graph

The Graph window is set to record sensor values against a **chosen time span** as a line graph display. The window opens with a real time logging wizard from which the time span, interval between samples, start condition and triggers for the recording can be chosen.

See page 9.
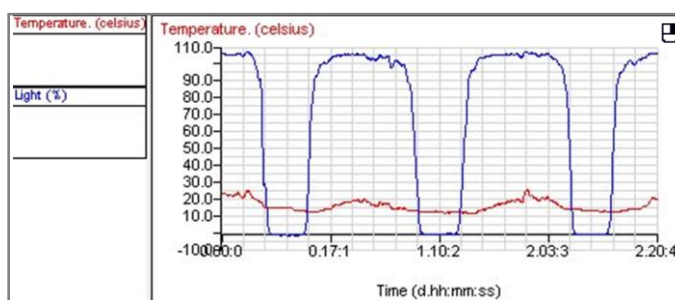
Scope

A simple oscilloscope type display. The data from a sensor is redrawn continuously on the screen. Ideal for demonstrating fast events where there are rapid changes such as ECG traces, sound waveform, etc.

Note: Scope is not available when the User level is set to Level 1.

See page 11.
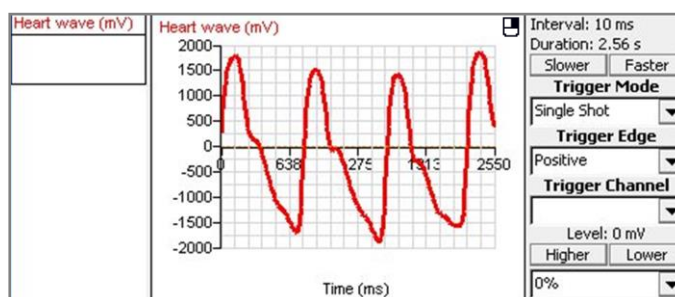
Timing

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.

See page 12.
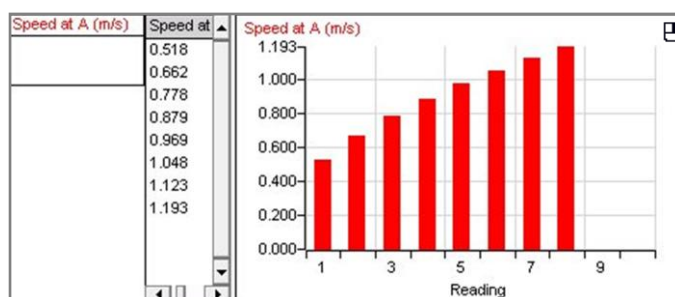
Open

Use to load a previously saved data file. Locate the correct EasySense file (.SSL) and select OK. See page 43.

Interface

Use to connect VISION as an interface controlled by the EasySense software on the PC computer. See page 47.

Apps

Use to open or manage other applications available on VISION e.g. the Periodic Table. See page 45.

14.7 The Meters option

Menu bar →

Close section window

Maximise window

Section window

Sensor and its unit of measurement →

Tap and **hold** (or **right** click mouse) to alter the sensor displayed.

Toolbar →

Start/Stop   Display Options   Changes   Numeric   Transfer to Graph

Home   Gauge   Dial   Notes
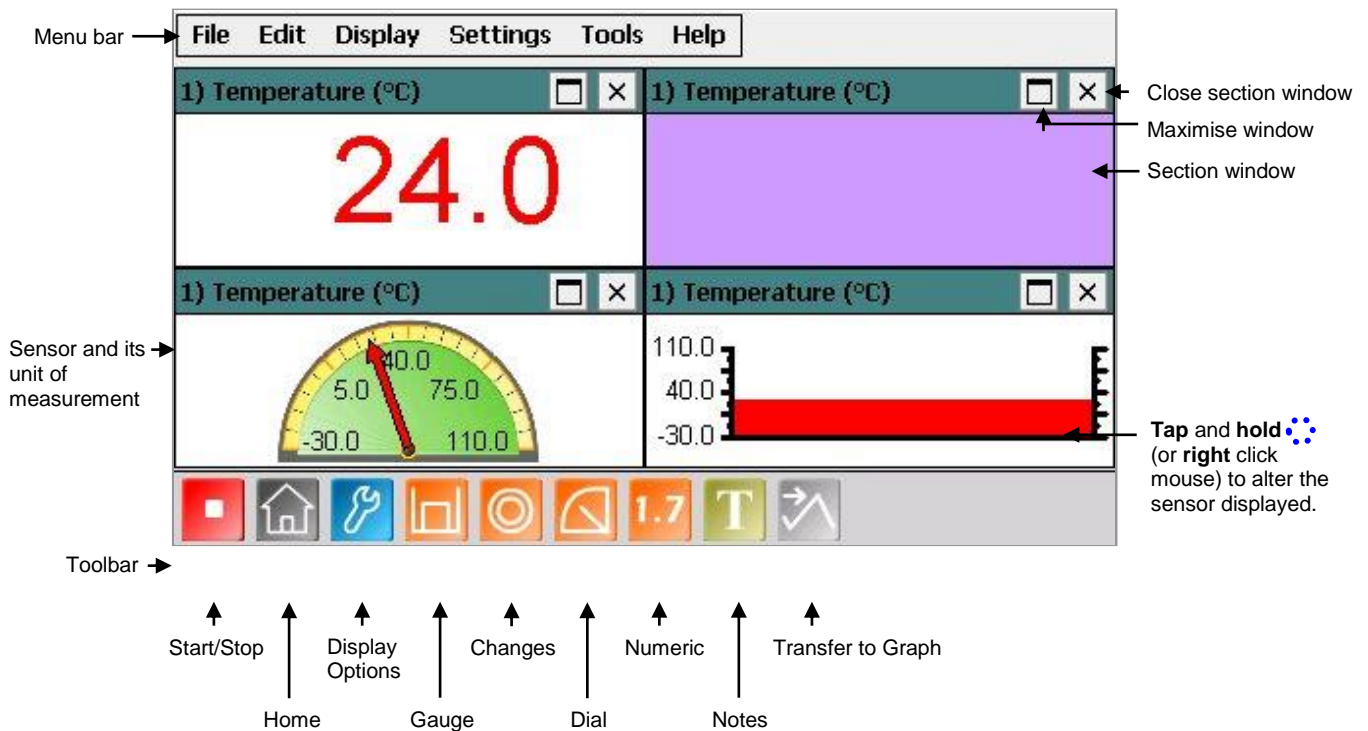
When Meters is selected from the Home screen, the window will open with live data being displayed from the first sensor it identifies in a Numeric window.

Select the **Stop** icon to stop data being recorded.

To begin recording again select the **Start** icon.

- Up to four section windows can be open at any one time and they can be any combination of sensors and displays.

- A section window can be opened either by selecting the appropriate icon on the Toolbar or from the drop-down Display menu.

- To alter the sensor displayed in a section, **tap** and **hold** (or **right** click with the mouse) in the section window and a **Sensor Selection** window will open. Select the sensor to display in that section from the list.

- Select the close button to close a section window.
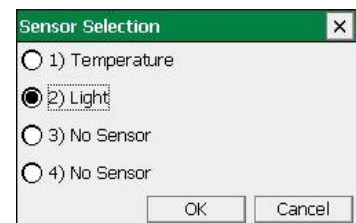
- A section window can be maximized to fill the whole window by selecting the maximize button, select again to return to ¼ screen size.

- Select the Home icon to return to the Home screen

As soon as you open Meters or click on the **Start**/Stop icon, the data is recorded 'behind the scenes'. This data can be transferred into the Graph window for display and analysis using the Transfer to Graph icon (or select from the Edit menu). When in Graph select the Back to Meters icon to return to the Meters window.

Changes

This is the simplest of all four sections. It displays a block of colour that changes to reflect the value being collected by the sensor.
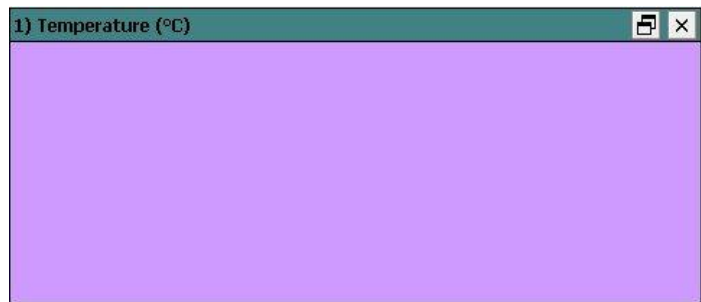
Colour changes happen within the span of a sensor's limits. The minimum and maximum of these limits can be altered in **Sensor Settings** from the Display menu or Options icon.

For example:
Temperature - begins at light blue (coldest) and then works its way up to become dark red (hottest).
Light - begins at black (no light), works through greys until it becomes white (full light).
pH – simulates the colour change of universal indicator.
Sound and other sensors – begin at dark green (minimum), becomes lighter until works through to bright green (maximum).

Note: To alter the sensor displayed, tap & hold ∵ (or **right** click with a mouse) in the section window and select the required sensor from the **Sensor Selection** window.

Gauge

This section will display a simple bar gauge that increases and decreases with the measured value.

The scale on the left-hand side is divided into sections to correspond to the sensor it is representing.

If **Show Min Max** from the Display menu is ticked, the maximum and minimum value recorded will be displayed on the right-hand axis by two short lines. Use **Reset Min Max** from Display to reset these values.

Dial

This section displays a traditional dial whose pointer moves to the right as the measured value increases and, likewise, moves to the left as the value decreases.

The scale around the dial is automatically set by the software to correspond to the sensor it is representing.
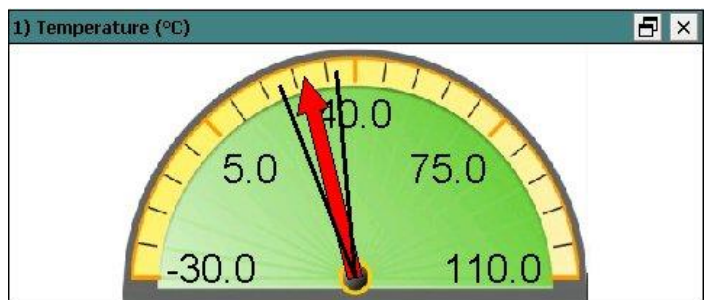
If **Show Min Max** from the Display menu is ticked, two thin lines will display the maximum and minimum value recorded. Use **Reset Min Max** to reset these values.

Numeric

This section displays the currently measured value as a number.

The maximum and minimum value recorded will be displayed if **Show Min Max** from the Display menu is ticked. Use **Reset Min Max** to reset these values.

Decimal numbers can be switched off by deselecting **Display Decimals** in **Sensor Settings** from the Display menu or Options icon. Without decimals selected, the reading will be rounded up to a whole number.

Sensors

The sensors are automatically identified when the Meter option is selected. To change sensors while Meters is open, simply replace the sensor with a different type. When logging is restarted Meters will automatically change the sensor settings so that the correct calibration scales are displayed.

To alter the sensor displayed in a section, tap & hold (or **right** click with a mouse) in the section window and a **Sensor Selection** window will open. Select the sensor to display in that section from the list.
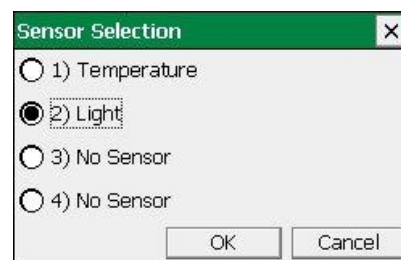
The decimals, name and the minimum and maximum limits of a sensor can be altered either from the **Display** menu or **Options** icon. See page 26.

To change the **range** of a sensor e.g. to alter the range of a Heart Rate sensor from Waveform to Beats per minute, select **Sensor Config** from the **Settings** menu. See page 28.

The EasyLog option

If **EasyLog** is selected from the Home screen, the graph window will open pre-set to record sensor values **continuously** as a line graph until stopped. This makes it ideal for experiments when the time of the recording is unknown.

Select the **Start** icon to begin recording.

Logging will start with a time span of 30 seconds and when it has elapsed the time span will double automatically. This will continue until the recording is stopped by selecting the **Stop** icon.

Choose EasyLog when an X vs. Y graph is required (to plot the readings of one sensor against another). Alter the X-axis to display a sensor (rather than time) – see page 25.

The SnapShot option

If **SnapShot** is selected from the Home screen, the graph window will open pre-set to record sensor values on demand (**manual sampling**) with a bar graph display.

- Select the **Start** icon to begin recording.

- Tap or click in the graph area to collect a sample.

- Select the **Stop** icon to stop data being recorded.

If you select **Start** again you will be given the option to add new readings to the end of the existing data. If 'No' is selected the existing data will be deleted.
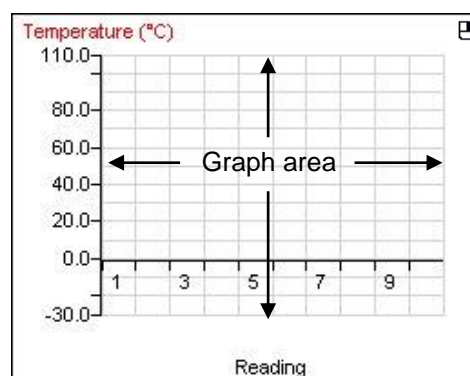
The Graph option

If **Graph** is selected from the Home screen, the graph window will open pre-set to record sensor values against a **chosen time span** as a line graph display. The window will open with a real time logging wizard from which the time span, interval between samples, start condition and triggers for the recording can be chosen. (The options available will depend on the level you have selected to work at). When your selection has been made, select Finish.

The logging wizard

User Level 1 has a simple two stage logging wizard to set up before capturing data.

Stage 1: Sensor selection

- Deselect the tick next to any sensors from which readings are not required.

  If sensors have been altered after start up, select the **Redetect** button to identify the change of sensor.
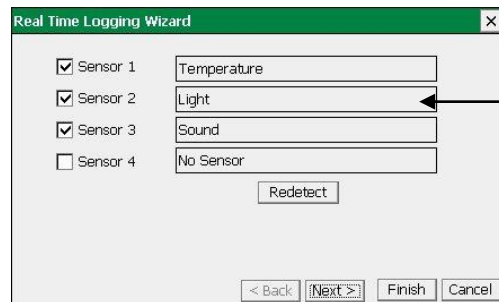
Select the name to open the set sensor range window

To change a sensors range select its name and the set range window will open. The range currently selected will be highlighted. Select the required range and OK. The sensor range setting will be retained until changed by the user.
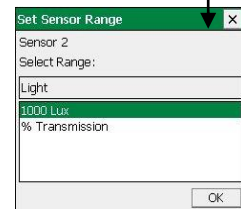
Stage 2: Recording duration

- Select the length of time that you want to record from the list.

  The interval between each sample and the number of samples will automatically alter when the time duration is selected.

- Select Finish.
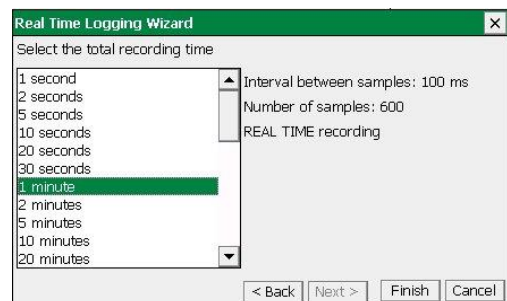
Select the **Start** icon ▶ to begin recording data.

User Level 2 and 3 has a three stage recording wizard.

Stage 1: Sensor selection

- Deselect the tick next to any sensors from which readings are not required.

  If sensors have been altered after start up, select the **Redetect** button to identify the change of sensor.
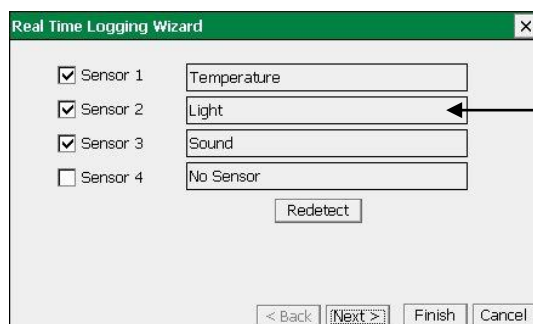
Select the name to open the set sensor range window

To change a sensors range select its name, the set range window will open. The range currently selected will be highlighted. Select the required range and OK. The sensor range setting will be retained until changed by the user.
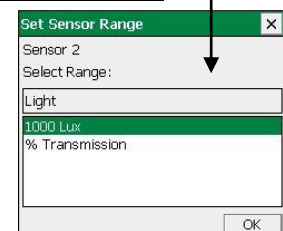
Stage 2: Recording duration

- Select the length of time that you want to record from the list.

- Select the interval between samples being taken.

    The number of samples will automatically alter when the total recording time and the interval between samples are selected.

    If a very short recording and intersample time are selected then the recording will be in FAST mode. In this mode there will be no screen display of the data until the recording ends.

    Note: If you wish to view fast data as it is being recorded then use Scope –see page 11.

- Select Next.
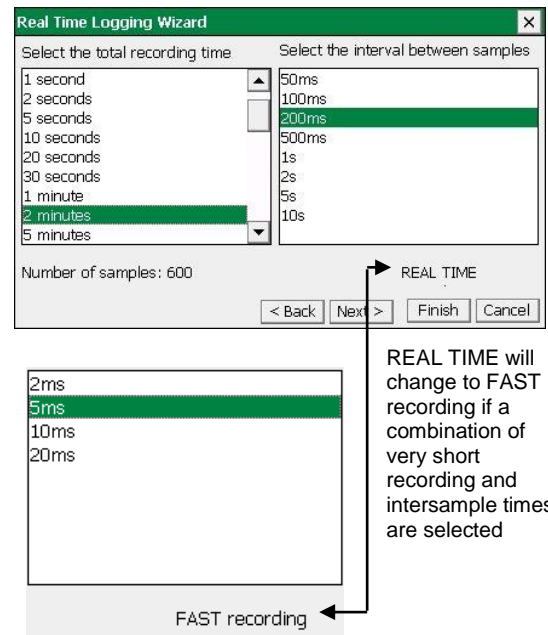
Stage 3: Select the Start condition as required.

This is used to set the condition required for the recording to start.

Pre-triggers will only become available if a FAST recording time is selected.
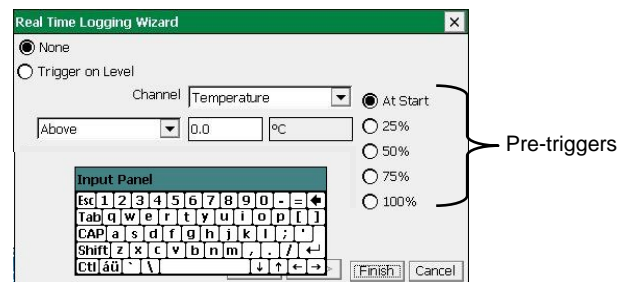
⦿ **None** - To begin recording as soon as you select the **Start** icon. ▶

⦿ **Trigger on Level** - To begin recording when the selected sensor is 'above', 'below', 'rises above' or 'falls below' a set value e.g. when the value from a temperature sensor rises above 15ºC.
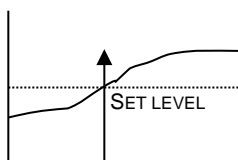
Above
For example: -
To start recording when the temperature is above 15ºC.
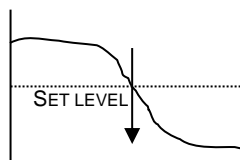
Below
For example: -
To start recording when the temperature is below 15ºC.
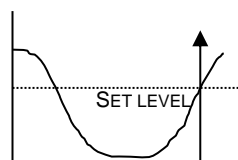
Rises above
For example: -
Logging will not start until the value rises up above 15ºC.
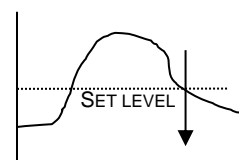
Falls below
For example: -
Logging will not start until the value falls down to below 15ºC.

⦿ Select any **Pre Trigger** requirements.

    Note: This option will only become available if a FAST recording time with a trigger on level condition is selected.

    Pre-trigger will allow a percentage of samples to be stored before the trigger condition is met and the remainder to be taken afterwards. For example, if 1,000 readings are to be taken and a 25% pre-trigger is selected, 249 readings will be taken before the trigger condition is met and 750 on and after the trigger.

    Note: Sufficient time must be allowed to elapse for the pre-trigger samples to be taken e.g. at a relatively slow sample time of 100 milliseconds with 1,000 samples and a 25% pre-trigger, it will take 25 seconds to get to the pre-trigger position.

- Select Finish.

- Select the **Start** icon ▶. Recording will start when the start condition you have selected is met. The recording will stop when the selected time span has passed.

If you want to stop recording before the time span has passed, select the **Stop** ■ icon.

If None was the selected trigger then the recording will start as soon as the **Start** icon is selected.

If recording REAL TIME, with a trigger on level selected, recording will begin when the trigger condition is reached.

If recording FAST with a triggered start, a recording data message will display (if there is sufficient time!) until the trigger condition is met. The data collected will download as soon as the recording has finished.

The Scope option

Scope models many of the functions of a simple oscilloscope. It displays 'real-time' plots (as they occur) from the value of a sensor versus time. Unlike a graph that has a beginning and an end, the scope trace is refreshed or 'redrawn' continuously as long as data is being measured.

Make your selection from the control panel on the right hand section of the Scope window and then select the **Start** icon ▶ to begin recording.

Once data has been recorded, it can be treated in the same manner as normal graph data e.g. the X-axis altered from time to reading number.

Note: Overlay and Pre-Log functions are not available.

Time base
Use Faster to decrease and Slower to increase the time period between samples.

Duration	5.12 ms	12.8 ms	25.6 ms	51.2 ms	128 ms	256 ms	512 ms	1.28 s	2.56 s
Interval	20 μs	50 μs	100 μs	200 μs	500 μs	1 ms	2 ms	5 ms	10 ms
Max. no. of sensors	1	2	4	4	4	4	4	4	4

Duration	Roll mode	Roll mode	Roll mode	Roll mode	Roll mode
Interval	20 ms	50 ms	100 ms	200 ms	500 ms

When the interval between samples is 20 ms or slower the graph trace will be redrawn continuously – roll mode. When you select **Stop** the trace displayed will 'freeze' and the data will become visible in the table.

When the interval between readings is **10 ms or faster**, scope will be in trigger mode.

Trigger Mode
- **Normal** – records a trace for the specified duration each time a specific starting condition (trigger) is met.
- **Auto** - operates in a similar way to Normal, but if after a second the specified start condition is not activated, a trace will be recorded. This feature is useful in testing that the trigger settings for an experiment are correct. The trace will continue to be updated at a frequency of once per second.
- **Single Shot** - records one single trace and then stops recording automatically.

Trigger Edge
- **Positive** - the reading from a channel has to rise above a set value to trigger a recording.
- **Negative –** the reading from a channel has to fall through a set value to trigger a recording.

Trigger Channel and Level
- Select the Channel to be used for the trigger condition from the drop-down menu.
- Tap or click on the Higher or Lower buttons to change the threshold value for the trigger. An orange dotted line on the graph will mark the current level.

Pretrigger allows a percentage of samples to be stored before the trigger condition is met and the remainder to be taken afterwards.
- Select the percentage pre-trigger from the pop-up menu (0%, 25%, 50%, 75% and 100%).
- When logging is stopped a brown dotted line will mark the pre-trigger position on the graph.

The Timing option

The diagram below shows a typical apparatus set up for use with Timing. This option is used to handle data from switch-type sensors such as Light Gates and Timing mats which only have two states, ON or OFF.

Connect the digital sensors being used to VISION.

Measurements can be taken from either a single sensor connected to Input 1:A, or from two sensors connected to both Input 1:A and 2:B.

To perform calculations for Speed/Velocity, Acceleration, Distance, Momentum and Kinetic Energy, it is necessary to enter the parameters used in an experiment. For example, to calculate speed from A to B, enter the distance between the two digital sensors connected to A and B.
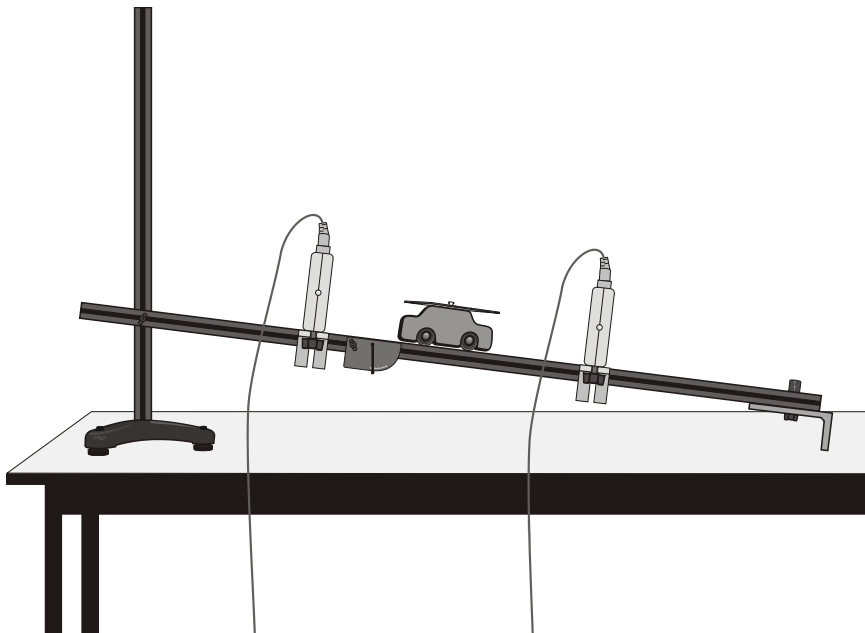
In this set up Light Gates are connected to Input A and B on the interface and are used to monitor the movement of a cart down a track. An interrupt card is fixed to the top of the cart. The card will cut through the Light Gate's infrared beam.

The Timing Wizard

User Level 1 has a simple wizard to record Time or Speed at A, Time or Speed from A to B, or Time from A to A (stopwatch).

Step 1	Step 2	Step 3 b
• **Time**	at A	Units and decimal places
	from A to B	Units and decimal places
	from A to A (e.g. Stopwatch)	Units and decimal places

Step 1	Step 2	Step 3 a	Step 3 b
• **Speed**	at A	Enter the length of the single interrupt card in millimetres	Units and decimal places
	from A to B	Enter the distance from the Sensor at A to the Sensor at B in metres	Units and decimal places

Step 1: Select whether you want to record Time or Speed/Velocity. Select Next.

Step 2: Select whether you want to measure at A, from A to B or from A to A:

Time	Speed
• at A • from A to B • from A to A (e.g. Stopwatch)	• at A • from A to B

Select Next.

Step 3: If a Time option was selected then the next page will be units and decimals – see 3b. If Speed was selected, the next page will be for entering the measurement required for the calculation of speed.

3a:
Velocity from A to B - enter the distance between the sensor connected to Input 1:A and the sensor at Input 2:B (in metres).

Tap or click on Next.
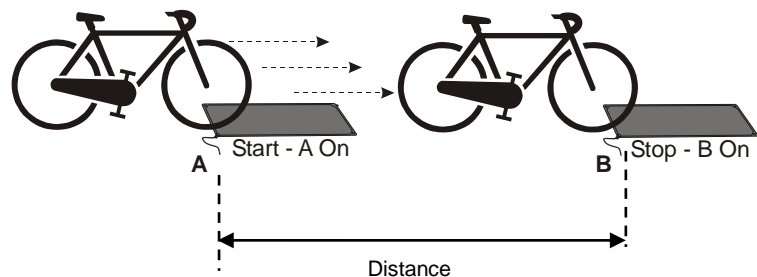
Speed at A - enter the length (*l*) of the single interrupt card that will pass through the sensor connected to Input 1:A (in millimetres).
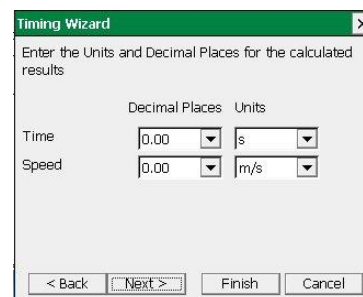
Tap or click on Next.
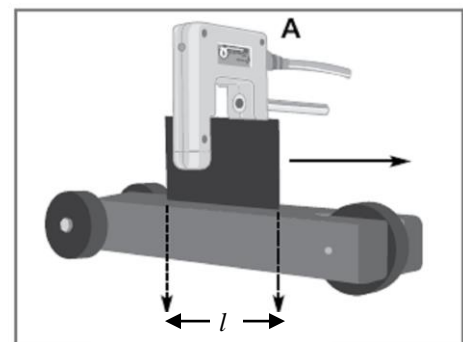
3b: Select the number of decimal places and the units for the display of calculated data from the drop-down menus.

Select Finish.

Select the **Start** icon.
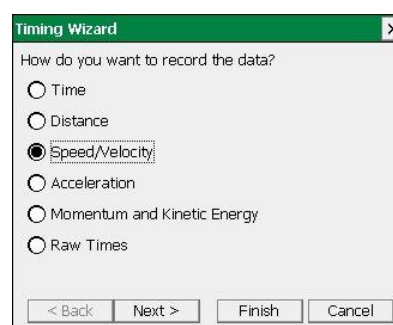
When a signal change from the digital sensor/sensors is received, the timing measurement will automatically be entered into the table and graph. The vertical axis scale will automatically adjust to match the largest value collected.

User Level 2 and 3
The pages in the Wizard will vary according to the choice made in the previous step.

Step 1: Select how you want to record the data.

Select Next.

Step 2: Select whether you want to measure at A, at A or B, from A to B, at A then B, etc.

Select Next.

Step 3: Select the apparatus/interrupter you will be using in the experiment.

Select Next.

Step 4: Enter the measurement of the apparatus or interrupter required by the calculation.

Select Next.

Step 5: Select the number of decimal places and the units for the display of calculated data from the drop-down menus.
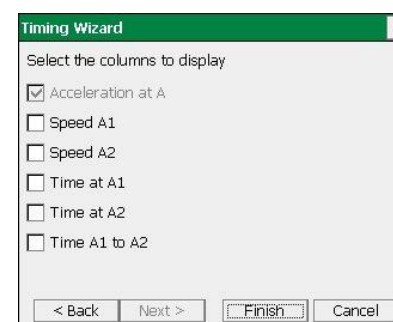
Select Next.

Step 6 (Optional): Select to display any additional columns of data that were used in the calculation of the final set of data.

Acceleration at A = $\frac{\text{Change in Velocity}}{\text{Time Taken}}$ = $\frac{\text{Speed A2 – Speed A1}}{\text{Time A1 to A2}}$ =

Note: The option to show these columns are also available from **Show Columns** in the **Settings** menu.

Select **Finish**.

LEVEL 2 and 3 choices are:

Measure		User Level	Interrupter	Measurement
Time	at A	1, 2, 3	-	-
	from A to B	1, 2, 3	-	-
	from A to A e.g. Stopwatch	1, 2, 3	-	-
	at A or B	2, 3	-	-
	at A then B	2, 3	-	-
	period at A e.g. Pendulum	2, 3	-	-

Measure		User Level	Interrupter	Measurement
Speed / Velocity	at A	1, 2, 3	Single interrupt card	- length of card (mm)
		2, 3	Double interrupt card	- segment length (mm)
		2, 3	Picket fence	- fence pitch (mm) - calculation increment (see page 18)
		2, 3	Pulley	- none
	from A to B	1, 2, 3	-	- distance from A to B (m)
	at A or B	2, 3	Single interrupt card	- length of card (mm)
	at A then B	2, 3	Single interrupt card	- length of card (mm)

Measure		User Level	Interrupter	Measurement
Distance	at A	2, 3	Picket fence	- fence pitch (mm) - calculation increment (see page 18)
		2, 3	Pulley	-

Measure		User Level	Interrupter	Measurement
Acceleration	at A	2, 3	Double interrupt card	- segment length (mm)
			Picket fence	- fence pitch (mm) - calculation increment (see page 18)
			Pulley	- none
	at A or B	2, 3	Double interrupt card	- segment length (mm)
	from A to B	2, 3	Single interrupt card	- length of card (mm)
	at A then B	2, 3	Double interrupt card	- segment length (mm)
	change from A to B	2, 3	Double interrupt card	- segment length (mm)

Measure		User Level	Interrupter	Measurement
Momentum and Kinetic Energy	at A	3	Single interrupt card	- length of card (mm) - mass of object passing through A (kg)
		3	Double interrupt card	- segment length (mm) - mass of object passing through A (kg)
		3	Picket fence	- fence pitch (mm) - calculation increment (see page18) - mass of object passing through A (kg)
		3	Pulley	- mass of object passing through A (kg)
	at A or B	3	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	3		- distance from A to B (m) - mass of object passing through A (kg)
	at A then A	3	Single interrupt card	- length of card (mm) - mass of object passing through A (kg)
	change from A to A	3	Single interrupt card	- length of card (mm) - mass of object passing through A (kg)
	at A then B	3	Single interrupt card	- length of card (mm) - mass of object passing through A (kg) - mass of object passing through B (kg)
	change from A to B	3	Single interrupt card	- length of card (mm) - mass of object passing through A (kg) - mass of object passing through B (kg)

Raw Times (interrupt edge times)	at A	3	-	-
	at A or B	3	-	-

Measurements

Measurement at A
Uses one digital sensor connected to Input 1: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 from A to A
E.g. stopwatch. Uses one digital sensor connected to Input 1: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.

Period at A
E.g. pendulum. Uses one digital sensor connected to Input1:A.

Start the pendulum swinging; when it is moving freely select 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.
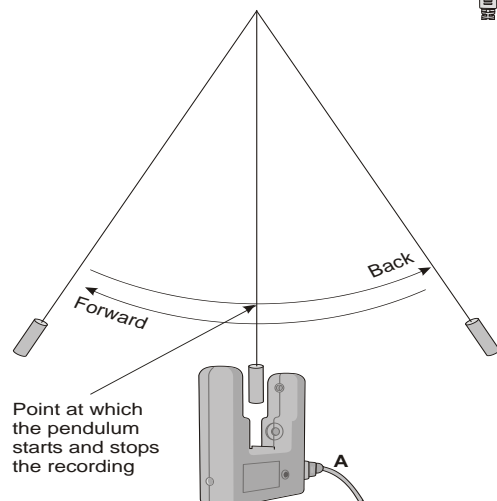
Measurement at A then A
Uses one digital sensor connected to Input 1:A. Time will be measured for a single interrupt card passing through a Light Gate (A1), and then returning back through (A2). E.g. for rebound collisions.

Change from A to A
Uses one digital sensor connected to Input 1: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.

Measurement from A to B
Uses two sensors connected to Input 1:A and 2: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 1:A and 2: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 or B
Uses two sensors connected to Input 1:A and 2: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.

Change from A to B
Uses two sensors connected to Input 1:A and 2: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 1: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.

Raw Times
Timing is 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.
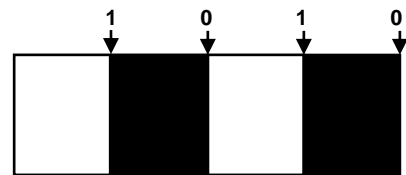
Apparatus

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
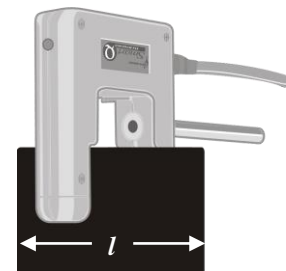
Double Interrupt card
The two segments of a double interrupt card must be equal in width. Measure the solid part of the card that will pass through the Light Gate (mm).
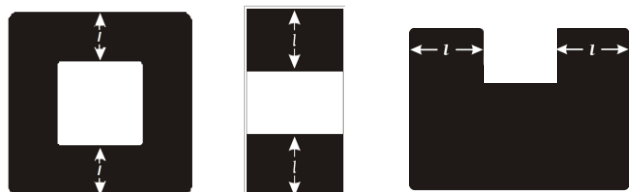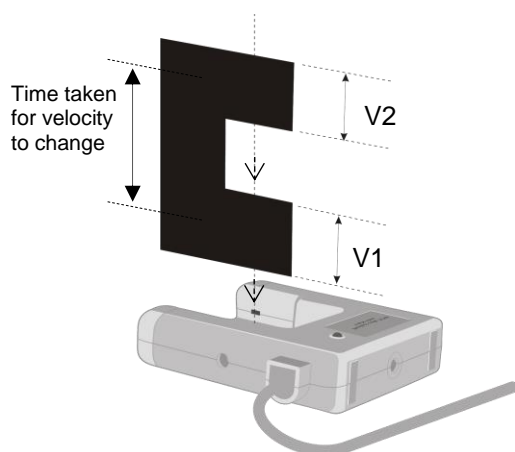
E.g. Average acceleration can be measured using a single Light Gate with a double interrupt card. Acceleration is calculated using the length of the segments on the double interrupt card.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time taken}} =$$

$$\frac{V_2\left(\dfrac{\text{Length of segment}}{\text{Time}}\right) - V_1\left(\dfrac{\text{Length of segment}}{\text{Time}}\right)}{\text{Time taken}}$$

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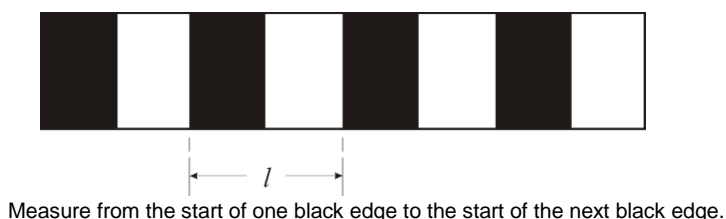
Note: A calculation increment (of more than 1) will result in fewer measurements than the number of pitches on a fence might indicate.

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 select the **Start** icon.

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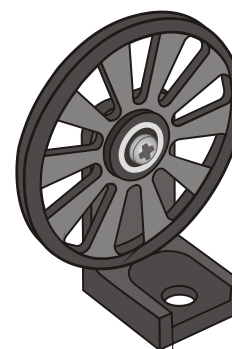
The Graph window

EasyLog, SnapShot, Graph and Timing use the graph window to display and analyse readings.

Double tap or left click mouse above the graph area to enter a Title

Menu tool bar

| File | Edit | Display | Settings | Analysis | Tools | Help |

Data Value Boxes

Temperature (°C)

Light (lx)

Sound (dBA)

Temperature (°C)

Y-axis

The graph area

X-axis

Left of the graph area: Tap or left click mouse to scroll through channels displayed on axis

Tap & hold or right click a USB mouse in the area to the left of the graph area to alter the sensor settings (name & axis limits)

Window divider

Time (ss)

Tool bar

For the graph menu (e.g. Show or Hide, Channels, Zoom, Autoscale, Predict, Add Text and Title) either tap on this mouse icon or tap & hold or right click a USB mouse within the graph area

Tap or left click below the graph area to scroll through any X-axis choices

Tap & hold or right click a USB mouse below the graph area for X-axis options

The Toolbar

Select this icon to return to the Home page

(Level 1, 2 & 3)

Overlay - adds a new set of data without the previous set being erased

(Level 1, 2 & 3 Graph, Snapshot and EasyLog)

Values - to find the value at a selected point

(Level 1, 2 & 3)

Difference between the data at two points

(Level 1, 2 & 3)

Area - calculates the area under a section of the graph

(Level 3 only)

Start or Stop

(Level 1, 2 & 3)

New - to set up a new experiment

(Level 1, 2 & 3)

Options - to change the way data is displayed

(Level 1, 2 & 3)

Interval - find the time elapsed between two data points

(Level 1, 2 & 3)

Gradient - calculates the rate of change

(Level 2 & 3 only)

Notepad – for entering information about an experiment

Recording data

To begin recording, simply select the **Start** icon.

During logging the icon shows a red square. Select this icon to **Stop** data being recorded before the selected duration has passed.

If you want too repeat the last experiment (with all of the settings the same) select the **Start** icon again.

If you want to graph a new set of data, without the previous set of data being erased, select **Overlay** before you select the Start icon. (Not available in Scope or Timing).

To set up a new investigation e.g. to change the duration of a recording in Graph, or to identify a change of sensors, select the **New** experiment wizard.

To go from one option to another e.g. from EasyLog to Snapshot, select the **Home** icon.

Selecting Data

To select **individual** readings: -
Tap or click on the reading in the table or on the graph. The reading will be highlighted in the table and marked with a cursor on the graph.

To **deselect** readings:
Tap or click above the
graph area.
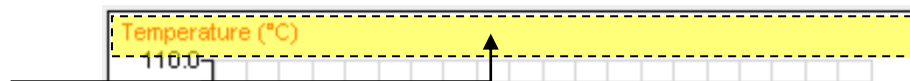
To select **more than one** reading in a series: -
Tap (click) and drag from the first to the last reading of the series.

The selected readings will be highlighted in the table and marked by a box in the graph.
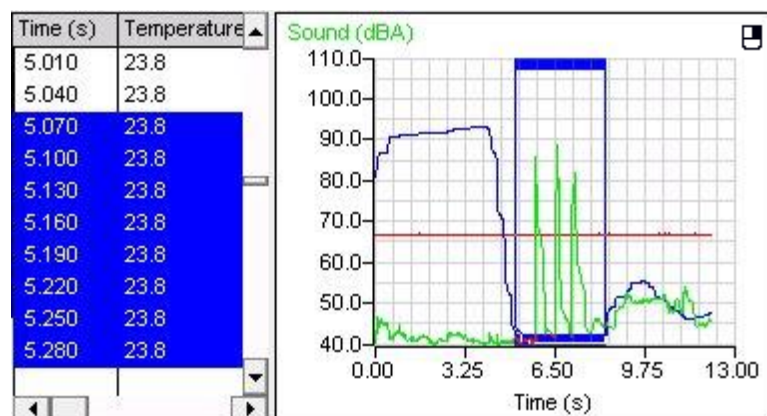
Use selection   *User Level 2 & 3*

To display a selection of the recorded data, select the data required from the table or graph area (so it its highlighted). Select **Use Selection** from the **Edit** menu and the graph will alter to use the selected data only.

If you save while the selected part of the data is displayed, then only the selected data will be saved, (not the full data set).

Selection Wizard   *User Level 2 & 3*

Selection Wizard from the **Edit** menu can be used to select readings at specified intervals.

Type in the first and last reading of the selection and the interval between the readings (e.g. every 10th reading). Select OK and the selected readings will be highlighted in the table and graph.
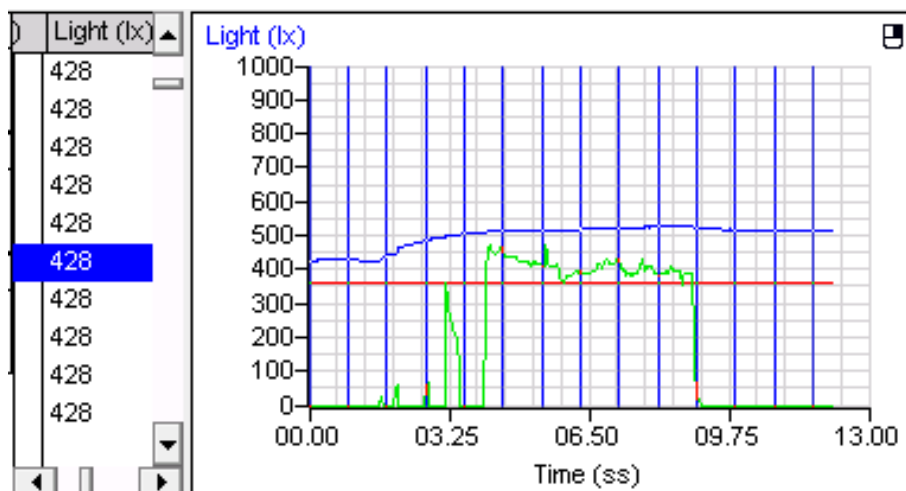
If the 'Use the selection' box is ticked the graph will automatically alter to display only the selected data.

Previous Selection   *User Level 2 & 3*

Use **Previous Selection** from the **Edit** menu to revert back to the previous selection.

Analysing captured data

There are a number of tools built into the graph window to allow the analysis of captured data. Select **Analysis** from the menu bar to open the Analysis menu.

Note: Some of these tools will not be available when the X-axis is a data channel i.e. Interval, Difference, Gradient and Area.
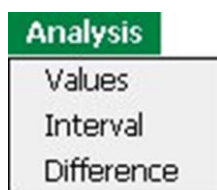
Analysis menu at Users **Level 1**

Analysis menu at Users **Level 2**

Analysis menu at Users **Level 3**

Values

Select **Values** either using its icon or from the Analysis menu.

Tap or click in the graph area. A cursor will appear which can be moved around the graph.

Position the cursor at the point where information from the graph is needed. The value will be shown in the data value box and highlighted in the table. The information box will indicate the time of the selected data point.
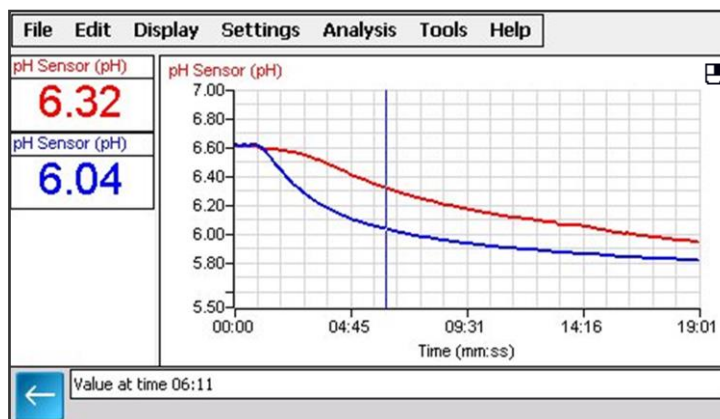
If the X-axis is a sensor, then cross hair cursor lines indicate what the value from the sensors would be if they crossed at the cursor point.

To deselect either tap or click on the arrow in the information box or deselect Values from the Analysis menu.

Interval

Select **Interval** either using its icon or from the Analysis menu.

Touch and drag from the first point to the second point on the graph.

(Drag by keeping the stylus in contact with the screen).

A box will be drawn around the section of graph and highlighted in the table.

The information box will display the time of the first point, the time at the second point and the interval between them.
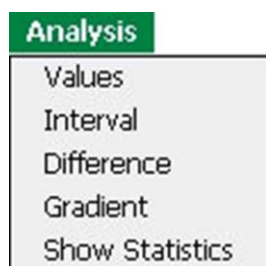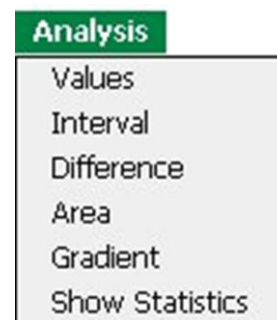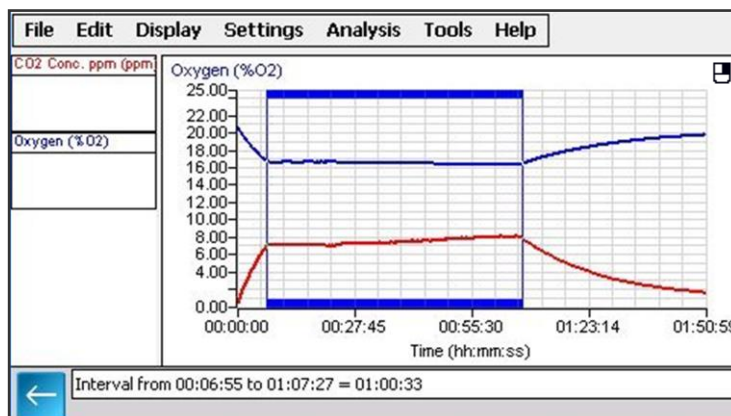
To deselect either tap or click on the arrow in the information box or deselect Interval from the Analysis menu.

Tap or click in the title area (just above the graph) to deselect any selected readings.

Difference

Select **Difference** either using its icon or from the Analysis menu.

Tap or click on the first reading to be used in the comparison, a fixed cursor will mark the point.

Tap or click on a second reading.

The values in the data boxes will show the difference between the data at the two points.

While Difference is still selected it is possible to repeatedly select a second reading to compare with the first.
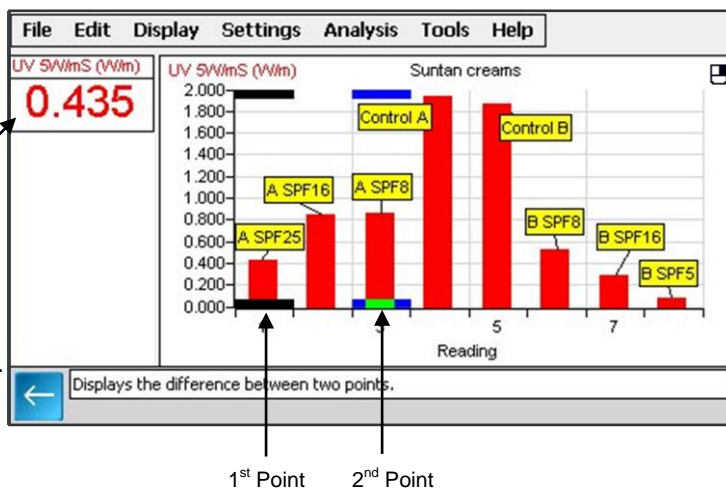
To deselect either tap or click on the arrow in the information box or deselect Difference from the Analysis menu.

Gradient   *User Level 2 & 3*

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. The calculation is performed over two points either side of the cursor.

Select **Gradient** either using its icon or from the Analysis menu.

Tap or click in the graph area and a vertical cursor with a small line will appear to indicate the slope of the graph for whichever data channel is currently selected on the Y-axis. The gradient value for all data channels will be shown in the data value boxes.

To deselect either tap or click on the arrow in the information box or deselect Gradient from the Analysis menu.

A manual Best Fit line can be used to calculate the gradient between two points – see page 40.

Area   *User Level 3*

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.

Select **Area** either using its icon or from the Analysis menu.

Touch and drag from the first reading point across the appropriate section of the graph.

(Drag by keeping the stylus in contact with the screen).

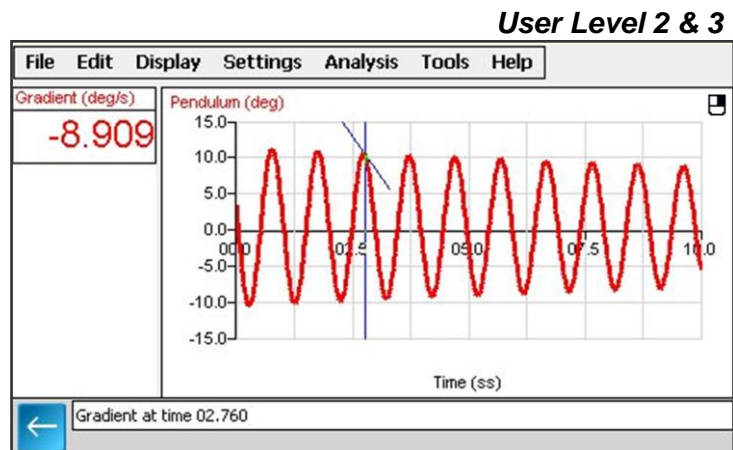Shading lines will mark the section under the graph for whichever data channel is currently selected on the Y-axis. The area value for all data channels will be shown in the data value boxes.

To deselect either tap or click on the arrow in the information box or deselect Area from the Analysis menu.

Tap or click in the title area (just above the graph) to deselect any selected readings.
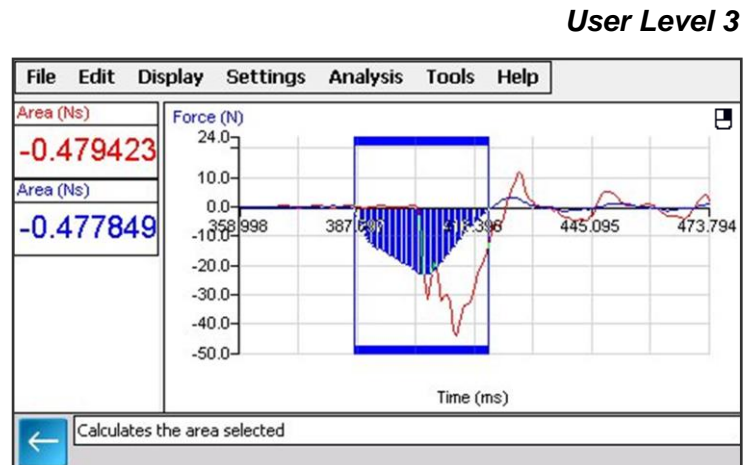
Show Statistics   *User Level 2 & 3*

Show Statistics calculates and displays statistical information about the data collected from the data channel currently selected on the Y-Axis.

Select the appropriate data channel on the Y-Axis. Select **Show Statistics** from the Analysis menu.

- Max (Maximum) – the highest value reading
- Mean – the arithmetic mean.
- SD (standard deviation) – the scatter of a series of measurements about their mean value
- Min (Minimum) – the lowest value reading

If only a part of the original graph is selected (e.g. by using Use selection) then the statistics will be calculated using the data from only the selected part of the graph.
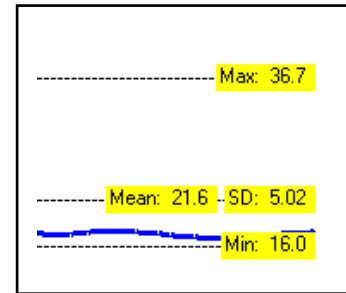
To switch statistics off, deselect Show Statistics from the Analysis menu.

Displaying data

Data Value boxes

The value recorded by a sensor will be displayed in a data value box. The colour used in a data value box corresponds to the colour of the plotted line and the axis label on the graph. Each data channel is allocated a different colour i.e. channel one is red, channel two is blue, and channel three is green. These colours relate to the channel of data, not the type of sensor or the input number e.g. if Temperature sensors are used connected to Input 2 and 4 on the interface, they will be allocated to the first available data channels, Channel 1 (red), and Channel 2 (blue).
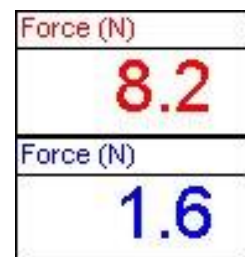
Axis display

Tap or click in the space to the left of the graph area to alter which data channel is displayed. Subsequent taps or clicks will cycle the Y-axis through all the data channels open.

Tap & hold ⣿ or click with the **right** mouse button to the left of the graph area to open Sensor Settings i.e. alter a channels name and minimum or maximum limits displayed (see page 26).
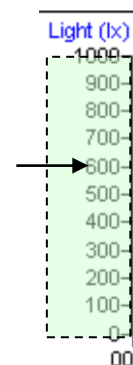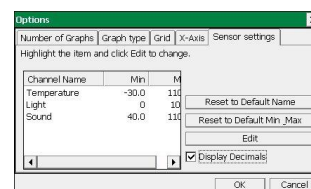
Tap or click in the space below the graph area to cycle through the options available for whatever is currently displayed on the X-axis.

1. **Time** - select between:
   - Elapsed Time - from zero until that point in seconds [Time (s)].
   - Elapsed Time in days, hours, minutes and seconds [Time (ss), (mm:ss), (hh:mm:ss), (d.hh:mm:ss)].
   - Absolute Time - the time & date from the start of recording until that point [Absolute Time (hh:mm:ss), (d.hh:mm:ss)].

2. **Sensor** - cycle through the data channels available.

3. **Reading Number** - no choice is available.

Tap & hold ⣿ or click with the **right** mouse button in the space below the graph area to open the X-Axis options. Select whether you would like Time, Reading Number or Channel (e.g. sensor) displayed on the X-axis.
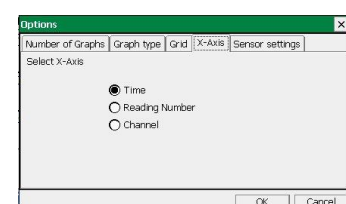
Display options
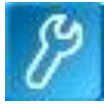
The options to alter the overall graph display are available either from the Display menu bar or the Options icon.

Note: Other display choices, e.g. Show or Hide Channels, Zoom, Title and Auto scale, which apply to an individual graph, are available by selecting the **right mouse** icon ⊟ (top right of the graph area) or by tap & hold ⋰ or right click mouse in the graph area. See page 27.
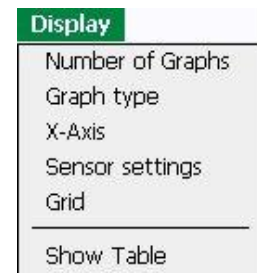
Number of Graphs

Select the radio button next to the number of graphs that you want displayed in the graph area.
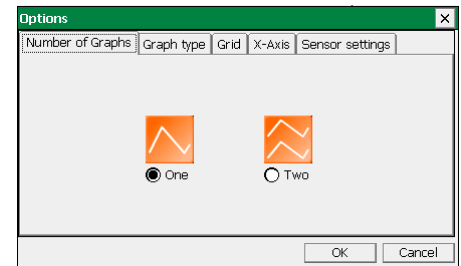
Graph type

Use this tab to customise the appearance of the collected data in the graph e.g. the graph type, thickness of line and point style.

Choose whether you want to display readings as a line or bar graph.

- If **Line Graph** is selected, then individual readings are by default joined by a line. There is a choice of different thickness of line or no line (none). The readings can be marked by a choice of symbols or remain unmarked (none).

- If **Bar Graph** is selected then readings will be shown as bars of colour.
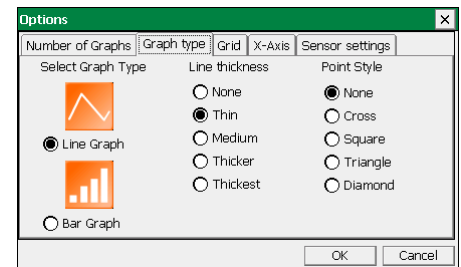
Grid

If a grid is selected then a faint grid is marked on the graph. There is a choice between a fine and coarse grid.
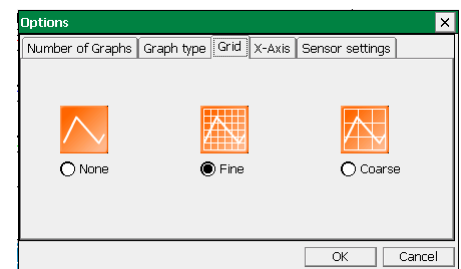
X-Axis

User Level 2 & 3

Select whether you would like Time, Reading Number or Channel (e.g. sensor) displayed on the X-axis

- **Time** - the selected time span is used for the X-axis.

- **Reading Number** - the X-axis will be set to the number of single readings taken from a sensor, without any regular time interval between them. This axis is used for Snapshot data.

- **Channel** - the X-axis will be set to use one of the data channels e.g. a sensor. This axis is used for an X vs.Y plot.

Note: To alter the data channel shown on the X-axis, tap or click with the mouse below the graph area to cycle through the data channels.
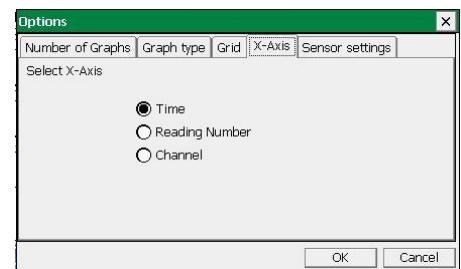
Sensor settings

From this tab the name and limits displayed for a data channel or sensor can be altered.

Normally the full scale of a sensor is displayed on an axis e.g. the scale for a Temperature sensor will show a minimum of -30 to a maximum of 110˚C. If the scale of an axis is too large, the minimum and maximum limits displayed can be altered e.g. reduced to a minimum of 10 to a maximum of 50˚C.
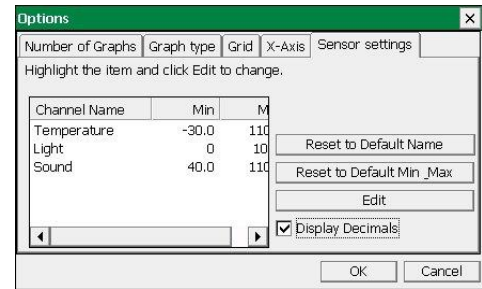
The name used for a data channel can also be changed e.g. from Temperature to Room Temperature.

- Select the data channel (sensor) you want to edit.
- Select **Edit** and type in a new name and/or minimum or maximum value number.
- Select OK. An altered name or number is marked by an asterisk.

To reset to the original name or scale, select the data channel then Reset to Default Name or Reset to Default Min_Max.

Display Decimals - used to switch decimal numbers on and off from the display. If Display Decimals is not selected, the reading will be rounded up to a whole number.

Select OK to finish.

Notes:
- If the value from a sensor being recorded rises above the maximum or falls below the minimum limits that have been set, Graph will not be able to accurately display the true value.
- While in Timing, the number of decimal places displayed can be altered - see Change Units on page 33.

Show Table

The table area

The table can be exposed by either:
- Selecting **Show Table** from the Display menu or
- Tap or click and hold on the window divider (between the data value boxes and the graph) until it becomes a solid black line and drag to the right.

Data value boxes

The graph area

Window divider
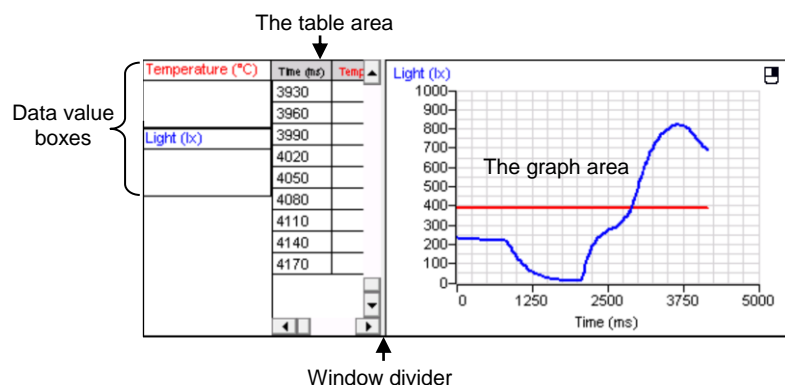
The sensors/channels columns in the table can be hidden from view.
- Tap & hold (or right click with a mouse) in the table area.
- Deselect the tick next to any sensors/channels you want to hide.

The Comment column

Once some data has been collected, text or numbers can be entered into the Comment column in the table. The comment column is the last column to the right in the table.

- Expose the table area and use horizontal scroll to locate the comment column.
- Double tap or click on the relevant cell in the comment column. A dialogue box will appear, type in any text or numbers. Select OK.

To Edit, double tap or click on the comment to re-open the dialogue box and alter as required.

Individual graph choices

Some display options i.e. Show or Hide Channels, Zoom, Auto scale and Title, are applied on an individual graph basis rather than to all graphs displayed. These are available by selecting the **right mouse** icon ⊟ (top right of the graph area) or by a tap & hold ⋮ (or right click with a mouse) in the graph area of the individual graph.
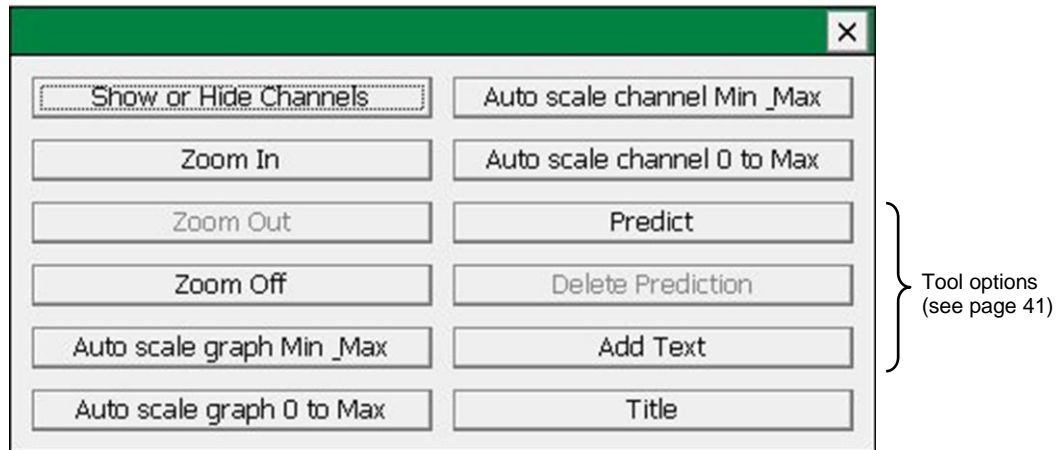
Show or Hide Channels

The data from a channel or sensor can be hidden from view in both the graph and table.

To hide data, select the right mouse icon ⊟ or tap & hold ⋮ in the graph area and select **Show or Hide Channels** from the menu. Deselect the tick next to any sensors or channels you want to hide.

Select ⊠ to close.

Reselect the tick to show data.

Example: If two graphs are open, Show or Hide Channels can be used to deselect one of the sensors from each graph.
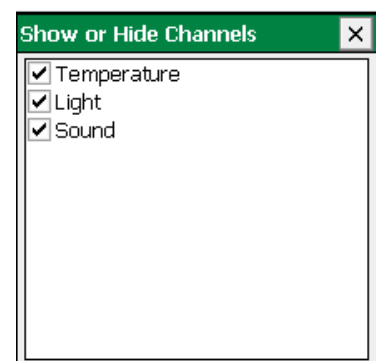
Zoom

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

Select the right mouse icon ⊟ or tap & hold ⋮ (or right click with a mouse) in the graph area and select **Zoom In**.

Position the mouse pointer at the top corner of the area to be magnified. Tap or click, hold down and drag the rectangular box over the area to be magnified. Release to show the magnified area.

To expand this magnified area further, select Zoom In again and repeat the above.

Select the right mouse icon or tap & hold ⋮ and select **Zoom Out** to zoom out by one step or **Zoom Off** to return to the original graph.

Auto scale

This option scales the Y-axis by using the values of the data collected. Select the right mouse icon or tap & hold ⋮ (or right click with a mouse) in the graph area and select one of four choices from the graph menu. The graph will automatically be adjusted.

- **Auto scale graph Min_Max** – applies Auto scale to **all** the channels of data on the graph using the minimum and maximum limits of the data.
- **Auto scale graph 0 to Max**– applies Auto scale to **all** the channels of data on the graph using a minimum value of zero to the maximum limit of the data.
- **Auto scale channel Min_Max** – applies Auto scale to whatever data channel is currently selected on the Y-axis using the minimum and maximum limits of the data.
- **Auto scale channel 0 to Max** - applies Auto scale to whatever data channel is currently selected on the Y-axis using a minimum value of zero to the maximum limit of the data.

Deselect to return to the original scale.

Title

To add a title to a graph:

- Either select the right mouse icon or tap & hold ⋮ in the graph area and select **Title** or double tap above the graph area.

- Type in the text for the title.
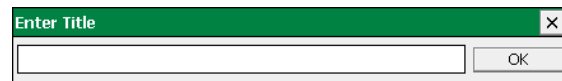
Settings

Overlay mode

Select the **Overlay** icon from the toolbar or **Overlay Mode** from the Settings menu, 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.

Note: This option is **not** available in Scope or Timing.

Set Language

If a choice of language is available then Set Language will be listed in the Settings menu. Use to select the language VISION operates with.

Change sensor range

All *Smart Q* sensors are automatically calibrated but some have multiple ranges. There are two methods of changing the range of a sensor e.g. to alter the range of a Light Level Sensor from Lux to % Transmission.

1. From the New recording wizard sensor selection page select the sensor's name and the set range window will open.

   The range currently selected will be highlighted. Select the required range and select Finish or Next to continue.
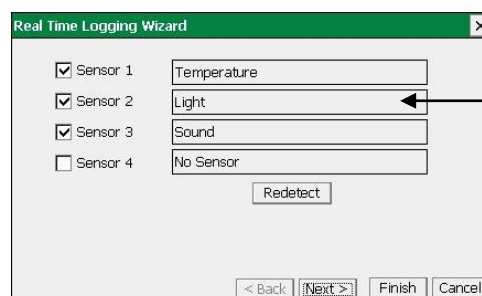
Select the name to open the set sensor range window

2. Select **Sensor Config** from the Settings menu.

    - Select the sensor from the list (it will be listed using its current range).

    - Select the **Change Range** button.
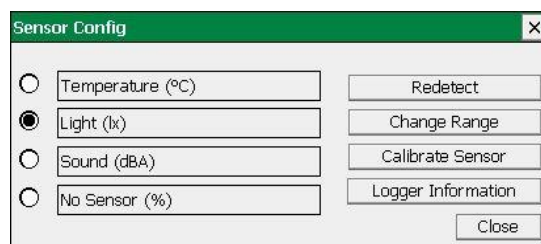
    The range currently selected will be highlighted.

    Note: If no choice is available a message to say 'This Sensor does not have multiple ranges' will be displayed.

    - Select the required range and select OK.

    - Close Sensor Config. Select **New** and then Finish for the change in range to be detected.
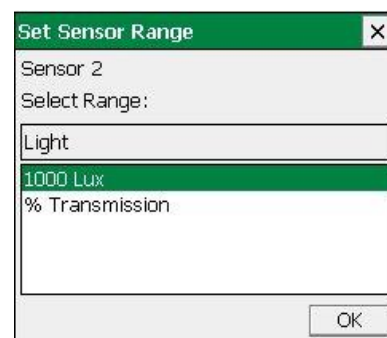
The sensor range setting will be retained until changed by the user.

Calibrate Sensor

All *Smart Q* Sensors are supplied calibrated. Certain Sensors allow the user to adjust the calibration constants to the conditions of the experiment. This option allows the user to adjust the sensor reading at either two or three points in its range. The adjustments made will affect the whole Sensor range, between and beyond these points. The accuracy of the user calibration will depend upon the number of calibration points used and their spacing.

For example:
The pH Sensor has a default calibration set for operation at a temperature of 25˚C. If the samples being measured are at a lower or higher temperature, then this default calibration may be improved by a 'User calibration'. Buffer solutions of a known pH are used to set the values for the calibration points. It is essential that the buffer solutions used are at the same temperature as the samples in the experiment and that the pH value entered is the value of the buffer at that temperature. For example, a buffer solution with a pH of 7.01 at 25˚C can change its value to 7.10 at 5˚C, or 6.98 at 40 ˚C.

- Select **Sensor Config** from the Settings menu.

- Select the Sensor requiring configuration from the list.

- Select the **Calibrate Sensor**.

    Note: If no choice is available a message to say 'This sensor does not have User Calibration' will be displayed.
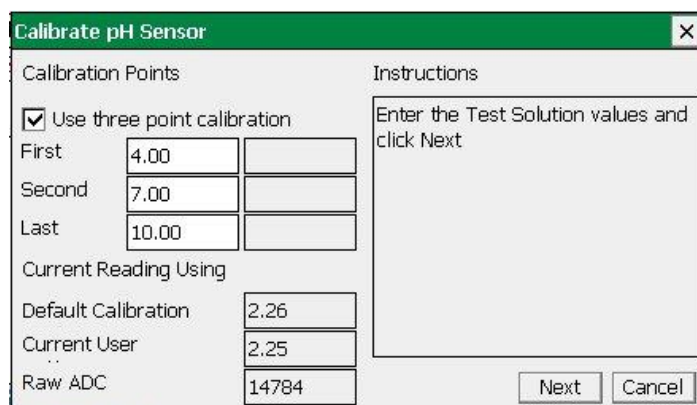
- If you are using 3 test solutions to set the calibration points, check the 'Use Three point calibration' box is ticked.

   If only 2 test solutions are available, deselect the tick in the 'Use Three point calibration' box. Only the First and Last calibration points will then be available.

- Enter the test solution values of **all** the buffers that will be used.

- Place the Sensor in the test solution with the lowest value e.g. pH 4 buffer solution. When the displayed reading stabilizes, select the **Next** button & the ADC value will automatically be entered into the First value box.

- Place the Sensor in the test solution with the mid range value e.g. pH 7 buffer solution. When the displayed reading stabilizes, select the **Next** button & an ADC value will automatically be entered into the Second value box.

- Place the Sensor in the test solution with the highest value e.g. pH 10 buffer solution. When the displayed reading stabilizes, select the **Next** button & an ADC value will automatically be entered into the Last value box.

- A message to say 'The User range has been reprogrammed' will be displayed. Select OK.

- Disconnect and reconnect the Sensor from VISION.

- Select **Change Range,** then **User Cal** as the range and OK.

- Close Sensor Config. Select New for the change in range to be detected.

The User calibration values will be stored in the *Smart Q* Sensor and will be retained until recalibrated.

The lower section of the Calibrate sensor window displays the current reading from the selected sensor.
- Default calibration – shows the current value recorded by the default calibration stored in the Sensor.
- Current User calibration – shows the current value recorded by using the calibration points last configured by the user.
- Raw ADC – shows the value from the analogue digital converter in the **EASY**SENSE unit in a range of 0 – 65535. This value is used by the software to calculate the calibration constants.

Level

Select Level from the Settings menu to check or alter the currently selected user level.

- Level 1 is aimed at 'start' level (e.g. up to 9 years old).
- Level 2 is aimed at 'mid' level (e.g. 9 – 15 years old)
- Level 3 is aimed at 'exam' level (e.g.15 years plus).

Note: The selected level will be saved when the **EASYSENSE** program is closed.

Change Units

Timing only

Select **Change Units** from the Settings menu in Timing to specify the units and number of decimal places displayed (0 to 0.000000). Each measurement has its own drop-down menu.

	Units
Time	ms, s
Distance	mm, cm, m
Speed/Velocity	mm/s, cm/s, m/s, mph, km/h
Acceleration	mm/s^2, cm/s^2, m/s^2
Momentum	g m/s, kg m/s
Kinetic Energy	mJ, J

Show Data as

Data can be recalculated in another form without having to repeat an experiment using **Show data as** from the Settings menu. A Timing Wizard will open, select how you want to show the current data and enter any measurements required for the calculation. E.g. recalculate Distance data collected using a picket fence to show Speed.

Timing only

Show Columns

To show the data used to calculate the final result select **Show Columns** from the Settings menu in Timing.

Tick the box next to any columns you would like displayed from the list. The columns available will vary depending on the Timing mode selected.
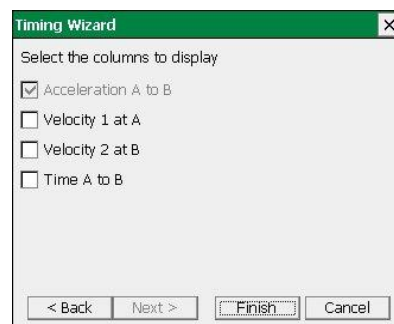
Timing only

System Settings

Use **System Settings** from the **Settings** menu to modify VISION's settings.
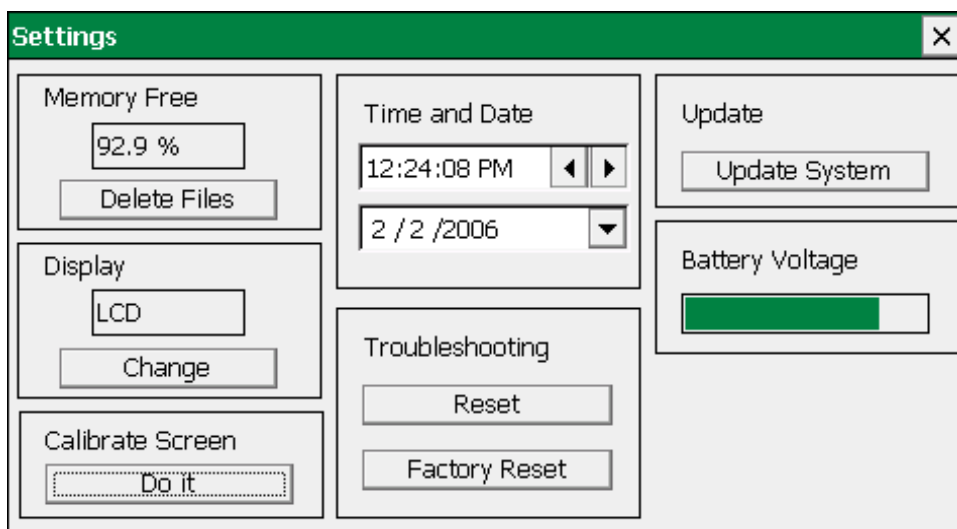
Memory Free
This value indicates the percentage of free memory available for storing user data or setup files.
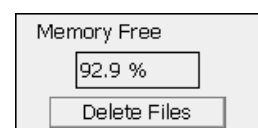
Deleting files
There are two methods of deleting user files (to free more memory).

1. From the Memory Free section in System Settings select **Delete Files**. Select the appropriate data file (.ssl) or user setup file (.sss) from the list, and select **Delete**.

2. Connect VISION to the PC in **Disc Drive** mode (from the Home screen select Disk Drive from the PC Connection menu). VISION will appear as a removable storage device on the PC; use Windows Explorer to delete files from VISION's file storage area. See .

Connecting VISION's VGA port to a projector or monitor

Ensure VISION is switched on* and connect a USB mouse to the USB host port ⚡ on VISION. Connect the VGA lead from a projector or monitor to the VGA port ▐▢▌ on VISION. The display device should automatically be detected by VISION and the display will switch from the LCD display to the VGA display device.

* If possible connect VISION to its mains power supply to prevent it automatically going into sleep mode.

If VISION does not detect the VGA device, a manual switch must be made:

• From the **Display** section in System Settings select **Change**. VISION will now switch to the VGA display device

   Note: As a safety measure, VISION will now give you 15 seconds to click on OK to stay on the VGA device; otherwise it will automatically switch back to the LCD display.

When you have finished using the VGA display device, either go back into System Settings and click change again or switch VISION off and on (it will default back to LCD at power up).

Calibrating VISION's screen

If screen taps are not accurate recalibrate the screen using VISION's screen calibration utility.

• From the **Calibrate Screen** section in System Settings select **Do it**.

TIP: If the inaccuracy of screen taps makes this selection difficult use a USB mouse.

• Enter **DHG2020** as the password (the password is case sensitive, so make sure DHG is in capitals).

Password = DHG2020

• Tap and hold the stylus on the centre of the target for about 4 seconds, when you release the tap the target will move (if not tap and hold firmly for longer).

• Repeat as the target moves around the screen (for the four corner positions).

• A message will indicate the new calibration settings have been measured, **tap anywhere** on the screen **to save the calibration** and exit.

   Note: To cancel your attempt wait for 30 seconds without doing anything and the new settings won't be saved.

Time and Date

• **Time**: Select any numbers that are not correct and use the left pointer ◄ to reduce its value or the right pointer ►to increase its value.

• **Date**: Select the down pointer ▼to open a calendar. Use the left or right pointers to scroll through the months and years and select the correct date.

System Reset

Should VISION fail to respond please attempt a reset, available at two levels:

1. **Reset** - which will restart VISION – saved data files will be safe but any unsaved data will be lost.

2. **Factory Reset** – this will reset VISION to its original factory settings. All user memory will be cleared this includes all user created data and setup files which will be erased.

- From the **Troubleshooting** section in System Settings select either Reset or Factory Reset and say Yes to the warning message.

- VISON will automatically reset and the start up screen will appear.

Update System (VISION's firmware)

Occasionally Data Harvest may release updated firmware which will contain improvements or new features. Firmware updates and instructions on how to upgrade will be made available on the Data Harvest website at www.data-harvest.co.uk/vision and Downloads - Firmware Updates.

Logger firmware number

The firmware version of your VISION unit is displayed in
1. **About** from the **Help** menu or
2. Logger Information in Sensor Config from the Settings menu.

Battery voltage

Shows an estimate of VISION's current battery voltage level.

Between 0 and 20%	Between 20 and 40%	Between 40 and 60%	Between 60 and 80%	Between 80 and 100%

Keyboard

Select **Show/Hide Keyboard** from the Settings menu to show or hide the keyboard on the screen.

Select Keyboard from the Settings menu can be used to change from the standard size keyboard to a larger version (or visa versa). The keyboard will automatically revert to standard size after a reset.

While a USB keyboard is attached to VISION the screen keyboard will not appear.

Using Tools on the data

Select **Tools** in the menu bar to open the Tools menu.

Note: Some tool options i.e. Predict, Delete Predictions and Add Text are applied on an individual graph basis rather than to all graphs displayed. These are available by selecting the **right mouse** icon (top right of the graph area) or by a tap & hold (or right click with a mouse) in the graph area. See page 41.

Tools
Smoothing
Notes
Test Mode

Tools menu at Users **Level 1**

Tools
Smoothing
Pre-log Function
Post-log Function
Best Fit
Notes
Test Mode
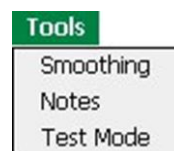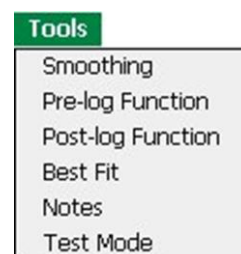
Tools menu at Users **Level 2 & 3**

Smoothing

Used to 'even out' the data of a selected line by applying a moving average.

Select **Smoothing** from the Tools menu. Select the data channel that you want to smooth from the drop-down menu. Tap or click on the **>** button to smooth or < to reverse the process. The smooth level advances at one unit at a time for the > symbol and 5 units for the >> symbol. Select OK when the smooth level is correct.

Smooth Level

Select the Channel to Smooth

pH Sensor

| << | < | 0 | > | >> | OK |

Notes

Select Notes from the toolbar or from the Tools menu to open the notes window, which has basic text editing facilities.
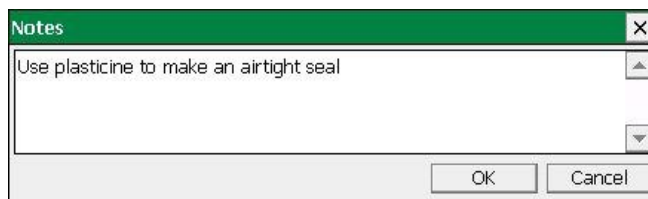
The text written in this window is automatically saved in a data file. Use this window to write notes that would be useful when setting up the experiment, information about how the data was collected, or your conclusions to the experiment.

Test Mode

Select **Test Mode** from the Tools menu to test that your sensor is operating correctly. The current value from the sensor will appear in its data value box.

The Test option will be active until it is deselected or a recording is started.

Pre-log or Post-log functions   *User Level 2 & 3*

Functions are mathematical operations that can be applied to data.

Note: Pre-log functions are not available in Scope or Timing. Post-log functions are not available in Timing.

Use a **Pre-log function** to produce a set of data that is created as logging progresses e.g. produce both a Distance and Velocity vs. time graph from a Motion sensor.

Use a **Post-log function** to create a set of data using data that has already been recorded e.g. use Voltage and Current data to calculate Power.
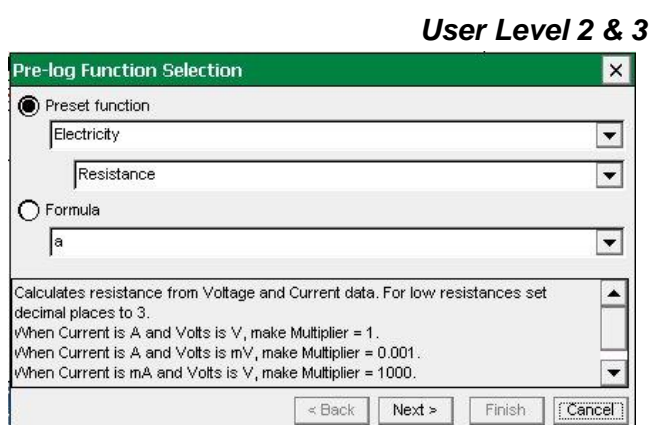
Note: There maybe a slight delay (in most cases unseen) between collection of data and presenting pre-log data on the screen e.g. 3 data points are needed before calculation of velocity can commence (acceleration would need 5 points).

- Select whether you want to use a pre-set function or formula.

   o **Pre-set** functions are described in words to make creating the data set simpler.
   o **Formula** - presents mathematical formula for generating data.

Pre-set functions:

1. Select the subject/topic area from the first drop-down list, and then select the functions available within this subject from the second list.

   The panel at the bottom of the window gives information about what the function will be calculating, what additional information will be needed for the calculation, units, etc.

   Select Next.
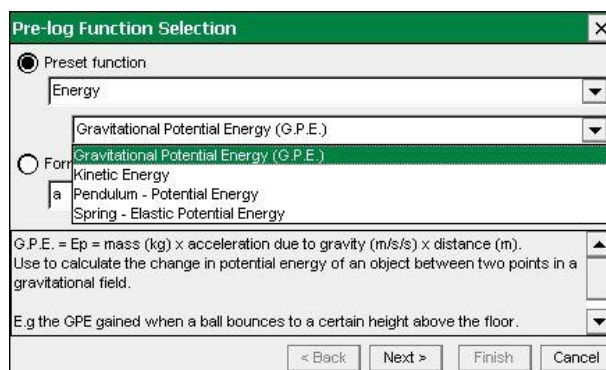
2. Select the data channel(s) to be used as
    the source from the drop-down list.

    The list of sensors is presented in the order
    of the connected sensor ports. With Post-
    log functions the list will include any
    derived data channels.

    Select Next.

3. **Details** tab:
    Enter the details for the new set of data e.g.
    type in a name and units.

    Alter the number of decimal places to be
    displayed if required.

4. **Limits** tab:
    Select whether the axis limits of this data should
    either expand to fit or use manual limits.

    Expand to fit - when the recording has finished,
    the axis will automatically redraw if data has
    exceeded the limits taken from the original
    data.

    Manual - use the limits of the axis as specified in the minimum and maximum boxes.

    Note: The default value is based on the default limits of the first source channel used in the calculation. If the
    maximum value calculated by the function is less than the source channel limits, apply Autoscale (see page 28)
    to find the limits of the calculated data.

5. **Parameters** tab;
    Enter any parameters required 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 Finish.

If you are using a Pre-log Function, select the **Start** icon. Data will be calculated and displayed on the
graph and table. Values will not be displayed in the data values boxes during logging.

Pre-set functions

SUBJECT	FUNCTION	INFORMATION
Electricity	**Resistance**	Calculates resistance from Voltage and Current data. Current sensor values can be in units of A or mA, Voltage in mV or V. Identify the sensor's units and select the correct multiplier (shown in the white information box). For low resistances set decimal places to 3. When Current is **A** and Volts is **V**, make Multiplier = **1** When Current is **A** and Volts is **mV**, make Multiplier = **0.001** When Current is **mA** and Volts is **V**, make Multiplier = **1000** When Current is **mA** and Volts is **mV**, make Multiplier = **1**
	Power	Calculates power from Voltage and Current data. Current sensor values can be in units of A or mA, Voltage in mV or V. Identify the sensor units and select the correct multiplier (shown in the white information box). When Current is **A** and Volts is **V**, make Multiplier = **1** When Current is **A** and Volts is **mV**, make Multiplier = **0.001** When Current is **mA** and Volts is **V**, make Multiplier = **0.001** When Current is **mA** and Volts is **mV**, make Multiplier = **0.000001**

SUBJECT	FUNCTION	INFORMATION
Motion	**Velocity**	Velocity, calculated from position, distance or displacement data (first derivative) as $\frac{dx}{dt}$ where x is the distance data and t is the time data. Enter the units as appropriate e.g. Linear Motion – units (m) – m/s; (cm) – cm/s; (mm) – mm/s; (in) – in/s. Pendulum, units (deg) – deg/s.
	Acceleration from position data or distance data	Acceleration calculated from position or distance data (second derivative) as $\frac{d^2s}{dt^2}$ or $\frac{d^2\theta}{dt^2}$. Enter the units as appropriate e.g. Linear Motion – units (m) – m/s/s; (cm) – cm/s/s; (mm) – mm/s/s; (in) – in/s/s. Pendulum – units; Angular acceleration – deg/s/s.
	Acceleration from Velocity data	Acceleration calculated as the first derivative of Velocity data (linear) Enter the units as appropriate e.g. Linear Velocity [m/s] – Linear Acceleration [m/s/s].
	Angular Acceleration from Angular Velocity data	Angular Acceleration calculated from Angular Velocity (first derivative) Enter the units as appropriate e.g. Angular Velocity (revs/s) – Angular Acceleration, units revs/s/s Angular Velocity (rads/s) – Angular Acceleration, units rads/s/s
	Displacement from a reference point	Displacement = the distance from a reference point. The distance value of the reference point is subtracted from the distance data to give the displacement. E.g. with an oscillating spring, the 'reference point' would be the distance value of the centre of the oscillation. The displacement required is the displacement from the centre of oscillation.
	Pendulum - **Linear Displacement**	Calculates the linear displacement along the arc of the pendulum oscillation. It is calculated from the midpoint of the oscillation. Assumption; the angles are small (less than 20˚) and sinR = R in radians
	Displacement from Velocity	Calculates the displacement from Velocity data.

Energy	Gravitational Potential Energy (G.P.E.)	G.P.E. = E_p = mass (kg) x acceleration due to gravity (m/s/s) x distance (m). Use to calculate the change in potential energy of an object between two points in a gravitational field. E.g the GPE gained when a ball bounces to a certain height above the floor. $\Delta E_p = m \times g \times \Delta h$
	Kinetic Energy	Kinetic Energy = [0.5 x mass (kg)] x velocity^2
	Pendulum – Potential Energy	Calculates the difference in the potential energy of the pendulum bob between the centre of the oscillation and any other position in the oscillation. The angular displacement data must be in radians before this function is used (see the Conversion pre-set functions).
	Spring – Elastic Potential Energy	Calculates the change in the elastic potential energy of the spring as a result of the displacement of the spring/mass system from the midpoint of the oscillation. Calculated as ½Fx (Joules)

General	Tare	Use this function to subtract an offset from a sensor reading (typically used to zero the value from a sensor). Find the tare value before using this function. **Note:** Make the value negative or positive as appropriate e.g. (2) - (2) = 0, (-2) - (-2) = 0.
	Asks for Value (*Snapshot Pre-log* only)	Each time you tap or click in the graph area to record a value, a dialogue box will appear for you to type in a number from the keyboard. **Note:** Enter a Name and Units as appropriate.
	Manual Entry	Use this function to create a column full of zeros so that your own data can be entered via the keyboard.
	Add a constant	Use this function to add a number (constant) to each data point.
	Subtract a constant	Use this function to subtract a number (constant) from each data point.
	Multiply by a constant	Use this function to multiply each data point by a number (constant). **Note**: Alter the number of decimal places as appropriate.
	Divide by a constant	Use this function to divide each data point by a number (constant). **Note**: Alter the number of decimal places as appropriate.
	Moving Average (simple)	This is a smoothing function. Each value is the mean of the previous 'a' number of data points e.g. if a = 5, then the averages of data points 1 to 5, 2 to 6, 3 to 7, etc. will be taken.
	Mean (x,a)	The sum of all the values in a set of 'a' data points divided by 'a' e.g. if a = 5, an mean will be calculated for each set of 5 data points, 1 to 5, 6 to 10, 11 to 15, etc.
	Average of 2 Channels	Adds and divides the data from two Channels to show the average of both channels. **Note**: Alter the number of decimal places as appropriate.
	Average of 3 Channels	Adds and divides the data from three Channels to show the average of all three channels. **Note**: Alter the number of decimal places as appropriate.

Titration	Asks for the Volume added (*Snapshot Pre-log* only)	This pre-log function will only be available in SnapShot mode. Each time you tap or click in the graph area to record a value from the pH Sensor, a dialogue box will appear for you to type in a number from your keyboard. Enter the TOTAL volume added so far.
	First derivative of pH	Creates a sharp peak to identify the point of most rapid change in pH.
	Convert Drops to **Volume**	Use this function to convert 'number of drops' to a volume measurement. This function needs a value for the volume of one drop. Divide the volume in cm^3 by the number of drops required to fill this volume e.g. 1 cm^3 = 27 drops, 1/27 = 0.037 cm^3 per drop. **Note**: Alter the number of decimal places as appropriate.

Spirometer	Spirometer Air Flow to **Volume**	This function converts Air Flow data from the Spirometer to Volume. Volume units = Litres (l)
	Spirometer Volume **drift correction** (*Post-log* only)	This function corrects Volume data (which has already been calculated from the Air Flow data) for drift. **Note:** Volume data must be available to select. The multiplier and constant values are pre-calculated.

Channel	**Multiply** Channel by Channel	This function multiples the data of two Channels together
	Divide Channel by Channel	This function divides the data from one Channel by a second Channel
	Subtract Channel from Channel	This function subtracts the data of one Channel from a second Channel
	Add two Channels together	This function adds the data from two Channels together

Oxygen	% Saturation to **mg/l**	This function converts Oxygen % saturation data to Oxygen in mg/l. You will need to supply the Air Pressure (default 101.3 kPa) and the Temperature (˚C).

Conversion	Convert Degrees (angles) to **Radians**	Converts Degrees to Radians. For Pendulum (±20˚) adjust the minimum channel limits to -0.4 and maximum channel limits to 0.4.
	Radians to **Degrees**	Converts Radians to Degrees
	Celsius to **Fahrenheit**	Converts Celsius to Fahrenheit
	Fahrenheit to **Celsius**	Converts Fahrenheit to Celsius
	Celsius to **Kelvin**	Converts Celsius to Kelvin

Formula functions:

1. Tap or click on the down arrow to view the formulae available and select from the list. The panel at the bottom of the window will give information about what the function will be calculating.

a	Mean (x,a)	$a/(x\char`^b) + c$	$a\ exp(bt) + c$
ax + by	ax^2	a tx + b	$a\ log10(bx) + c$
ax - by	$a/x^2 + c$	a t/x + b	$a\ log_e(bx) + c$
axy	$ax^2 + bx + c$	a sin(bx) + c	$a\ log10(bt) + c$
ax/y	$at^2 + bt + c$	a cos(bx) + c	$a\ log_e(bt) + c$
a/x + c	a dy/dx	a exp(bx) + c	
(x - a)/b	a dx/dt	a sin(bt) + c	
Moving average	$ax^b + c$	a cos(bt) + c	

   Select Next.

2. Select the data channel(s) to be used as the source of x or y. Tap or click on the arrow to reveal the list of sensors connected (presented in the order of the connected sensor ports). With Post-log functions the list will include any derived data channels.

   Select Next.

3. **Details** tab: Enter the name and units for the new set of data. Alter the number of decimal places to be displayed if required.

4. **Limits** tab: Choose whether the axis limits of this data should either expand to fit or use manual limits.

   o Expand to fit - when the recording has finished, the axis will automatically redraw if data has exceeded the limits taken from the original data.

   o Manual - use the limits of the axis as specified in the minimum and maximum boxes.

   Note: The default value is based on the default limits of the first source channel used in the calculation. If the maximum value calculated by the function is less than the source channel limits, apply Autoscale (see page 28) to find the limits of the calculated data.

5. **Parameters** tab: Enter any parameters required e.g. a and b are constants i.e. a number or scaler, c is an offset or intercept number. Numbers can be negative or positive (make sure there isn't a space between the + or – sign and the number).

   Select Finish.

   Notes:
   ▪ 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.
   ▪ 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).
   ▪ A number multiplied by 1 gives the same number.
   ▪ 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*.

If you are using a Pre-log Function, select the **Start** icon. Data will be calculated and displayed on the graph and table. Values will not be displayed in the data values boxes during logging.

Best fit   *User Level 2 & 3*

Select **Best Fit** from the Tools menu to calculate and produce a straight line which fits most closely to the collected data. It can be applied to the whole set of data or to a selected part.

Note: If you want to apply an automatic line of best fit to only a part of the collected data, make your selection before choosing Best Fit.

- Select the method of Best Fit

   Automatic (computer calculated) - the line will be drawn automatically across the entire range of the selected data.

   Manual (drawn freehand) - lets you draw the line of best fit between any two points
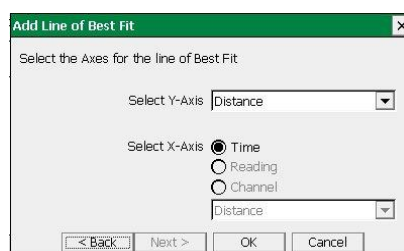
- Select Next.
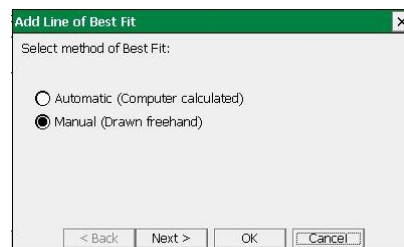
   Manual
   - Select the Axes for the line of Best Fit

      Y-Axis – select the data channel/sensor to which you want to fit to the line from the drop-down menu.

      X-Axis – the current X-axis will be selected by default. If the X-axis is Channel, select the data channel to be used from the drop-down list.

- Select OK to finish.
- Tap or click and hold at the start point, drag the 'rubber band' line to the end point and tap or click to finish.

   A manual best fit line can be adjusted. Tap or click on the end point of the line, hold down and drag to its new position.

   To **delete** a best fit line, tap & hold ∴ (or **right** click with a mouse) on the line and select **Delete**.

   Information shown
   Manual: (y = bx + a)

   y = the data channel selected
   x = as selected (i.e. time, reading or a data channel)
   a is the intercept
   b is the constant of the slope (gradient between two points)

   Automatic
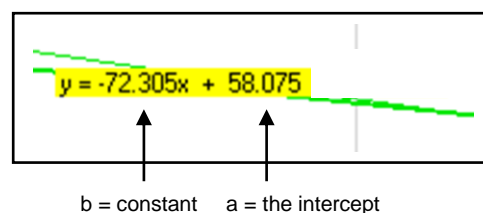   - Select the Axes for the line of Best Fit
      Y-Axis – select the data channel/sensor to which you want to fit to the line from the drop-down menu.
      X-Axis – the current X-axis will be selected by default. If the X-axis is Channel, select the data channel to be used from the drop-down list.

   - Select OK to finish or if you currently have data selected but want the best fit line to be applied to the whole set of data select Next, No then OK.

   - The line will be drawn automatically.

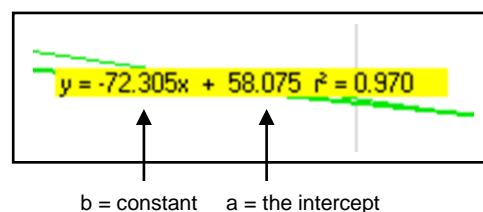   **Information shown**
      Automatic: (y = bx + a), r^2 =

      y = the data channel selected
      x = as selected (i.e. time, reading or a data channel)
      b is the constant of the slope (gradient between two points)
      a is the intercept

r^2 is a fraction between 0 and 1. A high r^2 tells you the line came very close to the points of data. When $r^2 = 1$, all points line up exactly on a straight line with no scatter (so knowing x would let you predict y perfectly). An r^2 value of 0 means there is no linear relationship between x and y (so knowing x doesn't not help you predict y).

Note: The r^2 value is only available if an Automatic line is drawn.

To **delete** a best fit line, tap & hold ⁞⁞ (or **right** click with a mouse) on the line and select **Delete**.

Show Calculation

Use to show how a result has been calculated for a reading in Timing.
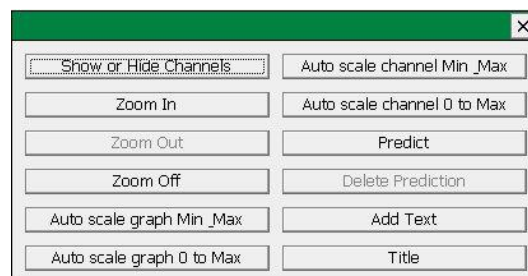
Timing only

Select a reading from the table, and select **Show Calculation** from the Tools menu. The formula and measurements used in the calculation will be shown.

Select Next to see the calculation for the next reading or Cancel to finish.

Note: A calculation will not be available for data collected using a Picket fence or Pulley.

Individual graph choices

Some tool options i.e. Predict, Delete Predictions and Add Text are applied on an individual graph basis rather than to all graphs displayed. These are available by selecting the **right mouse** icon ▤ (top right of the graph area) or by a tap & hold ⁞⁞ (or right click with a USB mouse) in the graph area of the individual graph.

|	
Show or Hide Channels	Auto scale channel Min _Max
Zoom In	Auto scale channel 0 to Max
Zoom Out	Predict
Zoom Off	Delete Prediction
Auto scale graph Min _Max	Add Text
Auto scale graph 0 to Max	Title

Predict

Used to anticipate the effect of a change to the measured parameter before data is recorded e.g. moving a Temperature Sensor from hot to cold water. Predict lines can be drawn on a graph to predict where you think the graph line will go.

To make a Prediction:

- Select the right mouse icon ▤ or tap & hold ⁞⁞ in the graph area and select **Predict.**

- Tap and drag from the start point and a thick black line will appear. Use the line to draw a prediction on the graph. Tap or click at different points on the graph to fix the line in position.

- Select the right mouse icon or tap & hold and deselect **Predict**.

- Record the data as normal to test the validity of your prediction.
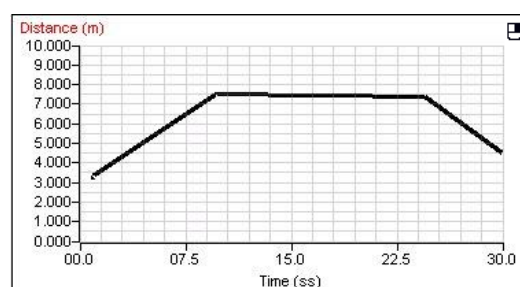
To delete any unwanted prediction lines select the right mouse icon or tap & hold ⁞⁞ in the graph area and select **Delete Prediction**. Use the forward and backward buttons to cycle through the prediction lines. As each line is selected it will turn red on the graph. Select the **Delete** button to erase the prediction.

Add Text

Used to annotate the graph with 'text boxes' that can be placed in any position in the graph area. Each text box has a line which can be made to 'point' to a part of the graph to which it refers.
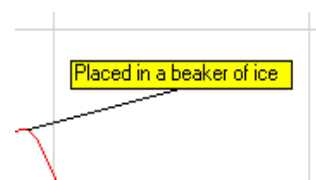
- Select the right mouse icon or tap & hold ⋮⋮ in the graph area and select **Add Text**.

- A dialogue box will open. Type in the required text and select OK. (Use the enter key to move text to a new line).

- Tap in graph area at the position you want the label to refer to, drag the 'ghost' rectangular box that appears to the required position for the label. Tap or click and the label will appear.

The label can be moved at any time - tap or click on the label and drag.

To edit or delete a label, tap & hold ⋮⋮ on the appropriate label and select **Edit** or **Delete**.

Deleting data
Delete selected
Select the data that you want to delete – see page 20. Select **Delete selected** from the **Edit** menu and confirm the deletion of the currently selected data.

If the data is recorded with a constant time interval between readings (Graph and EasyLog), the data will be deleted but the time intervals will remain consistent. If readings are displayed as joined by a line, it will redraw between the data points.

If data is recorded with an inconsistent time point (Snapshot), both the data and reading number will be deleted and the graph will redraw.

Edit a value

Double tap on the appropriate reading in the table, edit the value and select OK.
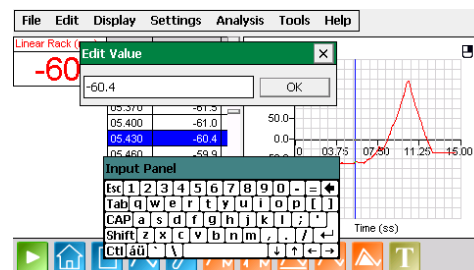
Delete Data Sets   *User Level 2 & 3*

Use **Delete Data Set** from the **Edit** menu to erase an entire set of data.

Choose the channel of data to erase from the drop down menu. Select Erase and confirm the permanent deletion of the data set from that channel.

Note: Once a data set has been deleted there is no recover option.
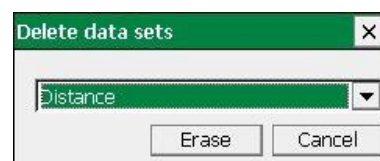
Merging Data   *User Level 3*

Select **Merge with file** from the **File** menu to merge the current data with a saved .SSL file. The data must be recorded with a time base (not suitable for Snapshot data) and the intersample time of the data must be the same for both.

Note: You may find it best to set up a recording using a method in which the intersample time for the recording is specified e.g. Graph rather than using EasyLog if you intend to merge the resulting files

This option is not available at User Level 1 & 2 or with SnapShot and Timing.

File options

| Item	Available in	Description
Home	Meters, EasyLog, Snapshot, Graph, Scope, Timing	To return to the Home screen.
New	EasyLog, Snapshot, Graph, Scope, Timing	Use to set up a new recording e.g. opens a Logging wizard.
Open	EasyLog, Snapshot, Graph, Scope, Timing	Use to load a previously saved data file. Locate the EasySense file (.SSL) and select OK. [Default save location is User Files\Data Files]. If you are opening a file saved on a memory stick connect the USB memory stick to the USB host port on VISION **before** selecting Open.
Save	EasyLog, Snapshot, Graph, Scope, Timing	Provided the file has been saved previously, the data will automatically be saved, retaining its original name. **Notes:** If you Save while only a selected part of the data is being used then only the selected data will be saved.
Save As	EasyLog, Snapshot, Graph, Scope, Timing	A dialogue box will open to allow the captured data to be saved as an EasySense file using a filename and destination of your choice. Saved as **.SSL** type. [Default save location is User Files\Data Files]. If you are saving to a memory stick connect the USB memory stick to the USB host port on VISION **before** selecting Save As. **Note:** The Save or Save As options are not available in Meters as the data collected is live, but data recorded 'behind the scenes' can be transferred into the Graph window and then saved. If VISION's battery voltage level drops too low then any data being recorded will be saved as an .SSL file called **Auto-Saved Data** in the User Files\Data Files folder.
Save Setup	Meters, EasyLog, Snapshot, Graph, Scope, Timing	The settings for an experiment can be saved as a **Setup** file. This allows the use of the same settings at a future date without going through the set-up process. See page 44.
Export as a CSV file (or .SID file)	EasyLog, Snapshot, Graph, Scope, Timing	From the dialogue box select the **Type** as either SID or CSV and enter a file name and destination of your choice. If you are saving to a memory stick connect the USB memory stick to the USB host port on VISION **before** selecting Export as. **Notes:** • Files saved in .SID format contain information about units and measurements so allow free exchange of data between varieties of data logging software systems. • Files saved in CSV format (comma-separated values) are in a simple text format suitable for database table /spreadsheet systems e.g. Microsoft Excel.

Setup Files

To save a Setup file

- Set up the parameters of an experiment using the appropriate logging option i.e. EasyLog, Meters, Snapshot, Graph, Scope or Timing.

  E.g. Select the Users level, recording times, interval between samples, any start conditions or pre-triggers plus any options required for display i.e. show table, number of graphs, line thickness and point style, grid on/off, X-axis, name, minimum and maximum limits, title, predictions, deselected channels, pre-log functions, notes, overlay, etc.

- Select **Save Setup** from the **File** Menu.

- Type in a suitable name for the experiment - this is the name that will be displayed in the setup window list. Select OK.
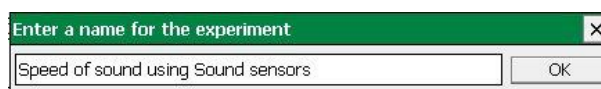
- A dialogue box will open. Type in the file name. Select OK.

  Note: The file is saved to the User Files\Setup Files folder.
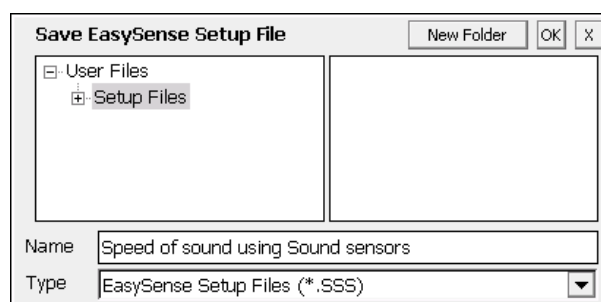
To open a Setup file

From the **Home** screen select **Open Setup** from the **File** menu to open the software pre-configured for an investigation.

To open one of the setups supplied with VISION:

1. Open the Data Harvest Investigations directory.

2. Open the folder for the appropriate setup files e.g. 5 Minute Activities.

3. Locate the investigation and double tap or click on its setup file. One of the logging options e.g. Graph, will open pre-set to record this investigation.
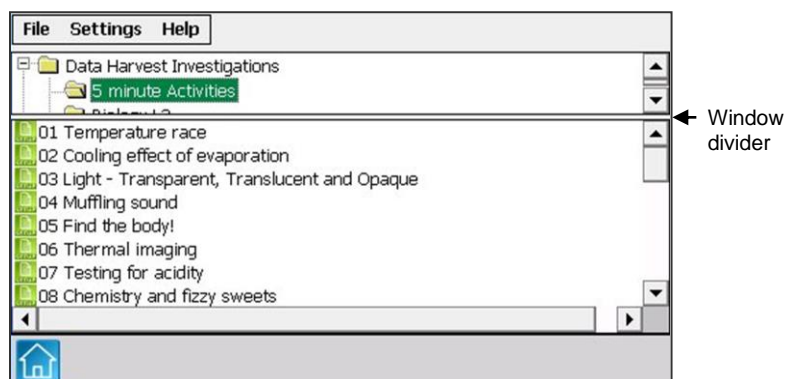
Tap and drag the window divider to reveal a larger area of the list.

To open one of your own set ups:

1. Open the My Investigations folder.

2. Locate the investigation and double tap or click on its setup file.
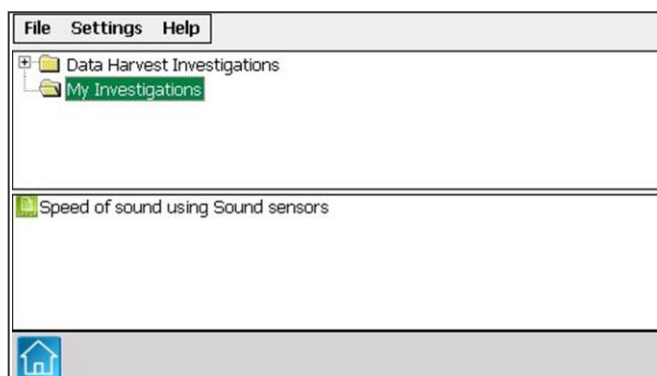
Screen capture

Graph and Table area

This method will capture and save whatever is shown in the graph and/or table area in EasyLog, Graph, Scope, SnapShot and Timing as a bitmap image for use in your report document.

- Ensure the graph and/or table that you wish to save is displayed on VISION's screen.
- Select **Export Screen** from the File menu.
- Enter a file name for the bitmap image and OK.
- Connect VISION to your PC computer as a Disc Drive (select Disc Drive from PC Connection on the Home screen). The bitmap images will be available in the Data Files directory.

Full screen capture

This method will capture a snapshot of the entire VISION screen, including any drop-down menus, etc.

- Plug a USB keyboard into the USB host port on VISION.
- Ensure what you wish to capture is displayed on VISION's screen.
- On the keyboard press the **print screen** button.
- Connect VISION to your PC computer as a Disc Drive (select Disc Drive from PC Connection on the Home screen). The bitmap images will available from a Screen Shots directory within Data Files using an incremental filename.
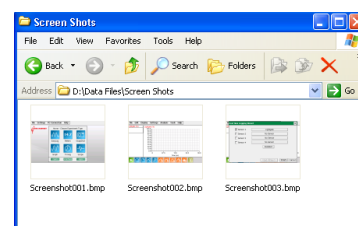
Printing

VISION will print to most Hewlett Packard PCL compatible printers in either a portrait or landscape format, back and white or in colour*.

Connect a compatible printer to the USB host port on VISION (printer turned on).

Print	Meters only	To print out a copy of the current screen display.
Print Graph	EasyLog, Snapshot, Graph, Scope, Timing	To print out a copy of the current graph.
Print Table	EasyLog, Snapshot, Graph, Scope, Timing	To print out a copy of the current table. Be aware that a table can use multiple pages to print.

*VISION will only print greyscale with a HP Colour LaserJet printer (not in colour).

Apps

Select **Apps** either from the **Home** screen or **File** menu to open or manage additional applications that have been installed on VISION e.g. the Periodic Table, Scientific Calculator.

To install a new App

- Download and Save the compressed application from our website to your PC computer. 'Unzip' to extract the applications folder to the top level of a USB memory stick.
- Connect the USB memory stick to the USB host port on VISION.
- Select **Apps** either from the **Home** screen or **File** menu.
- Select **Install/Update** from the **Settings** menu.
- Select the application to install from the list and OK.

To uninstall an App

- Select **Apps** either from the **Home** screen or **File** menu.

- Select the application you want to remove.
- Select **Remove** from the **Settings** menu.
- Enter **DHG2020** as the password (the password is case sensitive, so make sure DHG is in capitals) and OK.

<div style="border:1px solid">

Password = DHG2020

</div>

Transferring files between VISION and a PC computer

Saved data files can either be transferred from VISION to your PC by using VISION in 'disc drive' mode or can be opened direct into the EasySense PC software by using the **Retrieve Remote** function while VISION is connected as an interface.

Saved setup or bitmap files can be transferred from VISION to your PC or visa versa by using VISION in 'disc drive' mode.

- Save any data you have on screen.
- Connect VISION to the PC using the USB cable supplied.

Using VISION in Disc Drive mode

- From the **Home** screen select **Disk Drive** from the **PC Connection** menu.
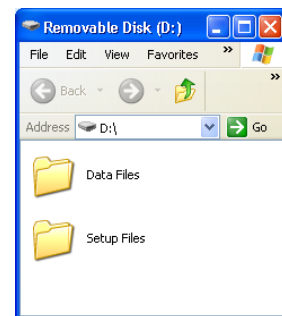
  VISION's screen will alter to show its USB connected.

- The first time VISION is connected allow the USB device drivers to install. VISION will appear as a removable storage device on the PC (no special drivers are required).

  Windows Explorer can be used to drag and drop files between VISION and your PC (maximum file size for VISION is 5 MB).

- When you've finished tell Windows that you are about to remove the device e.g. using the Safely Remove Hardware icon from the computer's taskbar and once safe to do so disconnect VISION from the USB port. VISION's EasySense software will automatically restart.

Retrieving data files with VISION connected as an Interface

- From **VISION's** Home screen select the **Interface** button.

  VISION's screen will alter to show its USB connected.
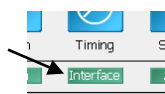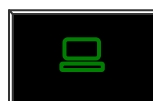
- Open the EasySense software on your PC computer.

- Select **Retrieve Remote** from the Home screen.

- Select the data file from the list then Retrieve.
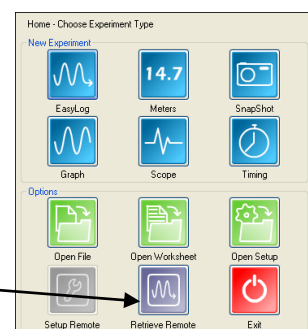
When you've finished using VISION as an interface, disconnect from the USB port and VISION's EasySense software will automatically restart.

Using VISION as in interface (controlled by the EasySense software on a PC computer)

- Save any data you have on screen.
- Connect VISION to the PC using the USB cable supplied.

- Select **Interface** either from VISION's Home screen or from the PC Connection menu.

  VISION's screen will alter to show its USB connected*.
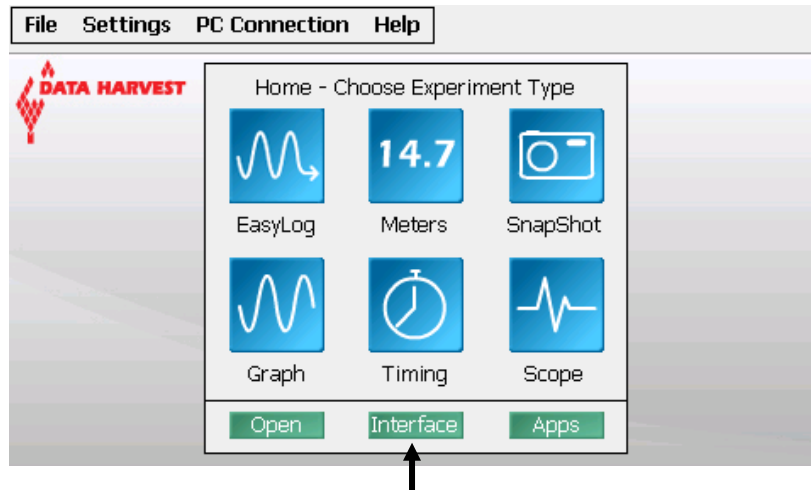
- The first time VISION is connected allow the USB device drivers to install.

- Open the EasySense software on your PC computer e.g. Start ► Programs ► Data Harvest ► and double click on EasySense Software. Select an experimental mode from the Home screen i.e. EasyLog, Graph, Meters, Scope, SnapShot or Timing.

When you've finished using VISION as an interface, disconnect VISION from the USB port and VISION will restart.

* If VISION does not find a connection with the PC within 10 seconds, it will automatically restart VISION's EasySense software.

Help - About

Contains information about the version number of the EasySense software and VISION's build and PIC firmware version number.

Duration and Interval Table for Logging

- **Pre-triggers** are only available with fast recording times and when a trigger has been set.
- For very fast sample rates there is a limit to the number of sensors that can be connected, this is indicated in the **maximum sensors** column.
- The following *Smart Q* Sensors are not able to provide readings at intervals of **less than 20 ms** (50 Hz): Ohaus Scout Pro Top-pan Balance Adapter (Product No. 3060), Carbon Dioxide Gas Sensor (Product No. 3152), Drop Counter and Bubble Sensor (Product No. 3266), Geiger Muller Sensor (Product No. 3265), the beats per minute range of the Heart Rate and Pulse Waveform Sensor (Product No. 3147), Motion Sensor (Product No.3705 or 3270) and the Polar Heart Rate Exercise Sensor (Product No. 3148).

Graph

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
20 ms	20 µs	1000	1	✔
(0.02 s)	25 µs	800	1	✔
	50 µs	400	1	✔
	100 µs	200	1	✔
	200 µs	100	1	✔
	500 µs	40	1	✔
	1 ms	20	1	✔
	2 ms	10	1	✔

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
25 ms	20 µs	1250	1	✔
(0.025 s)	25 µs	1000	1	✔
	50 µs	500	1	✔
	100 µs	250	1	✔
	200 µs	125	1	✔
	500 µs	50	1	✔
	1 ms	25	1	✔
	2 ms	12	1	✔

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
50 ms	20 µs	2500	1	✔
(0.05 s)	25 µs	1000	1	✔
	50 µs	1000	2	✔
	100 µs	500	2	✔
	200 µs	250	2	✔
	500 µs	100	2	✔
	1 ms	50	2	✔
	2 ms	25	2	✔
	5 ms	10	2	✔

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
100 ms	25 µs	4000	1	✔
(0.1 s)	50 µs	2000	2	✔
	100 µs	1000	4	✔
	200 µs	500	4	✔
	500 µs	200	4	✔
	1 ms	100	4	✔
	2 ms	50	4	✔
	5 ms	20	4	✔
	10 ms	10	4	✔

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
200 ms	50 µs	4000	2	✔
(0.2 s)	100 µs	2000	4	✔
	200 µs	1000	4	✔
	500 µs	400	4	✔
	1 ms	200	4	✔
	2 ms	100	4	✔
	5 ms	40	4	✔
	10 ms	20	4	✔
	20 ms	10	4	

Duration	Interval	Samples	Max. no. of sensors	Pre-trigger
500 ms	200 µs	2500	4	✔
(0.5 s)	500 µs	1000	4	✔
	1 ms	500	4	✔
	2 ms	250	4	✔
	5 ms	100	4	✔
	10 ms	50	4	✔
	20 ms	25	4	
	25 ms	20	4	
	50 ms	10	4	

Duration	Interval	Samples	Pre-trigger
1 s	500 µs	2000	✔
	1 ms	1000	✔
	2 ms	500	✔
	5 ms	200	✔
	10 ms	100	✔
	20 ms	50	
	25 ms	40	
	50 ms	20	
	100 ms	10	

Duration	Interval	Samples	Pre-trigger
2 s	500 µs	4000	✔
	1 ms	2000	✔
	2 ms	1000	✔
	5 ms	400	✔
	10 ms	200	✔
	20 ms	100	
	25 ms	80	
	50 ms	40	
	100 ms	20	
	200 ms	10	

Duration	Interval	Samples	Pre-trigger
5 s	2 ms	2500	✔
	5 ms	1000	✔
	10 ms	500	✔
	20 ms	250	
	25 ms	200	
	50 ms	100	
	100 ms	50	
	200 ms	25	
	500 ms	10	

Duration	Interval	Samples	Pre-trigger
10 s	5 ms	2000	✔
	10 ms	1000	✔
	20 ms	500	
	25 ms	400	
	50 ms	200	
	100 ms	100	
	200 ms	50	
	500 ms	20	
	1 s	10	

Duration	Interval	Samples	Pre-trigger
20 s	5 ms	4000	✔
	10 ms	2000	✔
	20 ms	1000	
	25 ms	800	
	50 ms	400	
	100 ms	200	
	200 ms	100	
	500 ms	40	
	1 s	20	
	2 s	10	

Duration	Interval	Samples	Pre-trigger
30 s	10 ms	3000	✔
	20 ms	1500	
	25 ms	1200	
	50 ms	600	
	100 ms	300	
	200 ms	150	
	500 ms	60	
	1 s	30	
	2 s	15	

Duration	Interval	Samples
1 min	20 ms	3000
	25 ms	2400
	50 ms	1200
	100 ms	600
	200 ms	300
	500 ms	120
	1 s	60
	2 s	30
	5 s	12

Duration	Interval	Samples
2 min	50 ms	2400
	100 ms	1200
	200 ms	600
	500 ms	240
	1 s	120
	2 s	60
	5 s	24
	10 s	12

Duration	Interval	Samples
5 min	100 ms	3000
	200 ms	1500
	500 ms	600
	1 s	300
	2 s	150
	5 s	60
	10 s	30
	20 s	15
	30 s	10

Duration	Interval	Samples
10 min	200 ms	3000
	500 ms	1200
	1 s	600
	2 s	300
	5 s	120
	10 s	60
	20 s	30
	30 s	20
	1 min	10

Duration	Interval	Samples
20 min	500 ms	2400
	1 s	1200
	2 s	600
	5 s	240
	10 s	120
	20 s	60
	30 s	40
	1 min	20
	2 min	10

Duration	Interval	Samples
30 min	500 ms	3600
	1 s	1800
	2 s	900
	5 s	360
	10 s	180
	20 s	90
	30 s	60
	1 min	30
	2 min	15

Duration	Interval	Samples
1 hour	1 s	3600
	2 s	1800
	5 s	720
	10 s	360
	20 s	180
	30 s	120
	1 min	60
	2 min	30
	5 min	12

Duration	Interval	Samples
2 hours	2 s	3600
	5 s	1440
	10 s	720
	20 s	360
	30 s	240
	1 min	120
	2 min	60
	5 min	24
	10 min	12

Duration	Interval	Samples
3 hours	5 s	2160
	10 s	1080
	20 s	540
	30 s	360
	1 min	180
	2 min	90
	5 min	36
	10 min	18

Duration	Interval	Samples
4 hours	5 s	2880
	10 s	1440
	20 s	720
	30 s	480
	1 min	240
	2 min	120
	5 min	48
	10 min	24
	20 min	12

Duration	Interval	Samples
5 hours	5 s	3600
	10 s	1800
	20 s	900
	30 s	600
	1 min	300
	2 min	150
	5 min	60
	10 min	30
	20 min	15
	30 min	10

Duration	Interval	Samples
6 hours	10 s	2160
	20 s	1080
	30 s	720
	1 min	360
	2 min	180
	5 min	72
	10 min	36
	20 min	18
	30 min	12

Duration	Interval	Samples
7 hours	10 s	2520
	20 s	1260
	30 s	840
	1 min	420
	2 min	210
	5 min	84
	10 min	42
	20 min	21
	30 min	14

Duration	Interval	Samples
8 hours	10 s	2880
	20 s	1440
	30 s	960
	1 min	480
	2 min	240
	5 min	96
	10 min	48
	20 min	24
	30 min	16

Duration	Interval	Samples
12 hrs	20 s	2160
	30 s	1440
	1 min	720
	2 min	360
	5 min	144
	10 min	72
	20 min	36
	30 min	24
	1 hour	12

Duration	Interval	Samples
1 day	30 s	2880
	1 min	1440
	2 min	720
	5 min	288
	10 min	144
	20 min	72
	30 min	48
	1 hour	24

Duration	Interval	Samples
2 days	1 min	2880
	2 min	1440
	5 min	576
	10 min	288
	20 min	144
	30 min	96
	1 hour	48

Duration	Interval	Samples
3 days	2 min	2160
	5 min	864
	10 min	432
	20 min	216
	30 min	144
	1 hour	72

Duration	Interval	Samples
4 days	2 min	2880
	5 min	1152
	10 min	576
	20 min	288
	30 min	192
	1 hour	96

Duration	Interval	Samples
5 days	2 min	3600
	5 min	1440
	10 min	720
	20 min	360
	30 min	240
	1 hour	120

Duration	Interval	Samples
6 days	5 min	1728
	10 min	864
	20 min	432
	30 min	288
	1 hour	144

Duration	Interval	Samples
7 days	5 min	2016
	10 min	1008
	20 min	504
	30 min	336
	1 hour	168

Duration	Interval	Samples
10 days	5 min	2880
	10 min	1440
	20 min	720
	30 min	480
	1 hour	240

Duration	Interval	Samples
14 days	10 min	2016
	20 min	1008
	30 min	672
	1 hour	336

Duration	Interval	Samples
21 days	10 min	3024
	20 min	1512
	30 min	1008
	1 hour	504

Duration	Interval	Samples
28 days	20 min	2016
	30 min	1344
	1 hour	672

Duration	Interval	Samples
35 days	20 min	2520
	30 min	1680
	1 hour	840

Scope

Duration	5.12 ms	12.8 ms	25.6 ms	51.2 ms	128 ms	256 ms	512 ms	1.28 s	2.56 s
Interval	20 μs	50 μs	100 μs	200 μs	500 μs	1 ms	2 ms	5 ms	10 ms
Max. no. of sensors	**1**	**2**	4	4	4	4	4	4	4

Duration	Roll mode	Roll mode	Roll mode	Roll mode	Roll mode
Interval	20 ms	50 ms	100 ms	200 ms	500 ms
Max. no. of sensors	4	4	4	4	4

INDEX

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