

# **LogIT SensorLab™ User Guide**

SensorLab v1.1

Copyright © 2010-2011 SCC Research

# 1. Table of Contents

1 Introduction.....	5
2 Supported Operating Systems and Hardware.....	7
2.1 Computer Specification.....	7
2.2 Linux.....	7
2.3 Mac OS X.....	7
2.4 Microsoft Windows.....	7
2.5 Consistent Across Platforms.....	8
3 Installing SensorLab.....	9
3.1 Linux.....	9
3.2 Mac OS X.....	9
3.3 Microsoft Windows.....	9
4 SensorLab Editions.....	10
4.1 Standard and Plus Editions.....	11
4.2 Licence.....	11
5 Activation.....	12
6 Levels of Sophistication.....	13
7 Measuring and Logging.....	14
8 Activity Selection Screen.....	15
8.1 Worksheets.....	15
8.2 Sidebar Icons (Activity Selection Screen).....	16
8.3 Logging Types.....	16
8.4 Logger and Sensor.....	17
8.5 Scale Options.....	17
8.6 Level and Help.....	18
8.7 Toolbar.....	18
9 Graph Screen.....	19
9.1 Sidebar Icons (Graph Screen).....	20
9.2 Level and Help.....	20
9.3 Toolbar.....	20
10 Oscilloscope.....	21
11 Set Up Wizard.....	23
12 Analysis.....	25
12.1 Zoom and Scale.....	25
12.2 Analysis Tools.....	25
12.2.1 Position Tool.....	26
12.2.2 Reading Tool.....	26
12.2.3 Change Tool.....	27
12.2.4 Difference Tool.....	27
12.2.5 Gradient Tool.....	28
12.2.6 Area Tool.....	28
12.3 Derived Data.....	29
12.3.1 Functions.....	29
12.3.2 Formula.....	30
13 Worksheets and Templates.....	32
13.1 Creating Worksheet Files.....	32
13.2 Creating Template Files.....	32
13.3 Associating a Template File.....	33
14 Reference – Sidebar Icons.....	34
15 Reference - Toolbar Icons.....	35

16 Reference – Keyboard and Mouse.....	36
16.1 Keyboard Shortcuts.....	36
16.2 Mouse Actions.....	37
16.2.1 Activity Screen.....	37
16.2.2 Graph.....	37
16.2.3 Table.....	37
16.2.4 Digits.....	38
17 Reference – Menus.....	39
17.1 Administrator Sub-menu.....	39
17.2 Colour Sub-menu.....	39
17.3 Data Menu.....	40
17.4 Edit Menu.....	41
17.5 Export Sub-menu.....	41
17.6 File Menu.....	43
17.7 Graph Menu.....	44
17.8 Help Menu.....	45
17.9 Logging Menu.....	46
17.10 Tools Menu.....	46
17.11 View Menu.....	47
18 Reference – Dialogues.....	49
18.1 Administrator's Settings.....	49
18.2 Calculate.....	50
18.3 Channel Details.....	51
18.4 Control Output Set Up.....	52
18.5 Custom Scale.....	53
18.6 Delete Channel.....	55
18.7 Duplicate Channel.....	55
18.8 Fetch from LogIT.....	56
18.9 Function.....	57
18.10 Graph Annotation.....	58
18.11 Graph Axis.....	59
18.12 Invert Values.....	59
18.13 Logging Setup Wizard.....	60
18.13.1 Set Up Wizard – Logging Type.....	61
18.13.2 Set Up Wizard – Periodic Logging.....	61
18.13.3 Set Up Wizard – Fast with trigger.....	62
18.13.4 Set Up Wizard – Timing.....	62
18.14 Match Sensors.....	65
18.15 Options.....	65
18.16 SensorLab Evaluation.....	66
18.17 SensorLab Licence.....	66
18.18 SensorLab Plus Evaluation.....	67
18.19 Set Logger's Clock.....	68
18.20 Set Logger's Security Stamp.....	69
18.21 Smooth Channel.....	70
18.22 Smooth.....	70
18.23 Tare.....	71
18.24 Unit Conversions.....	72
19 Timing Explained.....	74
19.1 Single Sensor Measurements.....	75
19.2 Dual Sensor Measurements.....	75
19.3 Time, Speed, Velocity, Kinetic Energy, Momentum.....	76
19.4 Acceleration.....	76

19.5 Simple Harmonic Motion Period .....	77
19.6 Manual Calculations.....	77
20 Bluetooth.....	78
20.1 Linux.....	79
20.2 Mac OS X.....	79
20.3 Microsoft Windows.....	79
21 Glossary.....	80
22 Acknowledgements and Credits.....	83
22.1 Trademarks.....	83
22.2 Credits.....	83
22.3 Contributors.....	83
22.4 Open Source Tools.....	83
22.5 Support.....	83

# 1 Introduction

SensorLab software is used to make measurements from sensors, such as Temperature, Light and Sound.

Sensors are represented by icons, like these:



Temperature

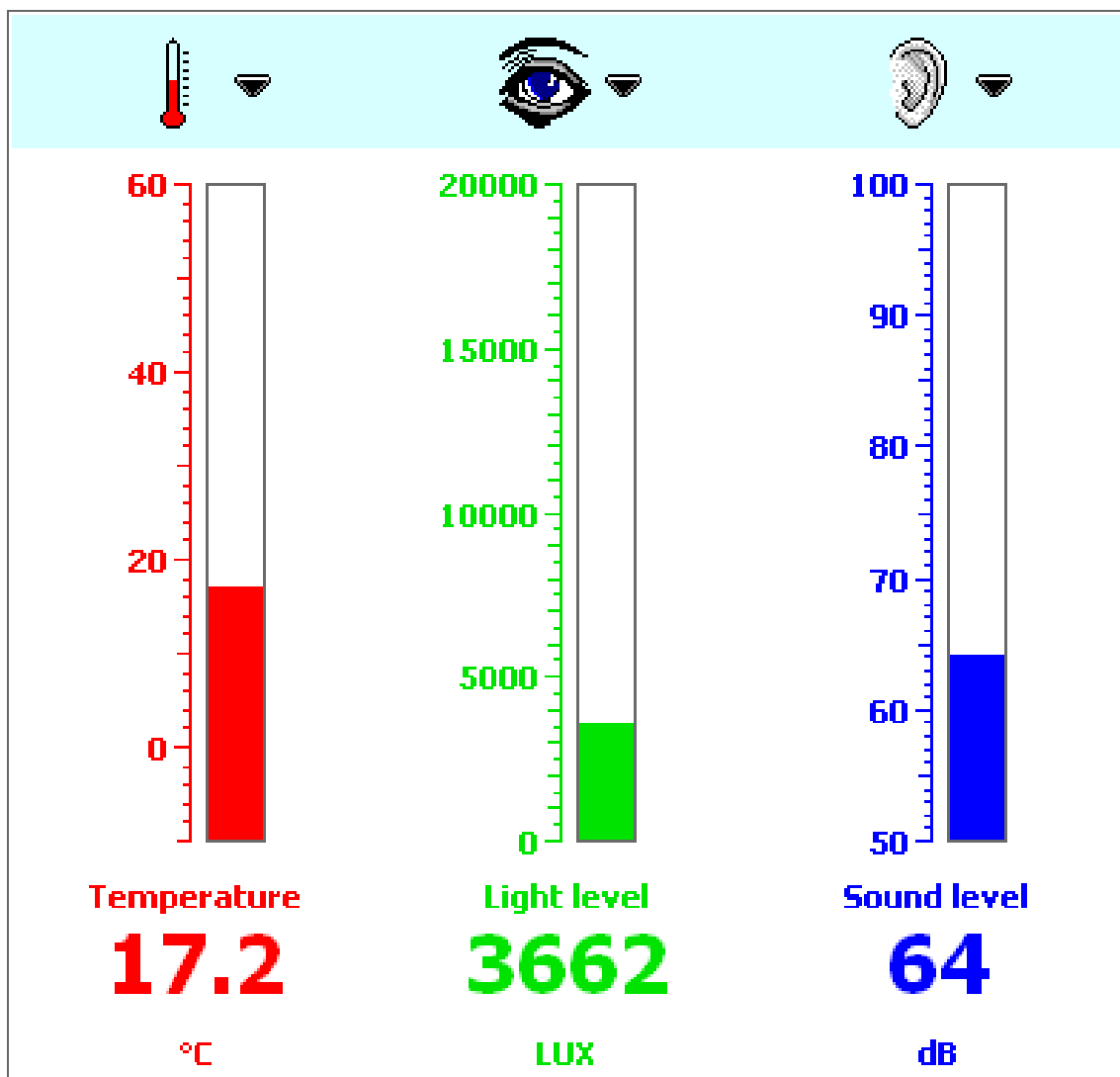


Light



Sound

Measurements can be displayed as numbers and gauges.



Measurements can be logged using two simple buttons:



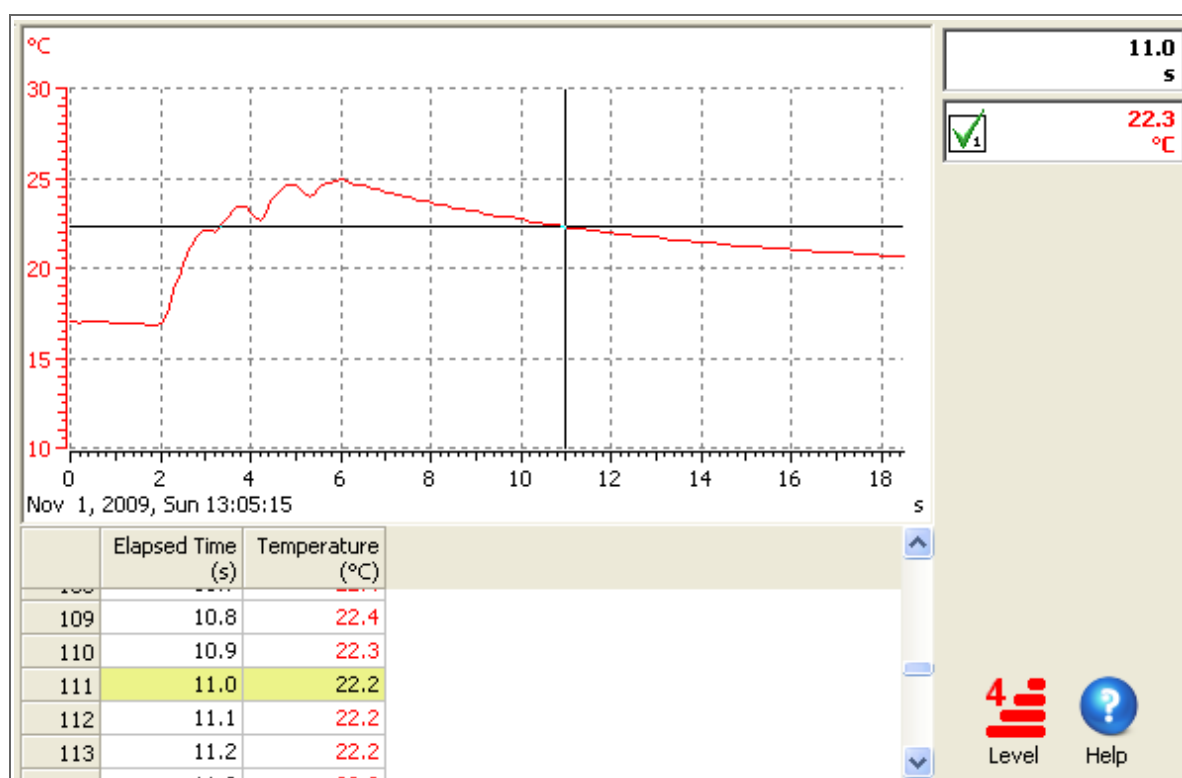
The green button starts logging



The Red button stops logging

These buttons perform similar functions to those on popular LogIT data loggers.

Logged measurements can be viewed and analysed using graphs and tables.



## 2 Supported Operating Systems and Hardware

SensorLab software is cross-platform (it is available for a number of different operating systems). These are:

- Linux
- Mac OS X
- Microsoft Windows

SensorLab supports most recent releases of these operating systems.

Further details are available in the installation guide (PDF file) for each operating system.

### 2.1 Computer Specification

Any computer hardware which runs one of the supported operating systems should run SensorLab equally well.

SensorLab has been designed to work with small screen Netbook computers, such as the Acer Aspire One and Asus Eee series.

The minimum computer specification required to run SensorLab is:

- Screen VGA (640 x 480 pixels) in 16-bit colour (64,000 colours)
- Processor speed 1 GHz single core
- Hard disk space 5 to 15 Mbytes depending on operating system
- Memory Depends on the operating system
  - Linux typically 512 Mbytes
  - Mac OS X 256 Mbytes for 10.4, 512 Mbytes for 10.5, 1 Gbyte for 10.6
  - Windows 256 Mbytes for 2000 and XP, 1 Gbyte for Vista and 7
- Ports 1 free USB port (or serial port for older logger)

### 2.2 Linux

SensorLab should run on most recent Linux distributions. However, there are a great many Linux distributions and we can not guarantee compatibility with all of them. SensorLab has been tested with a number of popular distributions, including: Fedora 9, Linpus Linux Lite 1, Mandriva 2008 and OpenSUSE 11. Further details can be found in the SensorLab installation guide (PDF file).

Check [www.logitworld.com](http://www.logitworld.com) for the latest information on supported distributions.

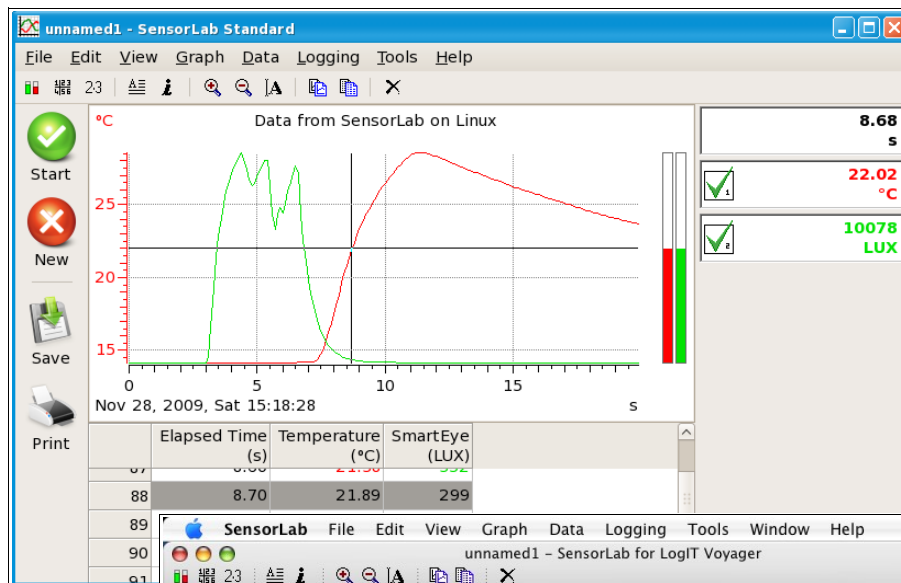
### 2.3 Mac OS X

The Mac OS X version of SensorLab runs on both Intel and PowerPC based Macs, which have Mac OS X 10.4 (Tiger), 10.5 (Leopard) or 10.6 (Snow Leopard).

### 2.4 Microsoft Windows

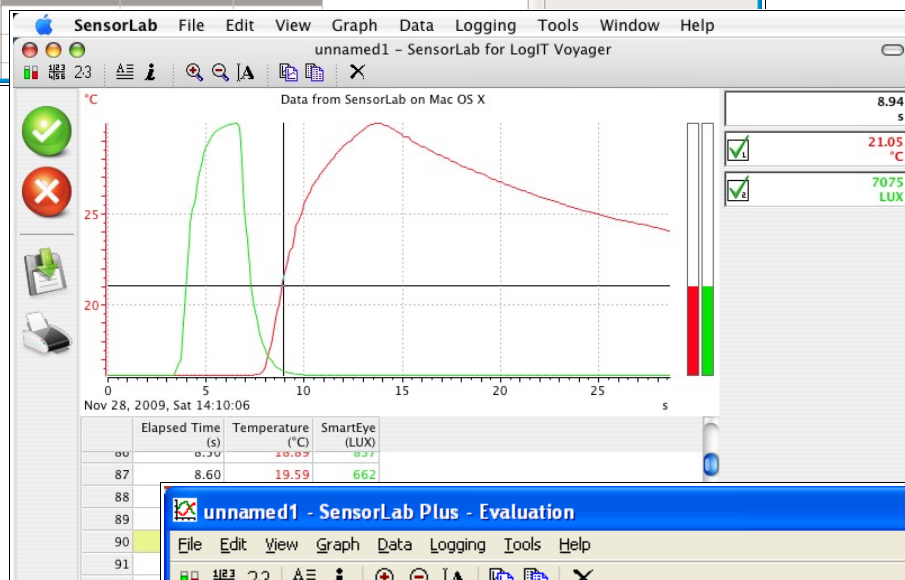
The Windows version of SensorLab runs on Windows 2000, Windows XP, Windows Vista and Windows 7.

## 2.5 Consistent Across Platforms

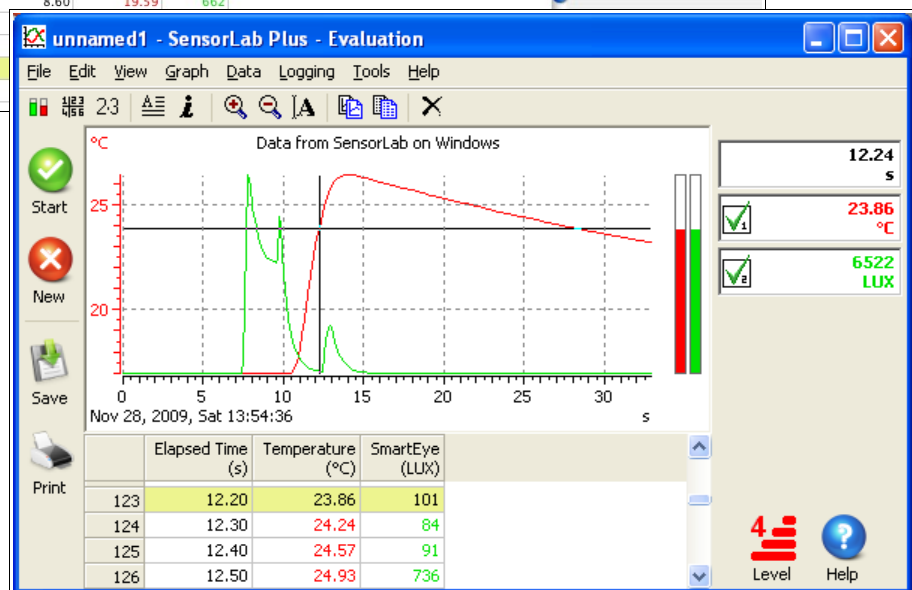


Linux

Mac OS X



Windows XP





## 3 Installing SensorLab

SensorLab is supplied with installation packages for each supported operating system.

Full installation instructions are supplied in separate PDF files.

If your computer does not have a CD ROM drive, the software can be installed by one of these methods:

- Connect an external USB CD ROM drive and use the supplied CD.
- Transfer the software from CD to USB flash drive (sometimes called a keyring memory or memory stick) using a different computer, then install from the USB flash drive.
- Download a copy of the software from [www.logitworld.com](http://www.logitworld.com)

Please note that SensorLab runs in Evaluation mode until activated.

SensorLab is provided in two basic formats:

- Installation Package
- Manual Installation

The Installation Package follows normal conventions to install the software. See “Installer” folder.

The Manual Installation format provides raw files for manual installation and, in some cases, provides a means of running the software without the need to install it first. See “Program” folder.

The ability to run the software without installation allows it to be used directly from a USB memory device. Unless the computer's security prevents you from doing so, you should just be able to walk up to a computer, connect a USB memory device containing the SensorLab program and run SensorLab.

### 3.1 Linux

Installation on Linux is a little bit more complex than the other platforms, primarily because of the way tight security does not allow free access to Serial and USB ports. It is therefore highly recommended that you read the installation instructions document very carefully.

### 3.2 Mac OS X

The Mac version has a conventional installation package. The program can be copied to the Applications folder with a simple drag and drop, but that does not set up USB handling so the program will run but may not communicate with loggers and sensors.

### 3.3 Microsoft Windows

Installation on Windows uses a conventional “Setup” program. An MSI file is included for network managers. SensorLab can also generally be run without installation by double clicking on the SensorLab program in the “Program” folder of the distribution CD.

## 4 SensorLab Editions

SensorLab can have either *Standard* functionality or *Plus* functionality. The following table highlights the major extra features found in SensorLab Plus and includes a comparison with LogIT Lab 4.

Features	LogIT Lab version 4	Sensor Lab Standard	Sensor Lab Plus
Windows 2000, XP, Vista, 7	Yes	Yes	Yes
Mac OS 10.4, 10.5 or 10.6	No	Yes	Yes
Linux (selected distributions)	No	Yes	Yes
Bluetooth, Serial and USB	Yes	Yes	Yes
Bundled with most loggers	Yes	Yes	No
Site licence	Optional	In bulk packs only	Optional
Support all LogIT loggers	Universal only	No	Yes <sup>1</sup>
Resources / worksheets	Hyperstudio only	Any format	Any format
Set up template files	No	No	Yes
Calculate data with user formula	No	No	Yes
Absolute time and date in table	No	No	Yes
Variable smoothing	No	No	Yes
Analysis tools	Reading Difference Gradient Area	Position Reading Change <sup>2</sup> Gradient Area	Position Reading Change <sup>2</sup> Difference Gradient Area
Standard deviation	No	No	Yes
Function plotting	Straight line fit Differentiation Integration	Straight line fit Differentiation Integration	Straight line fit Differentiation Integration Difference Product
Overlay oscilloscope traces	No	No	Yes
Overlay data from file	No	No	Yes
Table highlight tracks cross hair	No	Yes	Yes
Overlapping timing events	No	Yes	Yes
Create set up template file	No	No	Yes
Select channel colours	No	No	Yes
Select colour theme	No	No	Yes
Time and date on X axis	No	No	Yes

Notes:

1 Limited support for LogIT model SL (no remote set up)

2 Change tool was known as Difference tool in LL4. SensorLab has new difference tool.

#### **4.1 Standard and Plus Editions**

SensorLab Standard is generally included with LogIT data logging systems and has a similar level of functionality to the earlier LogIT Lab 4 software.

SensorLab Plus is purchased as additional software. It has extra features and generally includes a full site licence. The extra features include support for all LogIT data logging systems.

#### **4.2 Licence**

In addition to being available with Standard or Plus features, SensorLab is also supplied with either a Single User Licence or a Full Site Licence.

A single user licence entitles the purchasing organisation to run one copy of SensorLab on one computer at a time. This can be on any one of the supported operating systems.

A site licence entitles the purchasing organisation to run any number of copies of SensorLab on any number of computers, with any supported operating system, at the purchasing organisation's single postal address. In addition, it can be run on any computers belonging to the purchasing organisation but temporarily used away from the organisation's postal address. It can also be used at home by staff and students of the purchasing organisation.

Full licence details are shown by selecting Software Activation from the File, Administrator menu.

## 5 Activation

SensorLab runs in Evaluation mode with most loggers and sensors until activated.

SensorLab version 1.1 is supplied pre-activated for uLog USB Sensors.

Evaluation mode enables the software to be evaluated before purchase. The evaluation version can also be downloaded and used to update an earlier installation. To evaluate SensorLab Plus select “Evaluate SensorLab Plus” from the Help menu.

In evaluation mode there are a number of limitations:

- Printouts are defaced
- Logged data can not be saved
- Logging is limited to a maximum of 8 minutes in duration

Activation enables functionality according to the licence purchased. There are two levels of functionality:

- Standard
- Plus

SensorLab Standard is generally included with LogIT data logging systems and has a similar level of functionality to the earlier LogIT Lab 4 software. The supplied licence may be for a single user or for a complete site. Generally SensorLab Standard only supports the data logging system it is supplied with.

SensorLab Plus is purchased as additional software. It has extra features and generally includes a full site licence. The extra features include support for all LogIT data logging systems. For a full list of the major extras features, see the section “SensorLab Editions”.

At any time, in Manager mode, the Activation option is available from the File, Administrator menu.

Once the licence terms have been accepted, the activation details may be entered. First enter Name, Organisation and Post/zip code details, then enter the activation code and click Apply. More than one activation code can be entered in this way. This may be necessary if the software is initially purchased as single user, then a site licence upgrade is purchased.

Activation code details can be found on the licence sheet supplied with SensorLab software.

### Technical Note:

Activation details are stored in a simple text file. To enable activation for all users of the computer, a second copy of this file needs to be stored in a central location. In some cases this is achieved by a user with Administrator privileges activating the software, in other cases it is necessary to copy the file manually. A prompt is given if this latter method is required. Network administrators may need to distribute the file to all their computers. Further details can be found in the separate installation document (PDF file).

## 6 Levels of Sophistication

SensorLab can be set to one of four levels of sophistication. Level four is the most sophisticated.



The level is usually displayed at the bottom right of the screen by one of the icons shown here.



Clicking on the Level icon causes the level to cycle up to the next most sophisticated, or cycle from level 4 around to level 1.



At lower levels the display is simplified, with less menu items and icons, a simple bold graph format is used and default display features, such as the table, are turned off or replaced by simpler alternatives.

The program start up level can be set for all users with the Administrator Settings option in the File menu. If the “Administrator's Settings” menu item is not shown, the Settings dialogue can be opened by pressing the key combination Shift/Ctrl/Alt/T.

Administrator Settings also has an option to “Allow users to save options”. With this enabled individual users can set their own start up level using Options from the Tools menu.

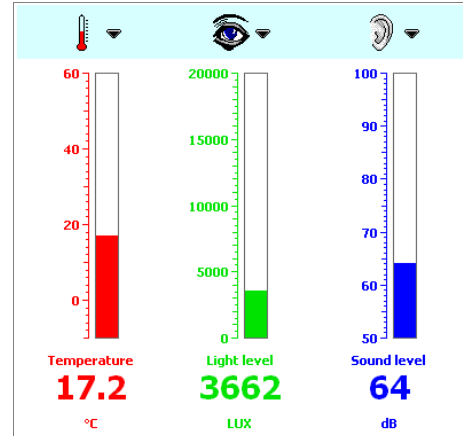
If Administrator's Settings is not shown in the Administrator menu, the software is probably not in Manager Mode. Manager mode shows menu items which a system administrator might prefer to hide from users. In such cases Manager mode can be turned off using Administrator's Settings. To turn Manager mode back on or to access other Settings, press the key combination Shift/Ctrl/Alt/T.

## 7 Measuring and Logging

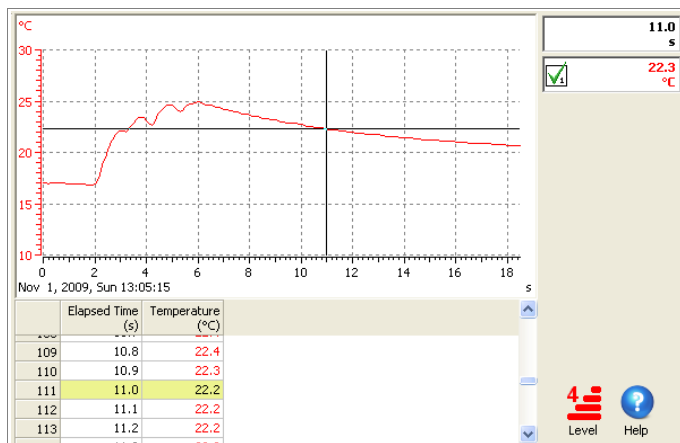
When SensorLab starts up it will look for any suitable data logging equipment connected to the computer. It will check USB connections and, where appropriate, the configured serial port.

If data logging equipment is found it will be shown as icons representing the sensors and interface. Below these are gauges indicating the current measurements. Sensors can be connected or disconnected at this point and the screen should update accordingly.

To store, or log, the measurements over a period of time, click the Green start button. A graph should now be drawn showing the measurements from all connected sensors. To stop logging, simply click on the Red stop button.



*Activity selection screen*



*Graph screen*

At any point during logging or after logging the data can be analysed with cursor tools from the Tools menu.

Results can be saved with the usual file Save option, or exported to other applications, such as a spreadsheet.

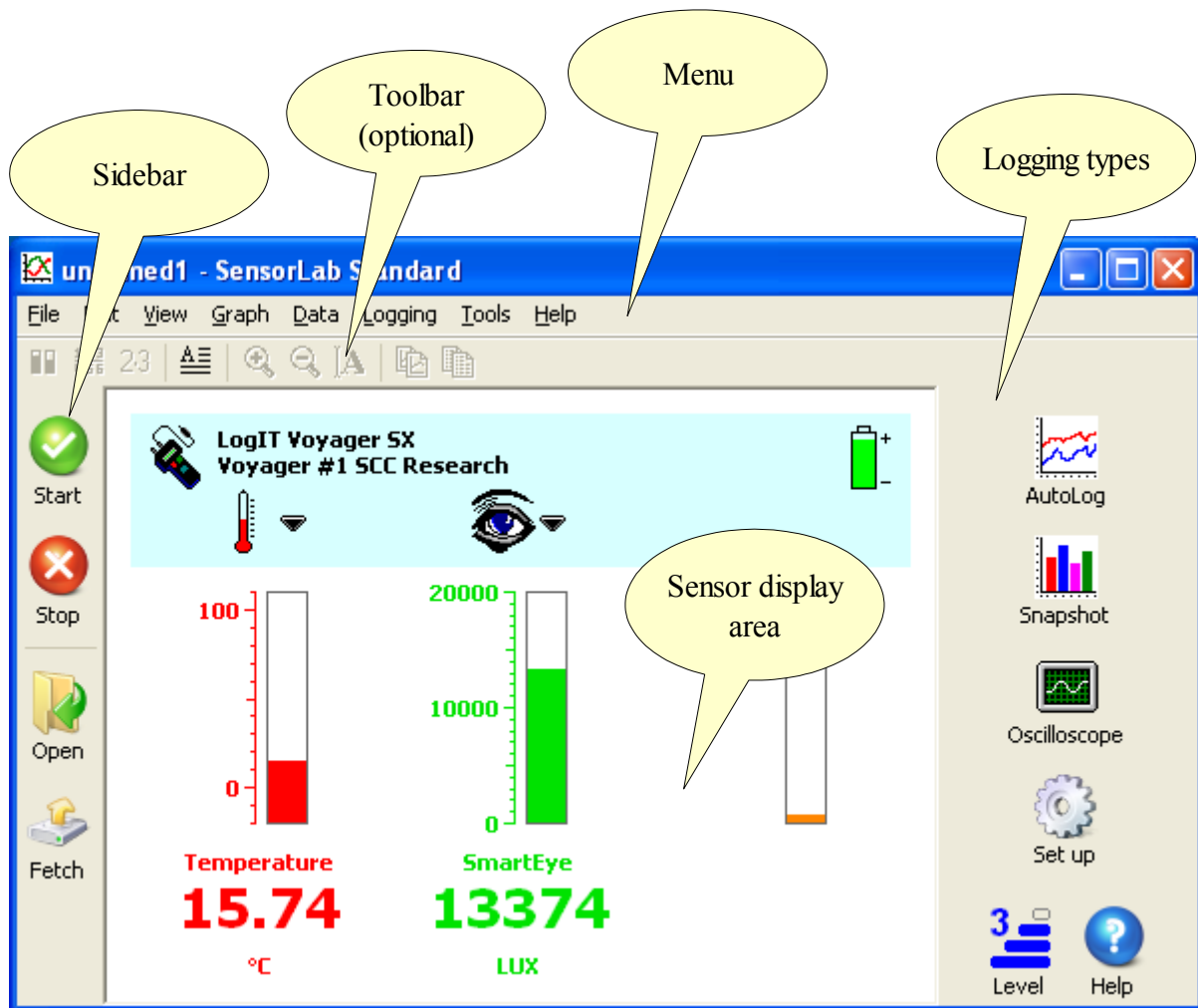


Some menu options and some display features may not be available depending on the current Level.

## 8 Activity Selection Screen

There are two main displays in SensorLab. The first is the Activity Selection screen, which is shown when the software starts or when New is selected. The second is the logging and analysis screen, which includes a graph of the current data.

The Activity Selection screen shows the currently connected data logger (or interface) and sensors, and allows selection of the required activity.



*Activity Selection Screen (Windows version)*

Measurements from the currently connected sensors are shown as gauges and values. This is as far as you need go if you only want to use the system as simple meter. Data logging can be started with the green button or one of the logging type buttons.

### 8.1 Worksheets

A worksheet or a set up template can be selected from the File menu. Worksheets can contain instructions for an experiment and can optionally configure SensorLab as required by the experiment. Note, templates are only available in SensorLab Plus.

## 8.2 Sidebar Icons (Activity Selection Screen)

The Sidebar contains just a few icons, but these are all that is needed for basic measuring and logging.

The sidebar icons on the activity selection screen are these:



Start data logging.

This is equivalent to the green button on LogIT data loggers and starts AutoLog, which logs data without any setting up until the stopped with the red button.



Stop measuring from sensors.

This is equivalent to the red button on LogIT data loggers and stops the current activity, in this case it stops measuring and allows sensors to return to standby.



Open an existing SensorLab data file.

A normal file open dialogue is displayed enabling selection of a data file to open. Some example data files are supplied with SensorLab.



Fetch data file from logger.

Some data logging systems are able to collect data without being connected to a computer. These data files can be transferred to the computer using 'Fetch'.

## 8.3 Logging Types

Simple logging using just the Green start button and the Red stop button is called AutoLog. This type of logging requires no setting up. It simply logs for as long as you leave it running. The logging rate adjusts automatically as the experiment progresses.

Other logging types can be selected from icons on the right hand side of the screen:



AutoLog can also be started with the Start button.



An alternative logging type is Snapshot. Snapshot logging stores one reading each time the Green button is pressed.



Some data logging hardware can collect data rapidly and display it like an Oscilloscope.



Set up allows more advanced options to be specified. These include setting various timing measurements, such as acceleration.

An alternative to selecting the measurement type is to open a Worksheet file or a Template file, which can set any required options.

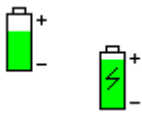


## 8.4 Logger and Sensor

The currently connected data logger (or interface) and sensors are indicated by icons, as illustrated below.



The icon on the left is the data logger or interface. Sensors are generally connected to a computer via an interface of some kind. This icon is labelled with the interface model name and also, where appropriate, its security stamp. Some devices can be given a unique name to identify it. This is called a security stamp.



A battery icon is shown when appropriate. Data loggers generally have a battery to power them when not connected to a computer. The state of this battery is indicated by the level of the green area of the icon. Some systems show a 'flash' icon when being powered externally, by USB, mains adapter or charger.

### Technical Note

Strictly speaking a device which can collect and store data independently of a computer is called a data logger, while a device which can only collect data when connected to a computer is only an interface. In the case of an interface it is the computer which is logging the data, the interface is only a means of obtaining measurements.

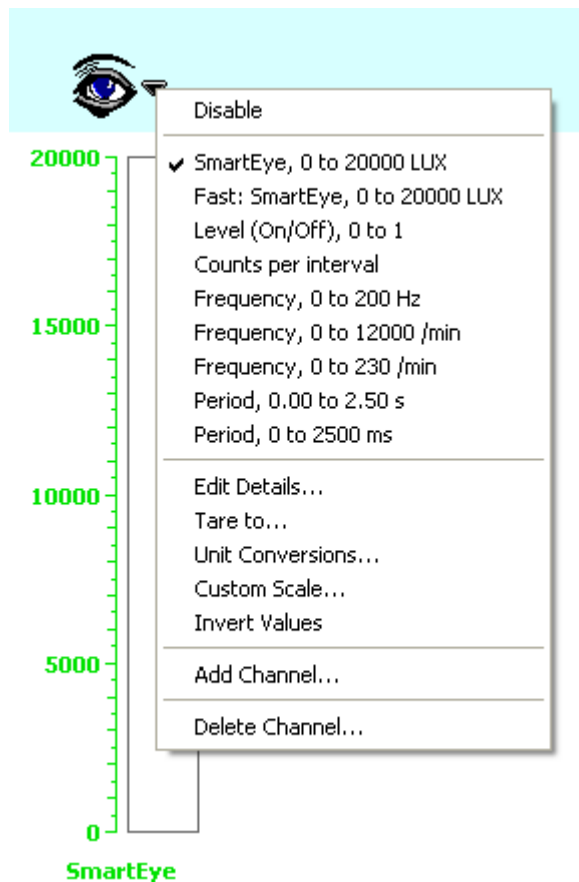
## 8.5 Scale Options

Some sensors offer a choice scales or are able to measure a range of different properties.

These options are presented in a menu, as illustrated to the right.

Click on the arrow to the right of the sensor icon to display the menu. Alternatively click on the sensor icon or gauge with the secondary mouse button (or equivalent).

Sensors can be disabled if not required. This is particularly helpful when a data logger has built in sensors which are not needed. A sensor can also be disabled by clicking on the sensor icon or gauge with the primary mouse button. The disabled status can be toggled on and off.



When available a list of scale options and measurement types is shown, with the current selection indicated with a tick (or similar symbol).

The menu also includes items to enable the scale to be edited. These options are described in detail in the reference section of this guide.

## 8.6 Level and Help

The bottom right of the screen contains icons for selecting user level and for obtaining help.



Level of sophistication.

Level 1 is the least sophisticated and level 4 is the most sophisticated.

Click on the icon to cycle through the levels.



Help.

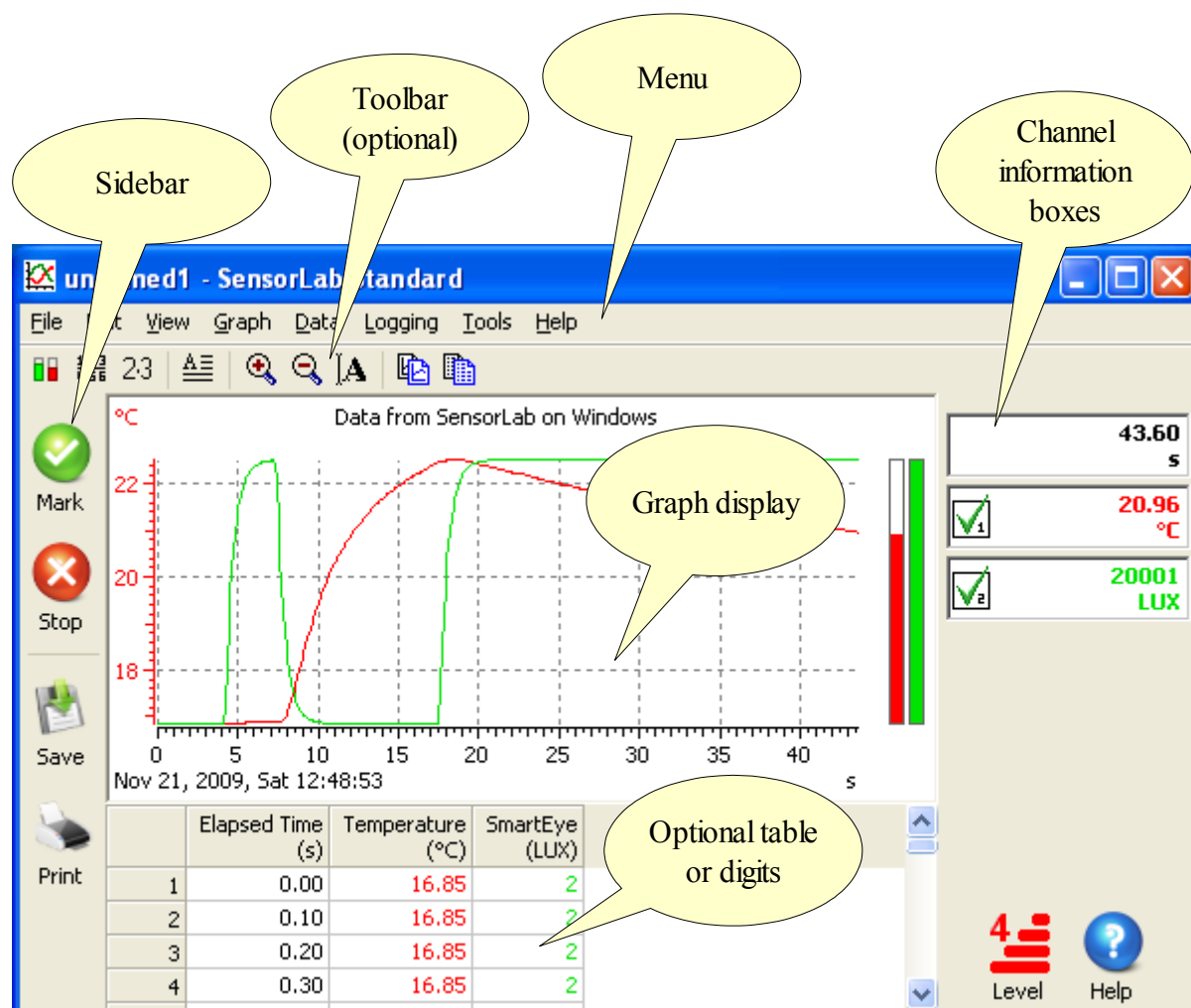
The help system window opens showing the contents page.

## 8.7 Toolbar

The optional toolbar, displayed at the top of the SensorLab window, contains icons which are essentially shortcuts for menu items. These are described in the Reference section of this guide.

## 9 Graph Screen

The graph screen displays data during logging and during analysis.



*Graph Screen (Windows version)*

Gauges to the right of the graph are optional. These show either the current measurements during logging or the analysis tool readings when an analysis tool is in use.

The main display area can either contain the graph only or it can be split to show the graph, plus either a table or large digits.

Measurement or analysis tool values are shown in the channel information boxes to the right. A channel can contain elapsed time, reading numbers, sensor measurements, values typed in (manual data channels) or values calculated with a formula entered or a pre-defined function.

## 9.1 Sidebar Icons (Graph Screen)

The Sidebar contains just a few icons, but these are all that is needed for basic measuring and logging.

The sidebar icons on the graph screen are these:



During data logging this button either marks an event or stores data.  
Mark – places a small arrow at the top of the graph to mark an event.  
Store – stores the readings in snapshot mode or the trace in oscilloscope mode.



During data logging this button stops the logging process.  
Logging stops and the current data is presented for analysis.



Save data.  
If the experiment has not already been saved, a standard Save As dialogue opens, enabling the data to be saved in a named file.



Print graph.  
The standard print dialogue is displayed enabling the current graph to be printed.

When analysing data, after logging has finished, the green button enables logging to be started again, either by overlaying the existing data or by repeating the experiment without keeping the current data. The red button begins a new experiment by returning to the activity selection screen.

## 9.2 Level and Help

The bottom right of the screen contains icons for selecting user level and for obtaining help.



Level of sophistication.  
Level 1 is the least sophisticated and level 4 is the most sophisticated.  
Click on this icon to cycle through the levels.



Help.  
The help system window opens showing the contents page.

## 9.3 Toolbar

The optional toolbar, displayed at the top of the SensorLab window, contains icons which are essentially shortcuts for menu items. These are described in the Reference section of this guide.

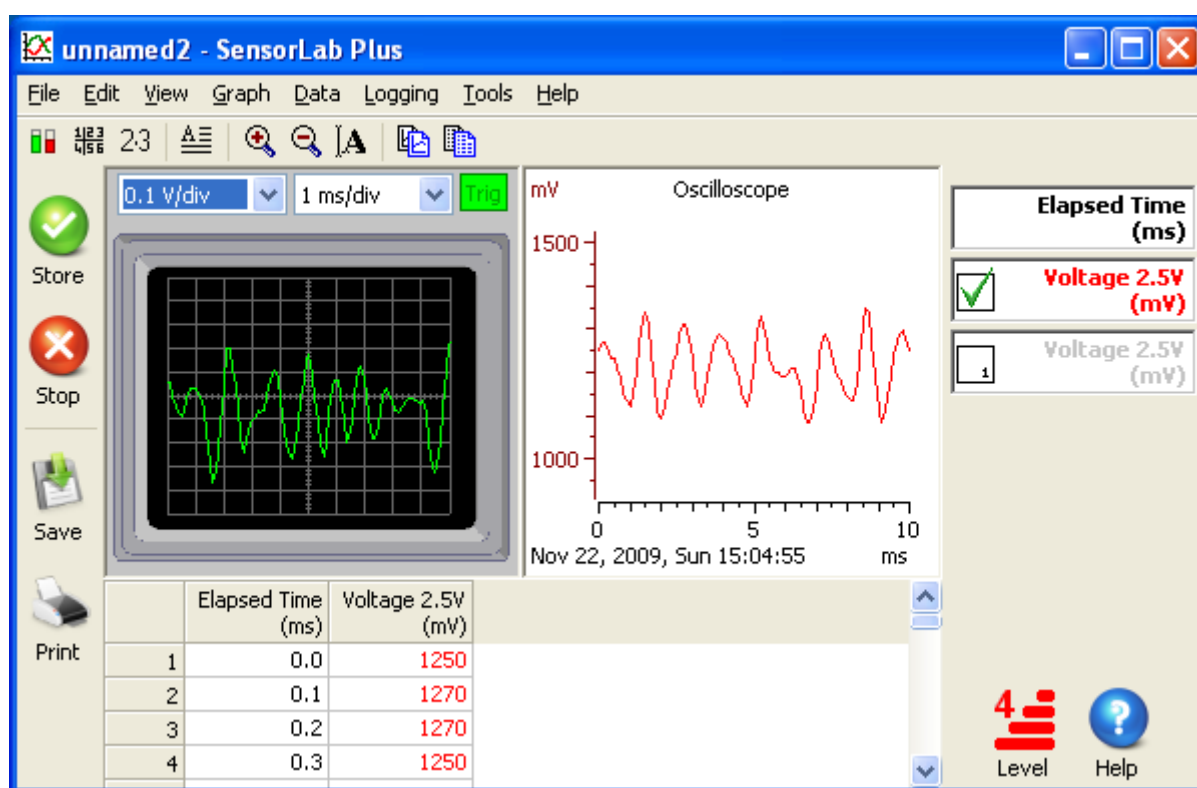
## 10 Oscilloscope

Oscilloscope mode is used to display fast changing signals, such as sound waveforms, in much the same way you would with a conventional oscilloscope.



This mode is selected with the oscilloscope icon on the activity selection screen. The oscilloscope icon is only available when suitable high speed data logging equipment is connected.

During measurement the display is split to show a live trace on the left and a graph on the right, as illustrated below. The green button is used to copy the current waveform to the graph. The Plus edition of SensorLab allows overlay of multiple waveforms on the graph, while the Standard edition only enables a single waveform to be copied to the graph. Data on the graph can be analysed like any other data in SensorLab.



*Oscilloscope (Windows version)*

Oscilloscopes are generally used to view repeating waveforms, with the trace continually redrawing. In order that each new trace starts at the same point in the waveform, a trigger condition is used. Without this trigger system each waveform would start at a random point and the display would be of much less use.

SensorLab's oscilloscope uses an automatic trigger. When the input signal meets the required trigger condition a display trace begins. When the trigger is met the trigger indicator turns green and when not met the indicator turns red. When the trigger condition is not met the display does not update.

The trigger condition is the input signal rising up through the half way point.

Oscilloscope's normally have controls to set the vertical and horizontal display resolutions. These are usually called Volt per division and Time per division. A division being the grid shown on the oscilloscope's display. SensorLab has similar settings available from drop down lists just above the oscilloscope display.

When the stop button is pressed the oscilloscope display is removed, leaving the stored data trace(s) shown on the graph. This data can be analysed and saved just like any other SensorLab data.

If the signal being monitored does not repeat, it is generally better to use the “Fast with trigger” mode, available from the set up wizard. This mode also has the benefit of capturing some measurements just prior to the trigger, which helps ensure the very beginning of the event is not missed.

## 11 Set Up Wizard

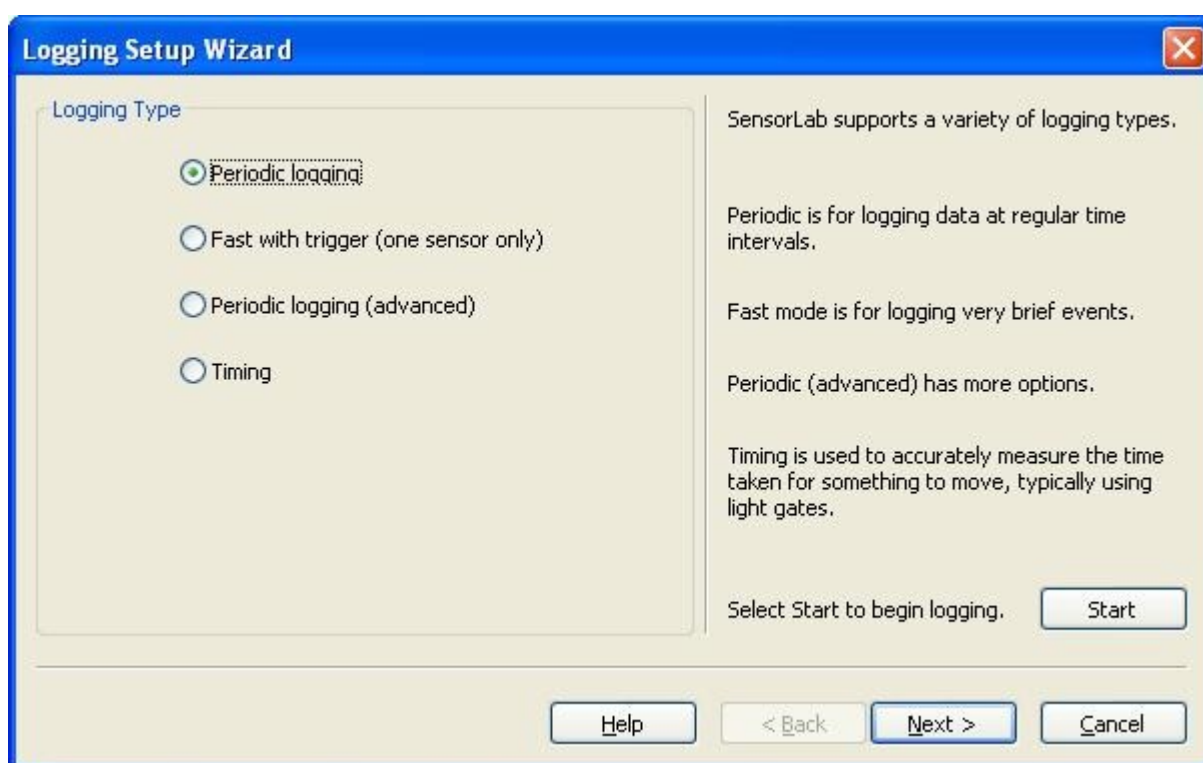
The set up wizard enables logging types and parameters to be specified. This includes being able to select the logging duration and sample interval, and to specify a range of timing based measurements, such as velocity and acceleration.



The wizard is available from the Set Up icon on the activity selection screen and from the logging menu.

A wizard is essentially a set of questions which guide the user through the options available. The questions are laid out on pages, with later pages being organised according to earlier answers.

The first page presented is the selection of the logging type, as illustrated below.



Periodic logging is where measurements are stored at regular time intervals. Following this selection a page is presented where the experiment duration and sample interval are set. The advanced option also enables the number of readings to be set.

The Fast with trigger option is designed to capture relatively rapid events, where such as a magnet falling through a coil of wire. Logging starts when the sensor detects a suitable change, avoiding the need to start logging at just the right time. To ensure the very beginning of the event is not missed, some measurements are stored just prior to the trigger. This is called pre-trigger logging. Following this selection a page is presented where the experiment duration and sample interval are set.

The Timing option allows logging of timing based measurements, such as velocity and acceleration. Further pages enable setting the shape and size of the object, the organisation and spacing of the

sensors, and the mass of the objects. Only relevant pages are shown. Timing options are described in detail in the section “Timing Explained”.

Logging Setup Wizard

Measurement

☒ One bar

☐ Two bars

☐ Four bars

Width of a bar (cm) 5

(the gap width must be the same as the bar width)

Select the shape of the object being timed.

A sequence of measurements can be made with a 'picket fence' which has a multiple of the selected number of bars.

Select Start to begin logging. Start

Help < Back Next > Cancel

*Set Up Wizard - Object shape (Windows version)*

It is not necessary to complete all pages, as there is a Start button on each page. This causes the experiment to start with options on later pages unchanged from their previous state. This can save time when making minor changes to a previous run of the experiment.

The Set Up Wizard is described in more detail in the reference section of this guide.





## 12 Analysis

Data can be analysed during and after logging. The graph can be zoomed and scaled to show the traces more clearly. Visual analysis tools can be used on the graph to make measurements from the traces displayed. In addition derived data can be calculated from a formula and from pre-defined functions.

### 12.1 Zoom and Scale

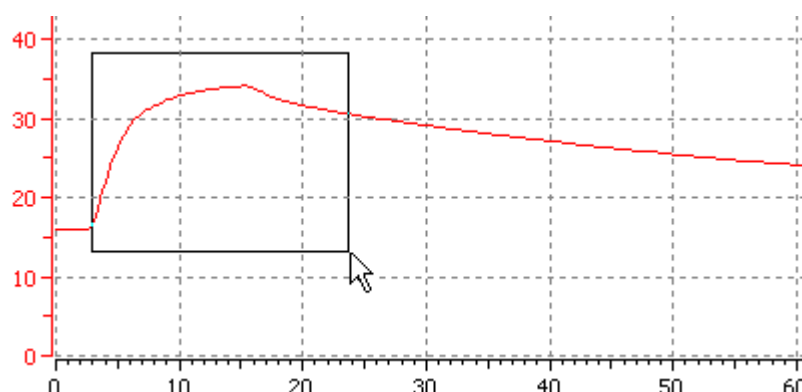
The graph can be zoomed and scaled as required.

Simple zoom in and out is available with the Auto Zoom and Default Zoom options. These are available from the graph menu and from these toolbar icons:

-  Auto Zoom – Zoom in so that traces fill the graph.
-  Default Zoom – Zoom out to default scale limits for each channel.

Auto Zoom is also available by double clicking in the graph area. Double click again to perform a Default Zoom.

To zoom into an area of the graph, click and drag a box around an area of interest, as illustrated below.



When the mouse button is released the graph is redrawn to display the area selected.

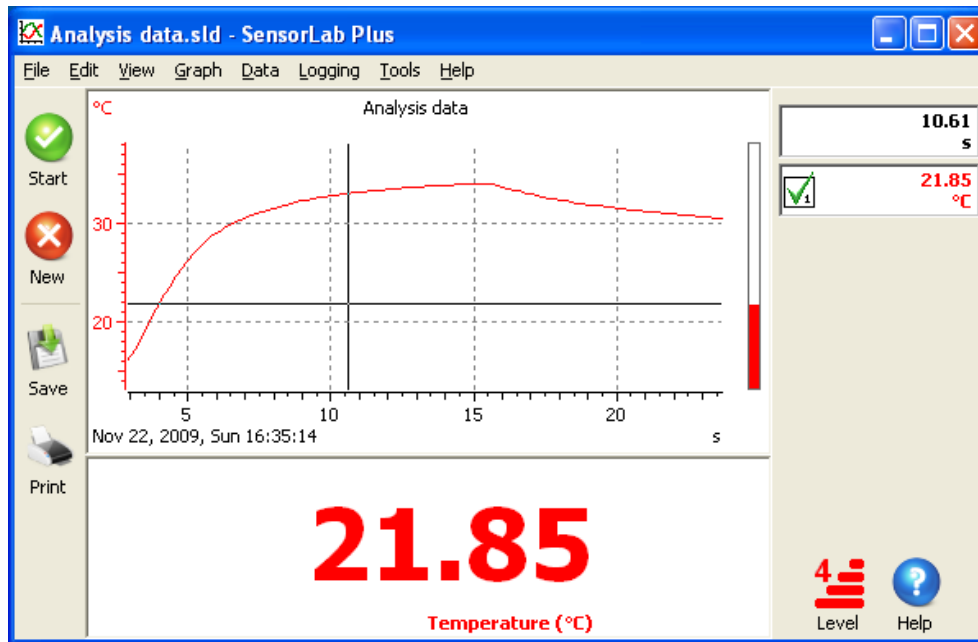
### 12.2 Analysis Tools

Visual tools are selected from the Tools menu. The currently selected tool is drawn on the graph, as a cross hair cursor or vertical line cursor, by clicking at the desired location. The cursor then follows the mouse pointer until the graph is clicked again, at which point the cursor is removed.

Whilst the cursor is shown the gauges (if shown) generally indicate the readings at the cursor position and the channel information boxes and large digits (if shown) show the measurements being made with the cursor. The channel units are those of the measurement being made, such that the units of gradient might be “°C/s” and the units of area might be “°C.s”.

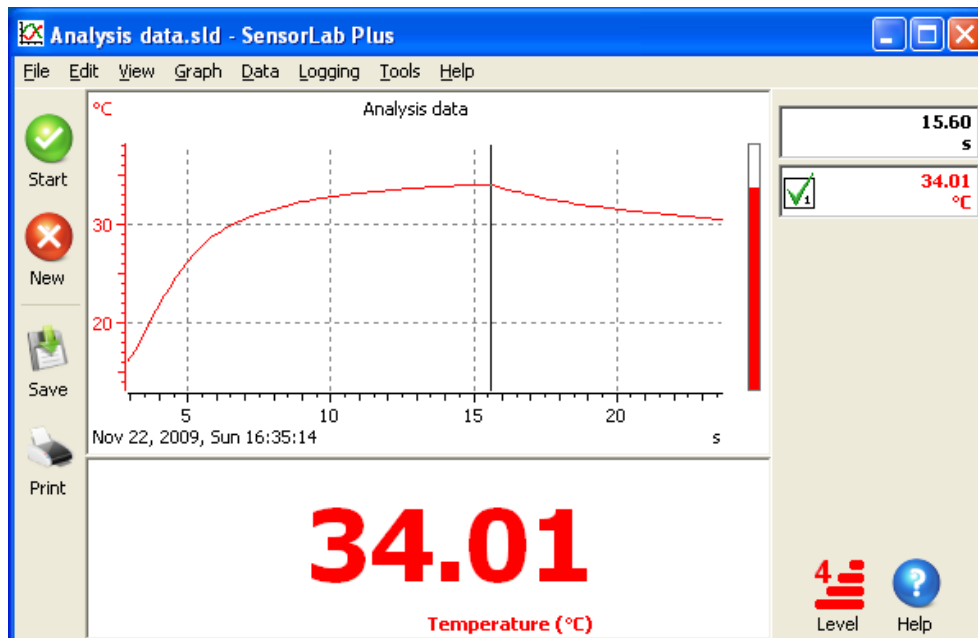
### 12.2.1 Position Tool

The position tool draws cross hair lines on the graph. The cross hair follows the mouse pointer and the display shows the values of the cross hair position. This provides a simple point and measure facility.



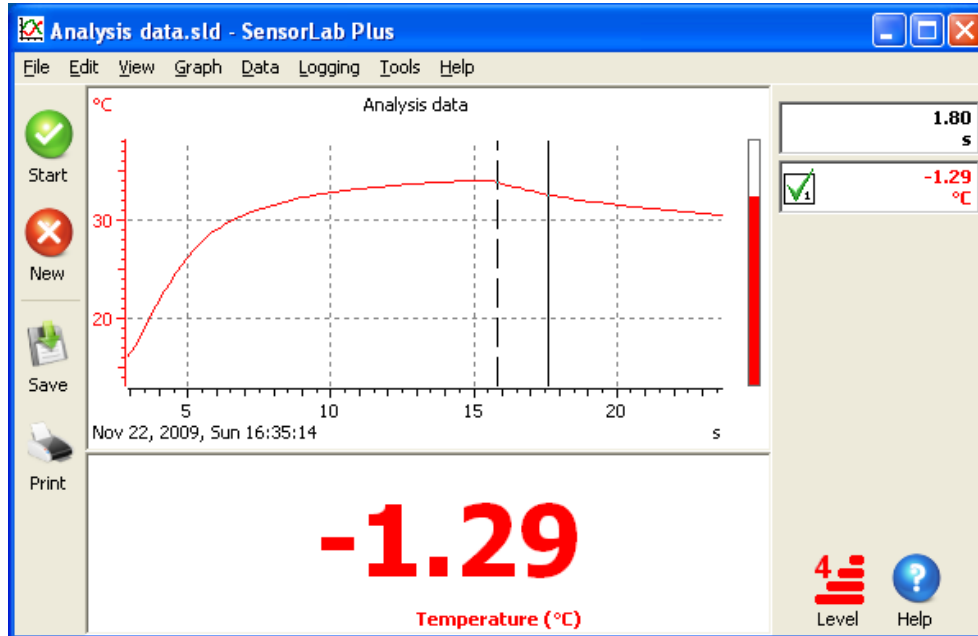
### 12.2.2 Reading Tool

A single vertical cursor line follows the mouse pointer. The values shown are those for each channel at the time index indicated by the cursor position. This tool is only available when the X axis is time.



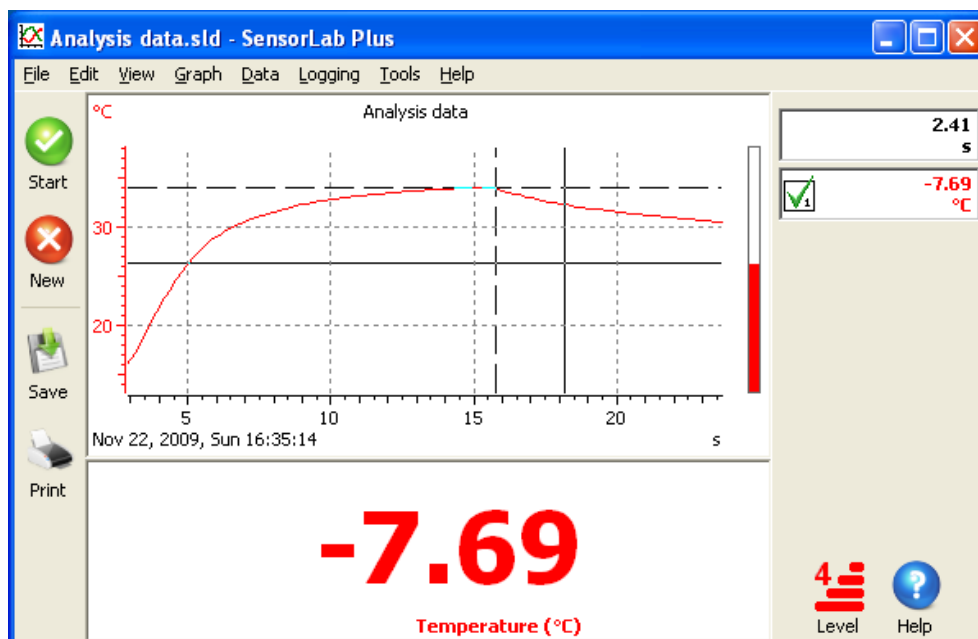
### 12.2.3 Change Tool

The initial position is indicated by a dash cursor line. A second cursor line follows the mouse pointer. The values shown for each channel are the difference between the readings at the two time indexes indicated by the cursors. This tool is only available when the X axis is time.



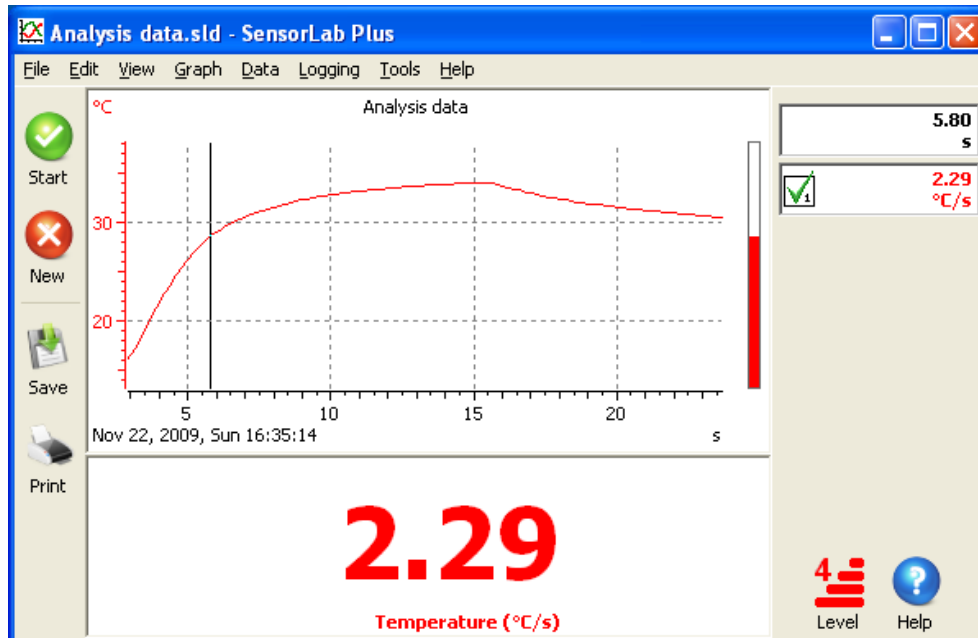
### 12.2.4 Difference Tool

The initial position is indicated by dashed cross hair lines. A second cross hair follows the mouse pointer. The values shown for each channel are the difference in position between the two cross hairs.



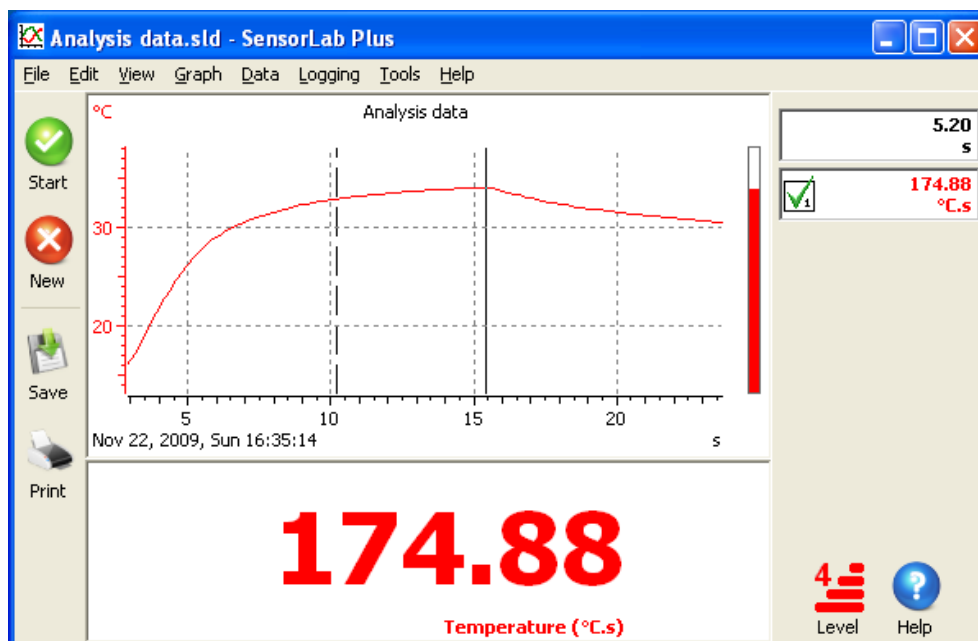
### 12.2.5 Gradient Tool

A single vertical cursor line follows the mouse pointer. The values shown are those for the gradient of each channel at the time index indicated by the cursor position. This tool is only available when the X axis is time.



### 12.2.6 Area Tool

The initial position is indicated by a dash cursor line. A second cursor line follows the mouse pointer. The values shown for each channel are the area under the trace between the cursors. This tool is only available when the X axis is time.



## 12.3 Derived Data

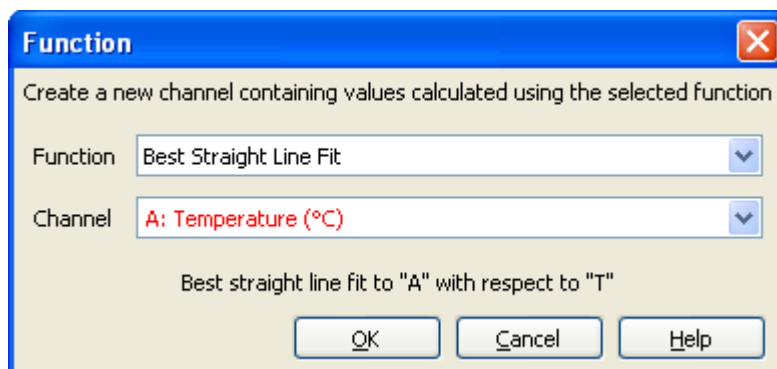
Derived data can be calculated from a formula and from pre-defined functions.

### 12.3.1 Functions

A number of pre-defined functions are available:

- Best straight line fit
- Differentiate (gradient)
- Integrate (area)
- Difference ( $a - b$ )
- Product ( $a * b$ )

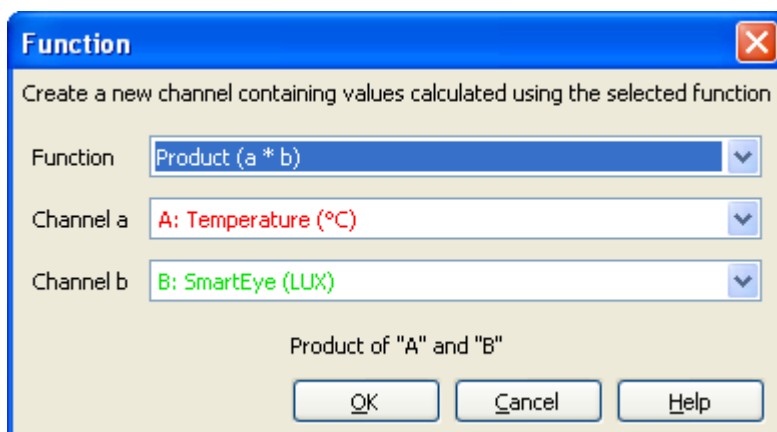
These functions are selected from the Functions dialogue, available in the data menu.



*Function Dialogue (Windows version)*

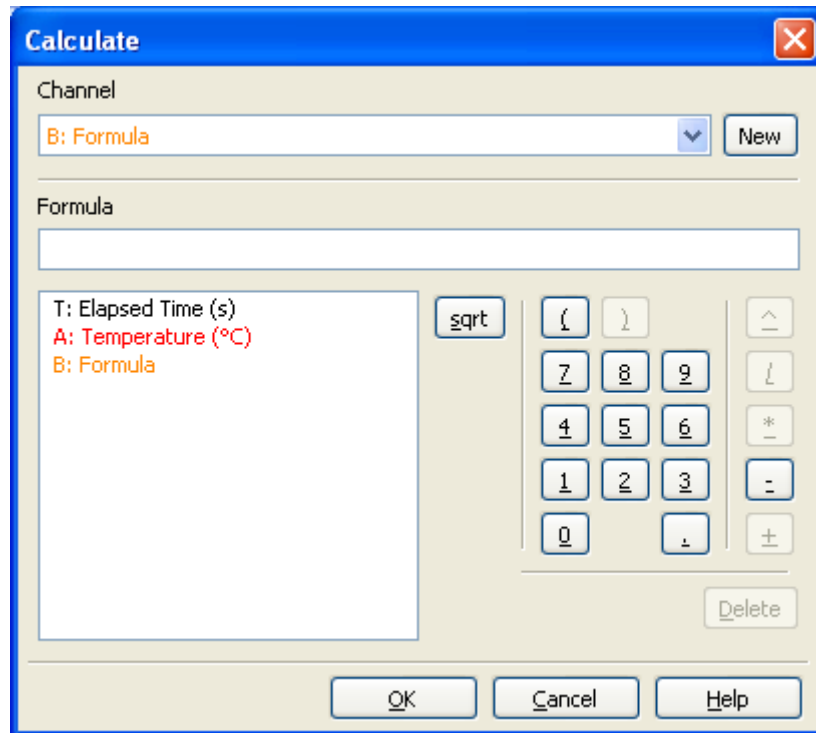
When a function is applied a data channel is created and filled with the results calculated with the selected function.

Some functions require two channels to be selected. When one of these functions is selected a second channel list is added to the dialogue, as illustrated below.



### 12.3.2 Formula

This is similar to the Function feature, but here the formula is entered with a calculator style keypad. A simple formula might be "Temperature + 20". The formula can be applied to existing data during analysis or to real time data during logging. The formula can also include references to sensor readings and elapsed time.



*Calculate Dialogue (Windows version)*

Calculate is available from the Data menu (SensorLab Plus only).

To create a new channel which contains a formula or to edit an existing formula, select Calculate from the Data menu.

If a new channel is being created, a Channel Details dialogue is presented. Enter here the new channel's details, such as Name and Units, then press OK.

The Calculate dialogue is then presented.

Click the calculator style buttons to enter the required formula. When a reference is required to an existing data channel, select it from the list on the left.

For example, to create the formula "Temperature + 20", click on the following items:

- Temperature (as shown in the panel on the left)
- '+' button
- '2' button
- '0' button
- 'OK' button

Note: this example assumes you have a temperature sensor connected and it has been identified in the Activity screen. If not it will not appear in the channel list.

Upon completion of the formula the new data channel should appear and the calculated data shown.

To edit an existing formula, select Calculate from the Data menu. Use the Delete button to delete items from the existing formula and the other buttons to enter new items.

## 13 Worksheets and Templates

Template files are only available in SensorLab Plus edition, while Worksheets are available in both editions.

Worksheet and template files can be opened from the File menu. Use the Worksheets item or the Templates item, not the Open item. These items may not be shown in the menu when the software is set to a low level of sophistication. The Templates item will not be shown in SensorLab standard edition.

A worksheet generally contains instructions and other information about an experiment to be carried out. The worksheet can be of any file type the computer can display and will be opened in a separate window to the SensorLab program. A worksheet could be a word processor document or a web page or almost anything else. If an associated template file is available it will be used to set up SensorLab. Typically this will result in SensorLab being ready to measure and log data in the way described in the worksheet file.

A template file contains settings and optional data. The settings information is used to configure SensorLab ready to begin logging. This makes repeating a previous experiment very easy.

When opening a worksheet file or a template file, the default locations offered are the folders “SensorLab Worksheets” and “SensorLab Templates” respectively. Both of these are in the SensorLab installation folder. Both these file types can however be stored anywhere, with normal file browsing available to locate them.

### 13.1 Creating Worksheet Files

Worksheet files can be created with any software, such as a word processor. When selected from SensorLab, worksheet files open with the default application for that file type. To create a worksheet simply use your preferred application to generate the worksheet, and save it in a convenient location.

To make a worksheet available to all users of the computer, the worksheet needs to be saved in a location that everyone can reach, such as a shared folder. To make the worksheet easy to find, it is best to save it to the default worksheet folder or a sub-folder of this. The default is “SensorLab Worksheets” in the SensorLab installation folder. This will generally require administrator privileges.

### 13.2 Creating Template Files

SensorLab Plus edition allows Template files to be created.

To create a template file which contains all the program settings needed for an experiment and also some sample data to overlay:

- Set up the desired experiment from the activity selection screen.
- Start logging and then stop logging when the desired data has been collected.
- Select Template from the File, Export menu.
- Save the template.

To create a template file which contains all the program settings needed for an experiment, but has no data:

- Set up the desired experiment from the activity selection screen.
- Start logging and then stop logging.



- Select Delete All from the Edit menu, to delete the data logged.
- Select Template from the File, Export menu.
- Save the template.

To make a template available to all users of the computer, the template needs to be saved in a location the everyone can reach, such as a shared folder. To make the template easy to find, it is best to save it to the default template folder or a sub-folder of this. The default is “SensorLab Templates” in the SensorLab installation folder. This will generally require administrator privileges.

### **13.3 Associating a Template File**

When a worksheet file opens the software looks in the template folder for a template file with a matching name. If one is found the software is set up according to the settings in the template file.

Regardless of where the worksheet file is stored, the software only looks in the default template folder for a matching template file. So any associated template file must be in this folder. It can not even be in a sub-folder of the default templates folder.

The default templates folder is in the SensorLab installation folder and is called “SensorLab Templates.”

The default worksheets folder is in the SensorLab installation folder and is called “SensorLab Worksheets.”

## 14 Reference – Sidebar Icons

Some sidebar icons are hidden at lower levels of sophistication.

These icons appear at the left of the screen:



Go button.

Used to start logging, to mark an event and to store readings.



Cancel button.

Used to stop logging, to select a new activity and to quit to program.



Open existing data file.



Save current data to file.



Print current graph.



Fetch file from data logger.

These icons appear at the right of the activity selection screen:



AutoLog.



Snapshot logging.



Oscilloscope.



Set up logging.

These icons appear at the bottom right of the screen:



Level of sophistication.

Level 1 is the least sophisticated and level 4 is the most sophisticated.



Help.

## 15 Reference - Toolbar Icons

Some toolbar icons are hidden at lower levels of sophistication. Also some features are only available in the Plus edition of SensorLab.

These icons appear at the top of the screen when the toolbar is enabled:



Show gauges next to the graph.



Show table below the graph.



Show large digits below the graph.



Show experiment notes.



Show experiment information and statistics.



Zoom In so that the traces fill the graph area.



Zoom Out so that the default scale limits are shown on the graph.



Annotate the graph.



Copy graph image to the clipboard so that it can be pasted into other software.



Copy table values to the clipboard so that it can be pasted into other software.



Delete last measurement stored.

## 16 Reference – Keyboard and Mouse

This section contains details of keyboard shortcuts and mouse actions.

Some features are hidden at lower levels of sophistication. Also some features are only available in the Plus edition of SensorLab.

### 16.1 Keyboard Shortcuts

In addition to using the mouse to make selections from the Toolbar and menus, you can also use keyboard shortcuts to quickly access some features..

Some menu items have an associated shortcut key or key combination, shown to the right of the menu item. For example, Save has the shortcut Ctrl+S, enabling you to save the current experiment by pressing the Ctrl (control) key and holding it whilst pressing the S key. There is also a further set of shortcut keys that are not show on the menu.

A full list of all shortcut keys is given below:

<b>A</b>	Auto zoom (graph)
<b>D</b>	Default zoom (graph)
<b>G</b>	Toggle grid on/off (graph)
<b>H</b>	Toggle heavy display mode on/off (graph)
<b>I</b>	View information
<b>L</b>	Start logging
<b>M</b>	Place marker (while logging data)
<b>N</b>	View experiment notes (from graph)
<b>O</b>	Overlay existing data
<b>P</b>	Stop logging (from graph)
<b>R</b>	Repeat logging (from graph)
<b>S</b>	Store reading (while Snapshot logging)
<b>T</b>	Toggle table on/off (from graph)
<b>= (+)</b>	Auto zoom (from graph or meter)
<b>_ (-)</b>	Default zoom (from graph or meter)
<b>Ctrl+I</b>	Display experiment information
<b>Ctrl+N</b>	New activity
<b>Ctrl+O</b>	Open existing experiment
<b>Ctrl+P</b>	Print graph
<b>Ctrl+S</b>	Save (with current name)
<b>Ctrl+T</b>	View table
<b>F1</b>	Display help
<b>F2</b>	Display experiment notes
<b>F3</b>	Toggle graph's grid on/off
<b>F4</b>	Toggle graph's lines on/off
<b>F5</b>	Toggle graph's points on/off
<b>F6</b>	AutoZoom (graph)
<b>F7</b>	Default zoom (graph)
<b>F8</b>	Mark event during logging

<b>F9</b>	Store reading (while Snapshot logging)
<b>F11</b>	Start logging
<b>F12</b>	Stop logging
<b>Del</b>	Delete last record stored
<b>Shift+Del</b>	Delete all data stored

## 16.2 Mouse Actions

In addition to clicking on menu items and toolbar icons, there are a number of mouse actions which can be used within this software.

Context menus are available for many display features. These menus provide options which are relevant to the item pointed to at the time. Where a second mouse button is available, which is standard on a PC, the second button is used to select the context menu. Where only a single button is available a key press is usually required to select the context menu.

### 16.2.1 Activity Screen

The Activity Screen is shown when the software starts and when New is selected.

- Click on a sensor icon or gauge to toggle the sensor on/off. This can be used to disable a logger's internal sensor when it is not required for an experiment.

A context menu is also available for the sensor icons and gauges. This provides options for each sensor, including the choice of measurement types and scales.

### 16.2.2 Graph

The following mouse actions apply when clicking and dragging in the graph area.

- Single click on the graph to display the current analysis tool. Click again to remove the tool.
- Drag the mouse pointer in the graph area to frame an area for zooming in.
- Double click on the graph to toggle the display between AutoZoom and default zoom.
- Single click on the channel information boxes (at the right of the graph) to edit channel details, including the numeric value of manual data channels.
- Single click just above the graph to edit the title.
- Single click to the left, right and below the graph to select the graph axis channels.

A context menu is also available in the graph area.

### 16.2.3 Table

The area below the graph can be used to display a data table.

- Single click a column heading to edit the channel's details.
- Double click in the column of a manual data channel to select the cell for editing. This enables the existing numeric value to be edited or entered.

A context menu is also available in the column heading area.

The context menu includes the option “Add Channel”. This adds a data channel, which is shown as a column in the table. The channel contains 'manually entered data' which can be typed into the table as required. This is useful for entering data which can not be easily measured with a sensor, such as the distance up a ramp.

#### **16.2.4 Digits**

The area below the graph can be used to display values as large digits.

- Click on one of the displayed values to edit that channel's details.

A context menu is also available in the digits area.

## 17 Reference – Menus

This section contains a feature by feature reference in alphabetical order for the program's menus.

Some menu items are hidden at lower levels of sophistication. Also some menu items are only available in the Plus edition of SensorLab.

### 17.1 Administrator Sub-menu

The Administrator Menu is an item in the File Menu. Most of the items in this menu are only available when Manager mode is enabled. To enable Manager mode, press the key combination Shift/Ctrl/Alt/T and tick the Manager mode option.

#### Set Logger's Clock

Some data loggers have an internal clock which provides time and date information for logged data. This option allows the logger's clock to be set to the same time as the computer's clock. This feature is not required very often as the software checks the logger's clock looks sensible each time it is connected, and updates it if it looks wildly wrong.

#### Set Logger's Security Stamp

Some data loggers have a customisable message which is displayed when the logger is turned on. This message can be used for any purpose, such as identify the owner or the logger number in a set.

#### Reload Logger's System Software

Some data loggers have built in software which can be reloaded if there is a problem, or updated to add new features or sensor support. Reloading the logger's software can cause data files in the logger's memory to be deleted, so it is recommended that these be fetched and saved first. Reloading can take a few minutes.

#### Software Activation

SensorLab runs in a function limited evaluation mode until activated. Activation involves entering an activation code. Consult the licence document, supplied with SensorLab, for details of the activation code. The activation code determines which features (Standard or Plus) are enabled, which data loggers are supported and also the licence type (single user or site).

#### Administrator's Settings

Administrator settings allows defaults values to be set for things like file location, sophistication level and serial ports. These are usually the settings which apply to all users of SensorLab. If the option "Allow users to save options" is enabled, then individual users can set their own start up options, overriding the defaults set with these administrator settings. The user options feature is available from the Tools menu.

### 17.2 Colour Sub-menu

The Colour Menu is an item in the View Menu.

#### Standard

This colour scheme uses shades of the initial channel colour when overlaying data from the same sensor. This maintains the link between channel colours on the computer screen and those indicated on

some data logging systems. The disadvantage is that it is not as easy to distinguish overlay channels from each other.

### High Contrast

The High Contrast option breaks the colour association in the interest of providing more easily distinguishable colours.

## 17.3 Data Menu

This menu provides features associated with a specified data channel. It is also available as a context menu when right clicking on a channel information box, at the right of the graph.

### Edit Details

Channel details, such as name, colour and decimal places, can be edited with this feature. For manual data channels the current numeric value can be entered here. A manual channel is one created with “Add channel” and is used to type in values instead of using a sensor.

### Smooth

Values in a channel are smoothed to reduce noise and other undesirable spikes. The Standard edition applies a simple fixed smooth, while the Plus edition offers a variable degree of smoothing.

### Tare to

This enables a channel to be adjusted from its current value to the new value entered. Every value in the data channel has an appropriate offset added or subtracted. This can be used to provide a single point calibration, such as adjusting pH readings to match a buffer solution.

### Unit Conversions

Some measurements have common alternative units which might be more suitable in some applications. A typical example is millivolts and volts. This feature offers a simple means of converting data from one unit to another, using pre-defined conversion functions. There is also a facility to specify simple conversion functions which are not pre-defined.

### Custom Scales

Custom scales allow new scales to be defined based on two known values. This can be used to provide a two point calibration facility.

### Invert Values

All values in the specified channel are inverted. Positive numbers become negative and negative numbers become positive. For example, 20 volts becomes -20 volts.

### Add Channel

A new channel is created for values to be typed in. This is typically used to provide values for which a sensor is not available. For example, when experimenting with the speed of a trolley when released from different distances up the ramp, the distance can be entered manually whilst the speed can be measured with a light gate.

### Duplicate Channel

The selected channel is duplicated. The new copy contains the same data as the original, but its name is preceded with an ampersand to indicate that it is not original data. The duplicate channel has the



same status as a channel created with the Add Channel feature, and its data values can be edited in the table. Duplicating channels can be useful as it allows original data to be compared with smoothed versions or when experimenting with editing data values.

### Function Plot

A new data channel is created and is filled with data values calculated using one of the pre-defined functions. Functions include Best straight line fit, differentiate, integrate, difference and product.

### Calculate

A new data channel is created and is filled with data calculated with a formula entered using a calculator style keypad. Calculations can be applied before, during and after logging. Calculating data before and during logging allows real time derived data to be shown.

### Delete Channel

The selected data channel is deleted and all its data discarded. This is particularly useful when logging multiple runs (overlays) of an experiment and unwanted data sets are no-longer required.

## 17.4 Edit Menu

This menu provides standard copy functions and data editing features

### Copy Graph

The current graph image is copied to the clipboard. From here it can be pasted into any suitable software, such as a word processor or image editor.

### Copy Table

The current table values are copied to the clipboard. From here it can be pasted into any suitable software, such as a spreadsheet (eg. Excel) or a word processor.

### Delete Last

Delete the last stored data record. This is particularly useful when snapshot logging or timing. If the last result stored is not wanted for any reason it can be deleted. For example, if making a timing measurement and the light gate is accidentally blocked, the resulting invalid measurement can be deleted.

### Delete All

This deletes all data values from all channels. This is useful when creating a template file, as these often want to be clear of any measurements. This feature can also be used to clear the data before repeating an experiment, although this is generally achieved by turning off the overlay option.

### Title

The experiment title, which is usually shown above the graph, can be edited using this menu item.

## 17.5 Export Sub-menu

The Export Menu is an item in the File Menu. This is primarily to enable data to be saved in a format suitable for use by other software. The data may not be able to be read back into SensorLab, so don't forget to also save it using the normal Save option. Some export formats are only really useful on one platform, such as Windows.

### Datalogging Insight (SID Format)

Data is saved in a format suitable for importing into the popular Insight range of data logging software. This range includes Datalogging Insight, Junior Datalogging Insight and iLog.

### InspireData (TEXT Format)

Data from SensorLab can be analysed and presented using InspireData software.

### Microsoft Excel (CSV Format)

Use this option to transfer the data into Microsoft's Excel spreadsheet.

### OpenOffice.org Calc (CSV Format)

The popular cross-platform office suit, OpenOffice, includes the Calc spreadsheet which can open files created with this option.

### Software Independent Data (SID)

This format is supported by many data logging and analysis program. It was designed by a group of developers, including ourselves, specifically to share measurement data. The format is documented in the 1992 NCET publication: ISBN 1 85379 221 7, "Resources for data monitoring and control for science education".

### Comma Separated Values (CSV)

The CSV format is a very common file format supported by most programs which handle tabular numeric data. This file is essentially a simple text file with the channel names of the top following by numeric data stored one record on each line. Each item on a line is separated with a comma. A CSV file produced by SensorLab stores the numeric values organised in the same way as they are shown in SensorLab's table. Typically therefore the file contains:

"Elapsed time","Channel 1 name","Channel 2 name"

"Elapsed time units","Channel 1 units","Channel 2 units"

<Elapsed time for first reading>,<Channel 1 first reading>,<Channel 2 first reading>

<Elapsed time for second reading>,<Channel 1 second reading>,<Channel 2 second reading>

etc.

### Tab Separated Values (TSV)

This format is very similar to CSV, except there is a TAB character between each item instead of a comma. Like CSV the channel names are in quotes.

### Text (TXT)

This is a standard text file, with the text file extension. It is similar to TSV, but the channel names are not in quotes. This is generally the best format to use when exporting data to programs designed to handle simple text.

### Template

A template is a SensorLab file which contains settings and optional data. This can be used as a quick way to set up SensorLab when repeating an experiment at a later date. It is also possible to associate a template file with a worksheet file, so that opening a worksheet file also opens its matching template file and thus sets SensorLab ready for logging.

## **17.6 File Menu**

The file menu contains the usual Open, Save and Print options, plus a few SensorLab specific items, such as worksheets.

### **New**

New returns the software to the activity selection screen ready to begin a new data logging session.

### **Open**

An existing SensorLab data file is selected and opened. SensorLab data files have the extension SLD.

### **Save**

Data is stored in the current SensorLab data file, replacing the previous version.

### **Save As**

A SensorLab data file name is selected and the current data is stored in that file.

### **Worksheet**

A worksheet file is selected and opened in a new window. A worksheet generally contains instructions and other information about an experiment to be carried out. The worksheet can be of any file type the computer can display. It could therefore be a word processor document or a web page. If an associated template file is available it will be used to set up SensorLab. Typically this will result in SensorLab being ready to measure and log data in the way described in the worksheet file.

### **Template**

A template file is selected and opened. A template file contains settings and optional data. The settings information is used to configure SensorLab ready to begin logging. This makes repeating a previous experiment very easy.

### **Fetch From Logger**

Some data logging equipment is able to collect data without being connected to a computer. It can later be connected and the Fetch option used to ready the data from the device.

### **Import**

Any file which SensorLab can read can be selected and opened. This includes LogIT Lab data files and Software Independent Data files. Imported data is not generally overwritten when Save is selected, but instead a SensorLab data file is created.

### **Export**

The Export sub-menu is opened. This menu is primarily to enable data to be saved in a formats suitable for use by other software. The data may not be able to be read back into SensorLab, so don't forget to also save it using the normal Save option. Some export formats are only really useful on one platform, such as Windows.

### **Page Setup**

A page set up dialogue is shown. Typically this enables page size and orientation to be set ready for printing.

## Page Margins

A page margins dialogue is shown (Mac OS X version only). This enables the printer page margins to be set.

## Print Preview

A print preview is shown. This shows the graph as it will appear if printed.

## Print

The print dialogue is shown. From here the graph can be printed.

## Administrator

The Administrator sub-menu is opened. Most of the items in this menu are only available when Manager mode is enabled. To enable Manager mode, press the key combination Shift/Ctrl/Alt/T and tick the Manager mode option.

## Exit (or Quit)

SensorLab terminates.

## Recent File List

A list of recently opened data files is shown at the bottom of the File menu on some platforms.

# 17.7 Graph Menu

This Graph menu contains options which determine what is shown on the graph and how it appears.

## Font

The font selection dialogue is shown, allowing selection of the font used for the graph.

## Annotate

The graph can be annotated with labels. A label is typed in and dragged to any point on the graph.

## Auto Zoom

The graph scales are zoomed so that the traces fill the graph. This is a quick and simple way to zoom in to small variation on the graph traces.

## Default Zoom

Graph scales are zoomed out to their default limits. The default limits usually show the full range of the sensor.

## X Axis Scale

The graph's X axis can be selected from all available channels. Usually the X axis is elapsed time, but options are available to show the actual time and date, as well as other data channels. By selecting a sensor channel the graph shows one sensor plotted against another.

## Y Axis Scale (Left)

The graph's Y axis can be selected from all available data channels except elapsed time. This axis is shown to the left of the graph.

### Y Axis Scale (Right)

As well as a scale on the left of the graph, a scale can also be selected to be shown on the right of the graph.

### Grid

The graph can be drawn with an optional grid. This menu item toggles the grid on and off. The grid is aligned to major scale divisions.

### Lines

Individual data points can optionally be joined with lines. This menu item toggles the lines on and off. A graph with lines between the points is often called a line graph.

### Points

Small crosses can be drawn at each individual data point on the graph. A graph with just points and no lines between is often called a scatter graph.

### Bars

Instead of showing a scatter graph or a line graph, it can be shown as a bar graph. A vertical bar is drawn from each data point to the X axis. If there are many data points the area under the graph becomes a solid coloured area.

### Heavy

The graph can be toggled between normal and heavy format. The heavy format uses a large bold font and draws the graph with thick lines. This makes the graph easier to see from a distance.

### Best Line Fit

This option toggles on and off the display of best straight line fits. These are shown as straight lines calculated to be the best fit to the data points shown. The line fit formula is also shown on the graph.

## **17.8 Help Menu**

The help menu provides access to the program's help system and also to on-line resources.

### Introduction

The introduction page of the help system is displayed.

### Contents

The help system's contents page is shown.

### LogIT World

Unless blocked by security software, a browser window opens showing the LogIT World website.

### Evaluate SensorLab Plus

Toggle between SensorLab Standard edition and evaluation mode for SensorLab Plus edition.

### Technical Support

A small window opens giving information about the technical support website.

## About SensorLab

A small window opens giving information about this version of SensorLab.

### 17.9 Logging Menu

This menu has options relating to data logging and feedback control.

#### Start

This item starts data logging. In overlay mode, new data is added to any existing data sets, otherwise the new data replaces any existing data.

#### Stop

Available only during data logging, this item stops data logging.

#### Mark

During some types of data logging this item enables a marker to be placed. A mark is shown as a small arrow at the top of the graph.

#### Store

During snapshot logging, this item stores the current readings. During oscilloscope mode the current oscilloscope trace is copied to the graph. The Standard edition of SensorLab only allows one oscilloscope trace to be copied to the graph, while the Plus edition allows overlaying of traces.

#### Overlaying

The overlay option can be toggled on and off. When overlay is selected, the start button causes a new set of data to be logged and added to any existing data sets. When not selected, the new data replaces any existing data.

#### Control

As well as measuring and logging the results, decisions can be made and outputs turned on and off. This enables simple applications such as temperature control to be implemented. This option requires suitable output devices to be connected. Some data logging systems allow output devices, such as relays, to be connected to 'sensor' sockets, while others use special units, such as SwitchIT.

#### Set Up

The set up wizard is opened allowing measuring and data logging to be configured. Options include selecting the logging interval, the logging duration and also a wide range of timing based measurements. When selecting this item from the graph screen the current data logging settings can be modified before re-running an experiment.

### 17.10 Tools Menu

The tools menu offers a range of visual analysis tools, such as area and gradient. To use the selected analysis tool just click on the graph. An analysis cursor then follows the mouse pointer and measurements are displayed. Click again to remove the cursor.

#### Position

The position tool draws cross hair lines on the graph. The cross hair follows the mouse pointer and the display shows the values of the cross hair position. This provides a simple point and measure facility.

## Reading

A single vertical cursor line follows the mouse pointer. The values shown are those for each channel at the time index indicated by the cursor position. This tool is only available when the X axis is time.

## Change

The initial position is indicated by a dash cursor line. A second cursor line follows the mouse pointer. The values shown for each channel are the difference between the readings at the two time indexes indicated by the cursors. This tool is only available when the X axis is time.

## Difference

The initial position is indicated by dashed cross hair lines. A second cross hair follows the mouse pointer. The values shown for each channel are the difference in position between the two cross hairs.

## Gradient

A single vertical cursor line follows the mouse pointer. The values shown are those for the gradient of each channel at the time index indicated by the cursor position. This tool is only available when the X axis is time.

## Area

The initial position is indicated by a dash cursor line. A second cursor line follows the mouse pointer. The values shown for each channel are the area under the trace between the cursors. This tool is only available when the X axis is time.

## Options

The options dialogue is shown, enabling the user to make changes to the sophistication level, data logger connections and file locations. If enabled by the administrator these options can be saved for the next time the program is used..

### **17.11 View Menu**

The view menu provides options which control what is shown on the screen. It also allows display of notes and information windows.

#### Title

The graph title can be toggled on and off. The title is displayed above the graph.

#### Gauge

Gauges can be shown to the right of the graph. These are toggled on and off with the gauge item.

#### Table

A table of results can be shown below the graph. The table can be toggled off so that a larger graph can be shown.

#### Digits

With this option selected the area under the graph is used to show measurements as large digits. As with the table option, digits can be removed to show a larger graph.

### **Time And Date**

The time and date option can be toggled on and off. When turned on the table includes a column showing the actual time and date of each reading. Also a time and date information box is added to the display at the right of the graph.

### **Toolbar**

The toolbar, show above the graph, can be toggled on and off.

### **Notes**

This item displays the experiment notes window. This window enables notes to be typed in to accompany the experiment results.

### **Information**

The information window shows details and statistics for the current data.

### **Colour**

The Colour sub-menu is opened. This provides a choice of colour schemes.



## 18 Reference – Dialogues

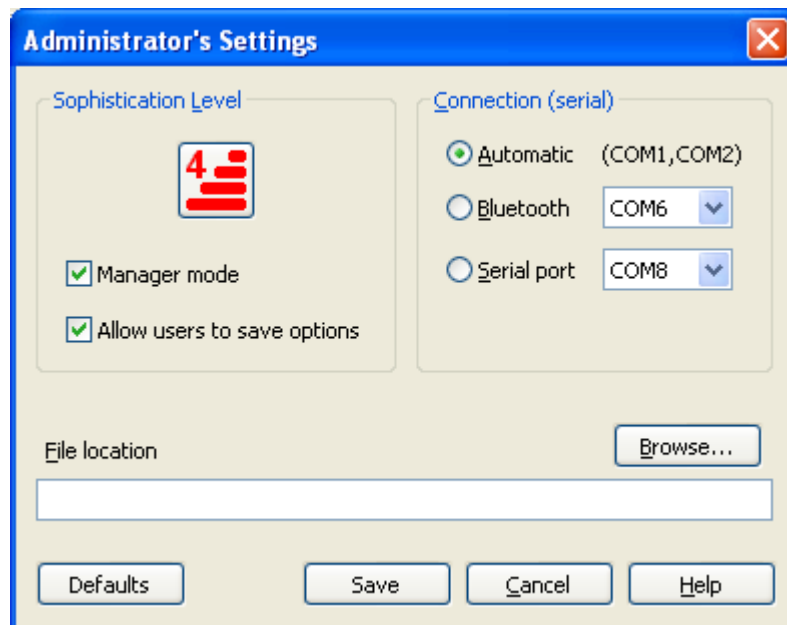
This section contains a feature by feature reference in alphabetical order for the program's dialogue boxes.

Some features described here are hidden at lower levels of sophistication. Also some features are only available in the Plus edition of SensorLab.

### 18.1 Administrator's Settings

Administrator Settings are designed to allow the system administrator to make settings which apply as the defaults for all users of the software.

Administrator Settings are shown by pressing the key combination Shift/Ctrl/Alt/T. In Manager mode these settings are also available from the File, Administrator menu.



*Administrator's Settings (Windows version)*

The Sophistication Level options determine which features are available to the user and the initial presentation style.

The Level is set from 1 to 4, with 4 being the most sophisticated.

Manager mode enables some menu items to be shown or hidden. These items, shown in the Administrator menu, are:

- Set Logger's Security Stamp
- Reload Logger's System Software
- Software Activation
- Administrator's Settings

To hide these items, clear the Manager Mode tick box and select Save.

When “Allow users to save options” is selected, individual users can save their own personal preferences with the Options dialogue from the Tools menu, thus overriding the defaults set here.

The File location is the initial place offered when opening and saving data files.

Serial and Bluetooth ports used to connect to a data logger can also be set where appropriate. The Windows version supports 'COM' ports for both serial and bluetooth connections. The Mac OS X version supports legacy serial ports (although these have not been available on Mac computers for a long while) and supports 'standard' bluetooth configuration (not using serial port emulation). The Linux version supports TTY devices for serial and RFCOMM devices for bluetooth. For more information on bluetooth see the Bluetooth section of this guide.

When saving these settings the software may display a confirmation of where the settings have been stored or it may display instructions on how to store these settings for all users of the computer. Some operating systems have security which prevents an application from storing such settings in a location which is available to other users. In some cases being logged on as an Administrator will allow this, in others it is necessary to provide a suitable password to enable the operation and in others it is necessary to copy settings manually.

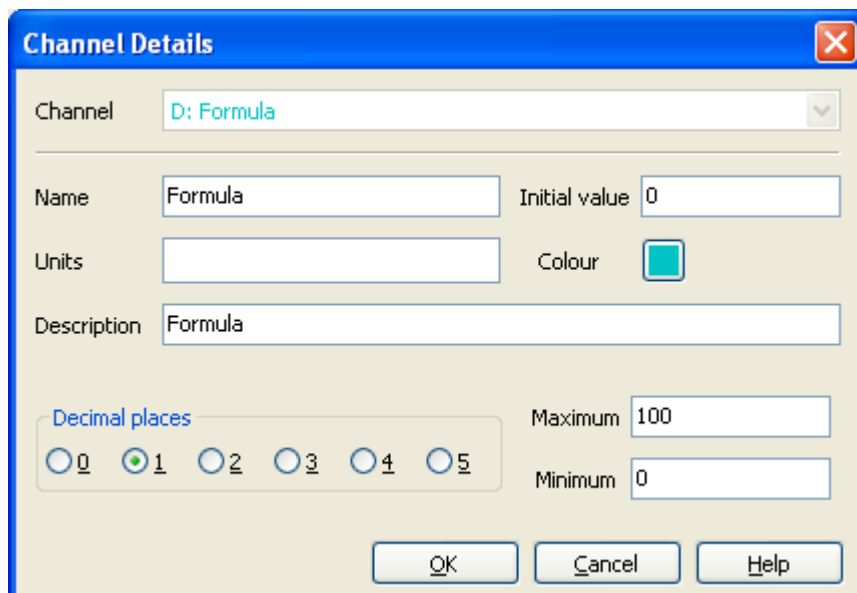
## 18.2 Calculate

The Calculate feature enables a data channel to be calculated using a formula. The formula can include references to sensor readings and elapsed time. A simple formula might be "Temperature + 20". The formula can be applied to existing data during analysis or to real time data during logging.

Calculate is available from the Data menu (SensorLab Plus only).

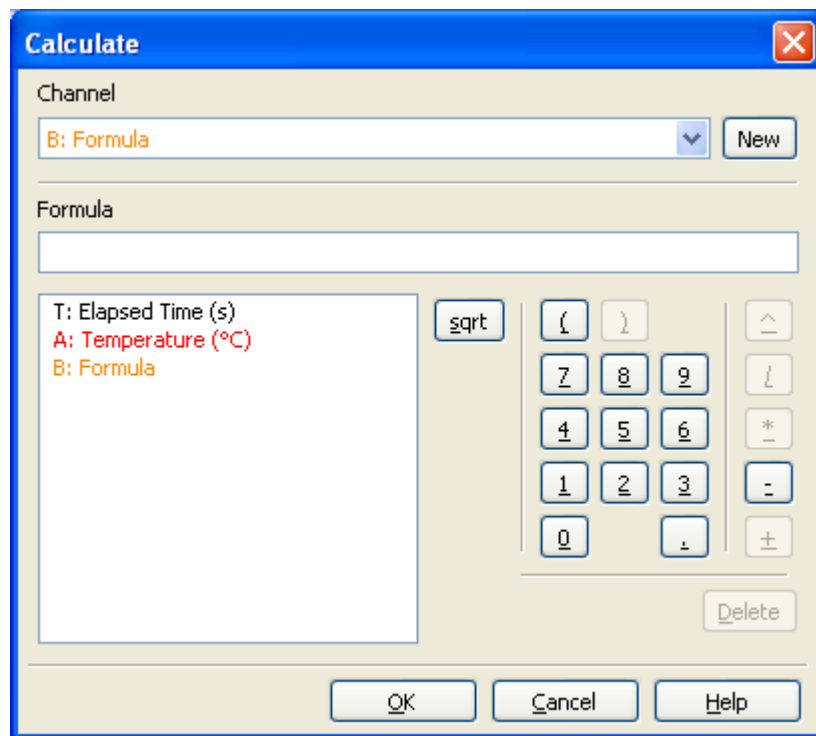
To create a new channel which contains a formula or to edit an existing formula, select Calculate from the Data menu.

If a new channel is being created, a Channel Details dialogue is presented. Enter here the new channel's details, such as Name and Units, then press OK.

The image shows a 'Channel Details' dialog box with a blue title bar and a close button (X) in the top right corner. The dialog contains several input fields and controls. At the top, there is a 'Channel' dropdown menu showing 'D: Formula'. Below this are fields for 'Name' (containing 'Formula'), 'Initial value' (containing '0'), 'Units' (empty), and 'Colour' (a small teal square). A 'Description' field contains 'Formula'. At the bottom, there is a 'Decimal places' section with radio buttons for 0, 1, 2, 3, 4, and 5; the '1' button is selected. To the right of the decimal places are 'Maximum' and 'Minimum' value fields, both containing '0'. At the very bottom are three buttons: 'OK', 'Cancel', and 'Help'.

*Channel Details - Calculate (Windows version)*

The Calculate dialogue is then presented, as illustrated below.



*Calculate (Windows version)*

Click the calculator style buttons to enter the required formula. When a reference is required to an existing data channel, select it from the list on the left.

For example, to create the formula “Temperature + 20”, click on the following items:

1. Temperature (as shown in the panel on the left)
2. '+' button
3. '2' button
4. '0' button
5. 'OK' button

Note: this example assumes you have a temperature sensor connected and it has been identified in the Activity screen. If not it will not appear in the channel list.

Upon completion of the formula the new data channel should appear and the calculated data shown.

To edit an existing formula, select Calculate from the Data menu. Use the Delete button to delete items from the existing formula and the other buttons to enter new items.

### 18.3 Channel Details

The Channel Details dialogue is used to enter or edit things like the Name, Units and Decimal places of a channel.

Channel Details is available from the Data menu or by left clicking on the channel information box or from the context menu associated with a channel.

*Channel Details (Windows version)*

The channel name is that shown in the sensor information box to the right of the graph and as a column heading on the table. A typical example is “Temperature”.

The units are the those shown by data values. A typical example is “°C”. It is important to note that changing the units here does not alter the data values. Thus changing “°C” to “F” does not alter the values to Fahrenheit. The units are just a label. To change the meaning of the data values, use the Unit Conversion feature.

The Description is stored for each channel. It is shown in the Information window, but otherwise has no functional significance. It can be used to provide more information about a channel. For example, with a number of temperature sensors used in cups made of different materials, it might be useful to describe these materials here. In such a case the description might be set to “Expensive china cup”.

The number of decimal places shown for the channel can be set from 0 (eg. 12 °C) to 5 (eg. 12.34567 °C).

The Value or Initial Value is used to set a numeric value for the channel. If the channel contains manually entered values, such as distance up a ramp, the Value is that stored when a record is logged. If the channel contains a formula the Initial Value is the value used to calculate the first point when the formula contains a reference to its own channel.

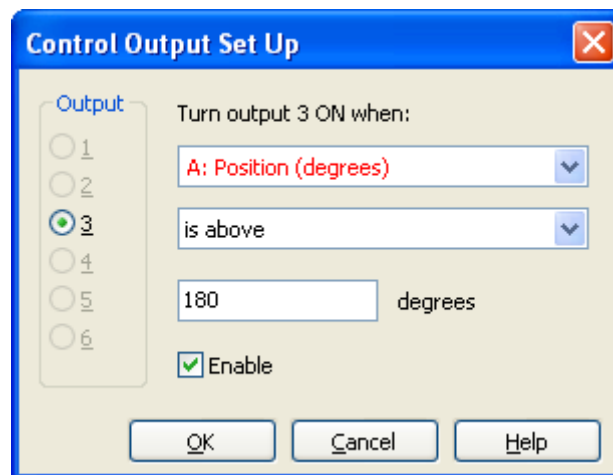
The Colour used by the specified channel can be set by clicking on the coloured button.

The maximum and minimum values are used as the default limits for the channel. When a graph is zoomed out, these are the scale limits shown.

## 18.4 Control Output Set Up

As well as measuring and logging, with suitable equipment connected, SensorLab is able to control things. For example, it is possible to build a temperature controller by connecting a temperature sensor and a heater.

Control is available from the Logging menu.



*Control Output Set Up (Windows version)*

The level of control offered is quite simple feedback control. SensorLab does not aim to compete with dedicated control systems.

The Control feature is available from the Logging menu when an output device is connected to a sensor socket or a control interface, such as SwitchIT, is connected.

There are 6 possible outputs. Only those which have been detected in the Activity screen are shown as available.

The required control condition is set by making selections from the drop down lists provided and a suitable threshold value entered. For example, to set a heater to come on when the temperature is less than 20 °C, select “Temperature” from the first list, “is below” from the second list, and enter “20” below that. Note, this example assumes a Temperature sensor has been detected.

The Enable box should automatically be ticked when selections are made, but it can be cleared if the control function needs to be disabled.

When a control condition has been set and enabled, the output is turned On when the condition is met and Off when not met. This is both during measuring (before logging) and during logging.

### **18.5 Custom Scale**

The custom scale option enables a conversion to be applied to numeric data values. The conversion is specified by providing new values for two points. All other values are calculated by extrapolating from these two.

The Custom Scale dialogue is available from the Data menu or from the context menu associated with a channel.

*Custom Scale (Windows version)*

The practical application of this feature is to provide a two point calibration mechanism. Not all measurements are perfect and where a correction is required based on two known values, this feature should be used.

The channel to be customised is set using the channel drop down list.

A new Name can be specified for the channel. Similarly a new Units label can be entered. It is important to note that changing the units here does not alter the data values. This is just a label.

The pair of data values are called Point 1 and Point 2. Initially these contain the maximum and minimum limits of the channel, with the “becomes” value being the same as the original. At this point the data values will not be changed, as there is no difference in the “becomes” values.

To specify a new values for the current maximum and minimum values shown, enter the new values in both of the “becomes” boxes. Alternative alter the original values as well.

### Home made sensor example

Lets say you have designed a system for measuring the volume of water in a water tank. The output of this device gives a voltage of 100mV per litre and you have it connected to the logger with a Designer Sensor adapter. This adapter normally measures 0 to 2.5 volts.

Suitable entries are:

Name = Water Volume

Units = Litre

Point 1 = 0 V becomes 0 Litre

Point 2 = 0.1 V becomes 1 Litre

### Two point calibration example

If you want to perform really accurate pH measurements you would normally use a buffer solution and adjust the probe or use the software's Tare facility. This would fine tune the reading at one known point. In extreme cases you may wish to correct an error in the 'slope' response of a probe. Here two

point adjustment is required. In the case of pH you might use two buffer solutions and make two test measurements. You may obtain the results:

Buffer solution 7, reads 6.9

Buffer solution 10, reads 10.1

To correct this error, enter the calibration points:

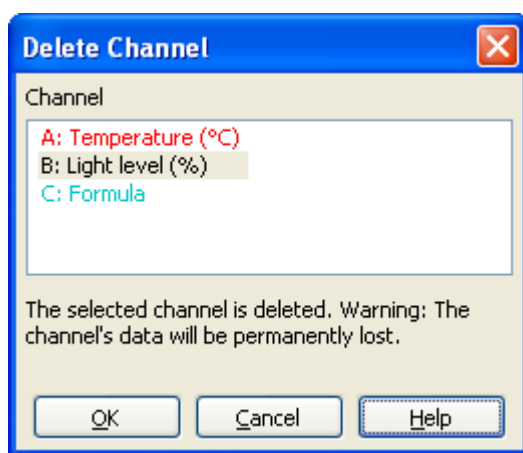
Point 1 = 6.9 pH becomes 7.0 pH

Point 2 = 10.1 pH becomes 10.0 pH

## 18.6 Delete Channel

Data channels can be deleted.

The Delete Channel dialogue is available from the Data menu and from the context menu associated with a channel.



*Delete Channel (Windows version)*

The selected data channel is permanently deleted and its data lost.

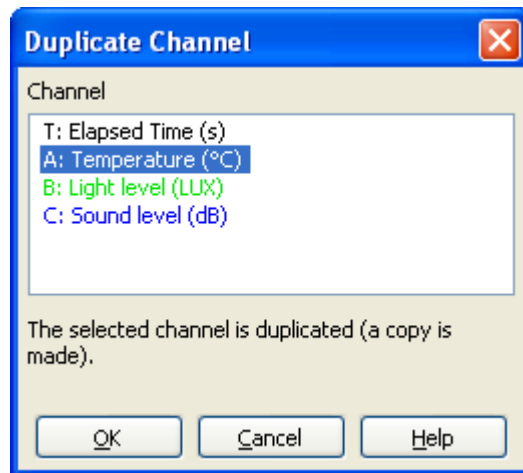
## 18.7 Duplicate Channel

Channels can be duplicated (copied).

The Duplicate Channel dialogue is available from the Data menu.

A new channel is created which is a copy of the one selected.

The new copy contains the same data as the original, but its name is preceded with an ampersand to indicate that it is not original data.



*Duplicate Channel (Windows version)*

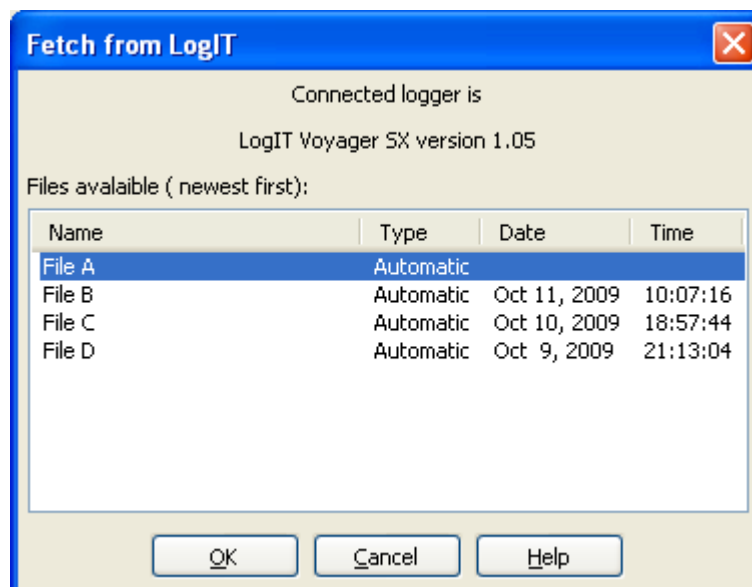
The duplicate channel has the same status as a channel created with the Add Channel feature, and its data values can be edited in the table.

Duplicating channels can be useful as it allows original data to be compared with smoothed versions or when experimenting with editing data values.

## 18.8 Fetch from LogIT

Remote data loggers, such as LogIT Voyager, allow data to be logged when the logger is not connected to a computer. This data is stored inside the data logger. The Fetch feature is used to read this data and display it.

The fetch dialogue is available from “Fetch from Logger” menu item or from the Fetch icon.



*Fetch from LogIT (Windows version)*

The Fetch dialogue shows all the data files stored in the connected data logger. The most recently logged data is shown at the top of the list. The data type and start time and date are shown for each file.



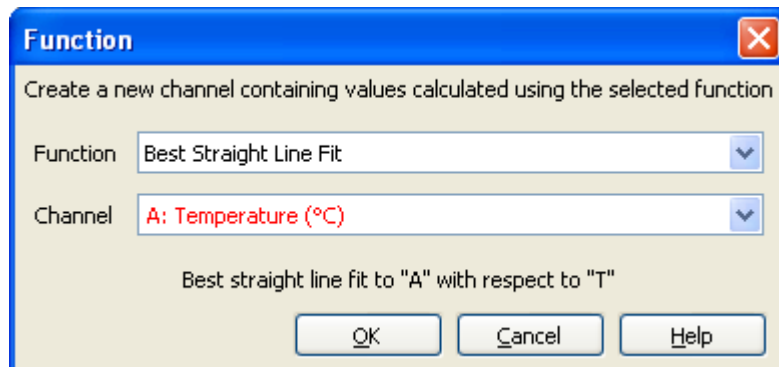
Select a file by double clicking on it or by clicking on it and then click OK.

The data is drawn on the graph as it is read, so it looks similar to real time logging.

## 18.9 Function

Pre-defined Functions can be applied to existing data or to data being logged. A new data channel is created and filled with values calculated with the selected function.

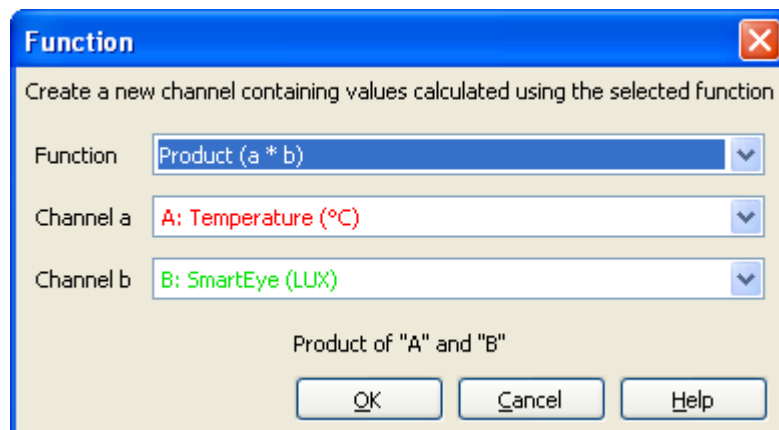
The Function dialogue is available from the Data menu.



*Function – Line Fit (Windows version)*

The required function is selected from the first drop down list.

Depending on the function selected, one or two data channels need to be selected for use by the function. For example, when plotting the difference between two channels, two must be specified, whilst only one is needed to plot a best straight line fit.



*Function - Product (Windows version)*

The available functions are:

- Best straight line fit
- Differentiate
- Integrate
- Difference ( $a - b$ )
- Product ( $a * b$ )

When a function is applied a new data channel is created and is given an appropriate name, units and description.

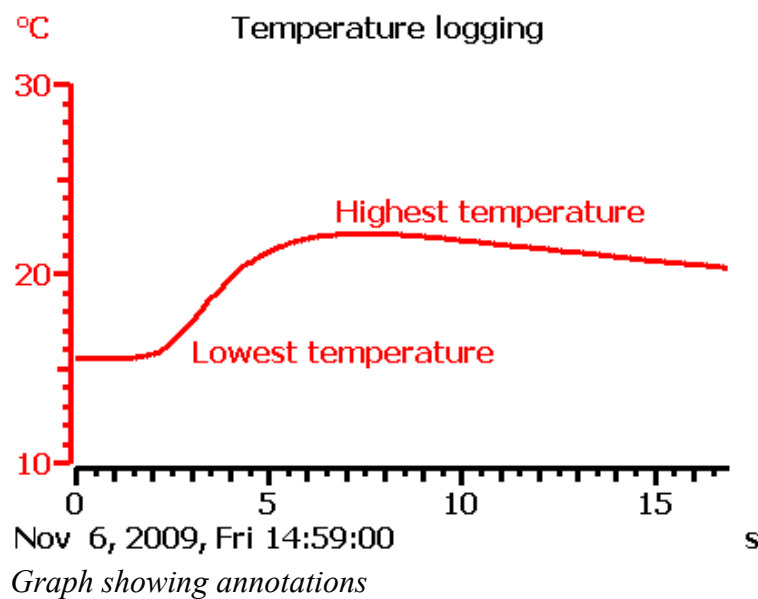
The Name is that of the first source data channel, prefixed with an apostrophe to indicate it is derived data.

The Units are set depending on the function used. Where a function is applied to two source channels, the units are A-B for difference and A.B for product, where A and B are the source channel units.

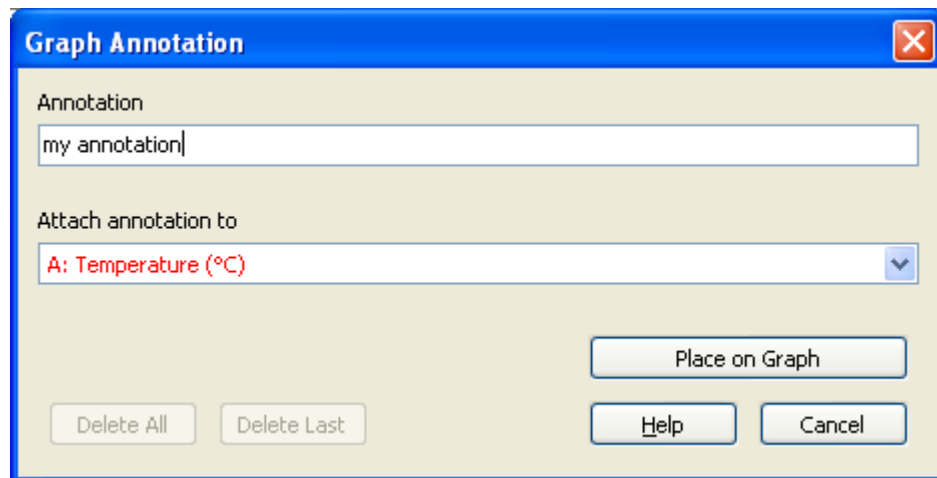
The description is set to indicate the function used. For example, it might say "Difference between "A" and "B"".

### 18.10 Graph Annotation

The graph can be annotated with labels, as illustrated below.



Annotate options are available from the Graph menu.



Annotate (Windows version)

Type the required annotation into the box labelled Annotation.

Select which channel the annotation should be attached to, from the list provided. The annotation will be shown in the colour of the selected channel and will be moved with that channel's graph trace.

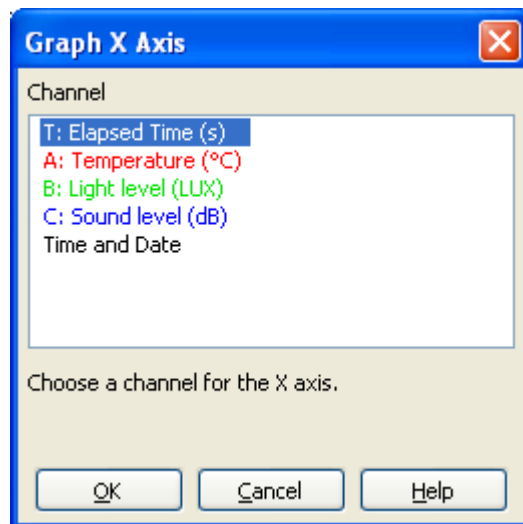
Click “Place on Graph” to put the label on the graph. The label will follow the mouse pointer until the primary mouse button is pressed, whereupon it will be fixed in position.

The Annotation dialogue also includes the buttons “Delete All” and “Delete Last”. Delete All removes all annotations from the graph, while Delete Last removes the last annotation placed on the graph.

### 18.11 Graph Axis

The Graph's Axes can be selected from a list of suitable channels.

The Graph Axis dialogue is available from the Data menu, from the graph's context menu and from clicking around the edge of the graph.



*Graph Axis (Windows version)*

The graph has an X axis, drawn at the bottom of the graph, and a Y axis, drawn to the left of the graph. It can also have a second Y axis, drawn to the right of the graph.

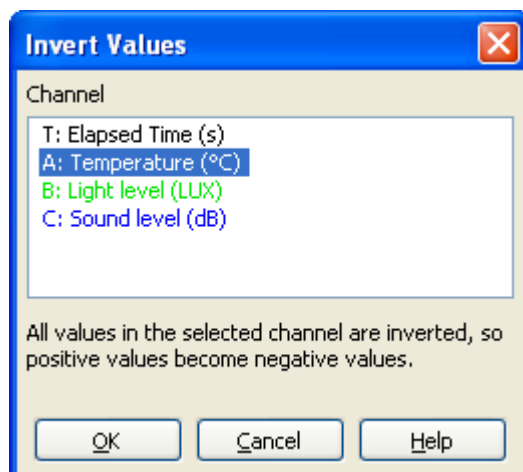
The X axis channel options can include elapsed time, reading number and also time and date. The time and date option shows the actual time and date, rather than the elapsed time, but is only available in SensorLab Plus.

The Y axis channels are restricted to sensor data, manual data and derived data. Elapsed time, reading number and time and date can not be used.

### 18.12 Invert Values

All values in a selected channel can be inverted.

The Invert Values dialogue is available from the Data menu.



All positive values in the selected channel become negative and all negative values become positive. For example, 12.34 becomes -12.34 and -100 becomes 100.

This can be useful when using current and voltage sensors which can easily cause confusion over polarity. A quick selection of Invert Values will reverse the polarity.

### 18.13 Logging Setup Wizard

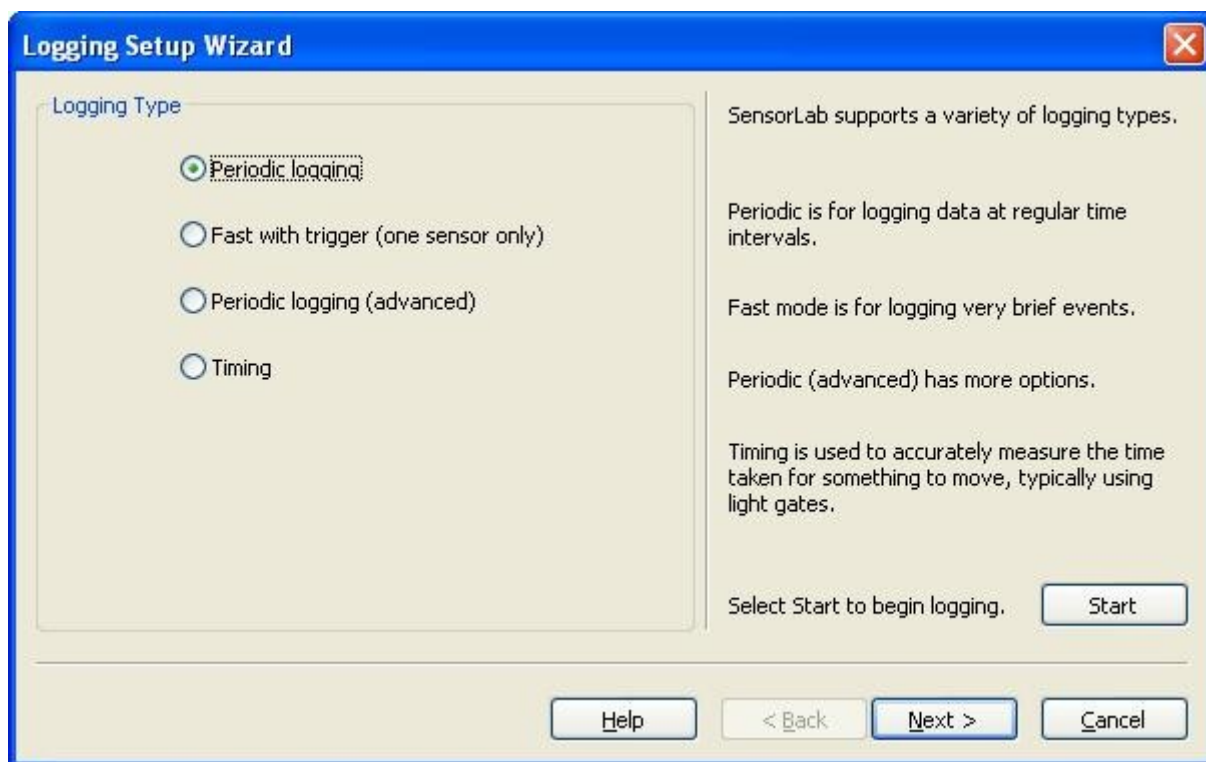
This Wizard guides the user through the options available when specifying measurement and data logging.



The Set Up Wizard is available from the Logging menu and from the Set Up icon on the Activity screen.

An alternative to using the set up wizard is to use a Worksheet or Template file which automatically configures SensorLab for the required experiment.

Set up options are arranged in a set of pages with Next and Back buttons. Options offered on later pages may depend on selections made on earlier pages.



*Logging Set Up Wizard (Windows version)*

### **18.13.1 Set Up Wizard – Logging Type**

There are three basic logging types: Periodic, Fast with trigger and Timing.

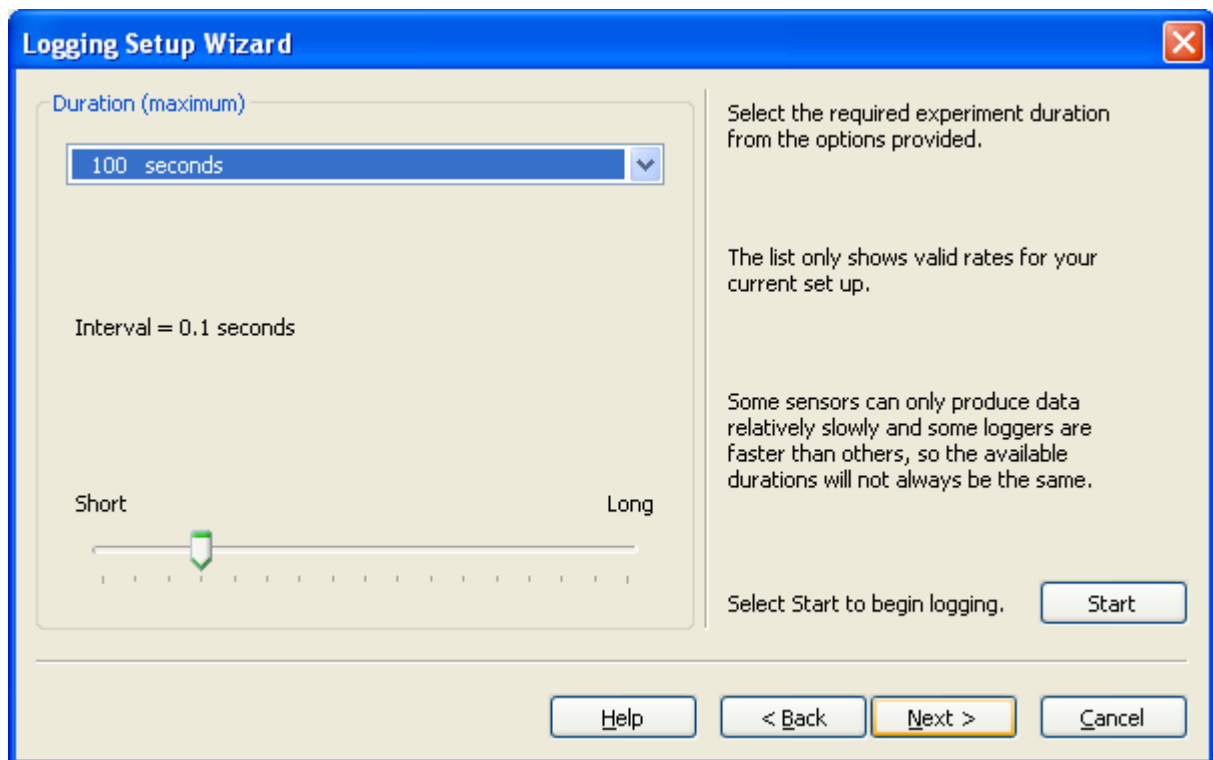
Periodic is where measurements are stored at regular time intervals.

Fast with trigger is for short events, such as a magnet dropping through a coil of wire, where logging starts when triggered by the measurements being made. The automatic logging start is required as it is difficult to click the start button at just the right time. When logging in this mode data is stored just prior to the trigger condition to ensure the start of the event is captured.

Timing is used for any measurements where the time events take is what is required. Data is not stored at regular intervals, but instead events are timed and these times, or values calculated from them, are stored. This feature is usually used with light gates, which detect objects passing through them. From the times measured, SensorLab can calculate Speed, Velocity, Acceleration, Momentum, Kinetic Energy and Simple Harmonic Motion Period.

### **18.13.2 Set Up Wizard – Periodic Logging**

Periodic logging requires the maximum duration of the data logging to be selected from a drop down list or set with a slider. The interval between readings being stored is also shown. When Periodic logging (advanced) is selected, the number of readings can also be selected. This enables very large data sets to be collected when required.



#### 18.13.3 Set Up Wizard – Fast with trigger

Fast logging also requires the duration of the data logging to be selected from a drop down list or set with a slider. The interval between readings being stored is also shown. The trigger condition is automatically set. Some data is collected just prior to the trigger to avoid missing the beginning of the event being studied. This is called Pre-trigger logging.

#### 18.13.4 Set Up Wizard – Timing

Various timing based measurements can be set up. A full explanation is given in the “Timing Explained” section at the end of this guide.

First set the measurement required, such as Acceleration. The Manual Calculation options results in the raw times being displayed rather than the calculated value, allowing the user to perform the calculation themselves.

**Logging Setup Wizard**

**Measurement**

☐ Time Difference  
☐ Speed  
☐ Velocity  
☐ Acceleration  
☒ Kinetic Energy  
☐ Momentum  
☐ Simple Harmonic Motion Period

☐ Manual Calculation

SensorLab enables very accurate measurement of time difference between events detected with sensors.

From these measurements various calculations can be performed.

Select the measurement type you require.

Select 'Manual Calculation' if you want to calculate the result yourself.

Select Start to begin logging. **Start**

**Help** **< Back** **Next >** **Cancel**

Depending on the measurement type and number of suitable sensors available there may then be the choice of making the measurement at any sensor, at each sensor or from one sensor to another. The distance between the sensors may also be entered.

**Logging Setup Wizard**

**Sensors**

2 suitable sensor(s) have been detected

Make one measurement:

☒ At any sensor  
☐ At each sensor  
☐ From one sensor to another

Distance between sensors (cm)

Sensors can be used in different ways.

At any sensor:  
a single measurement is made at any available sensor.

At each sensor:  
one measurement is made at each available sensor.

From one sensor to another:  
a single measurement is made with two sensors, typically as an object moves from one sensor to another.

Select Start to begin logging. **Start**

**Help** **< Back** **Next >** **Cancel**

Again depending on the measurement type there may be a choice of object shapes. The width of the object may also be entered.

The 'Logging Setup Wizard' dialog box is shown with the 'Measurement' tab selected. On the left, there are three radio button options: 'One bar' (selected), 'Two bars', and 'Four bars'. Each option is accompanied by a small icon representing the object shape. Below these options is a text input field for 'Width of a bar (cm)' with the value '5'. A note below the field states '(the gap width must be the same as the bar width)'. On the right side, there is instructional text: 'Select the shape of the object being timed.' and 'A sequence of measurements can be made with a 'picket fence' which has a multiple of the selected number of bars.' At the bottom right of the right panel, it says 'Select Start to begin logging.' with a 'Start' button. The bottom of the dialog features four buttons: 'Help', '< Back', 'Next >', and 'Cancel'.

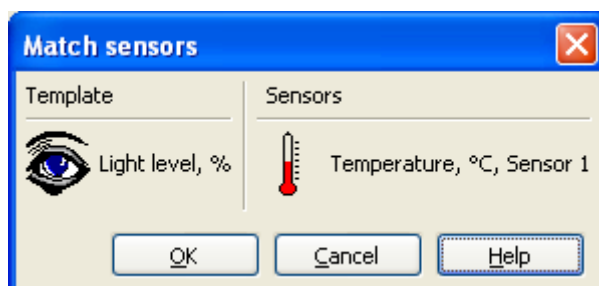
Finally, some measurement types require the mass of the object(s) to be entered.

The 'Logging Setup Wizard' dialog box is shown with the 'Mass' tab selected. On the left, there are three text input fields for mass values: 'Mass at sensor 1 (kg)' with '1', 'Mass at sensor 2 (kg)' with '1', and 'Mass at sensor 3+ (kg)' with '1'. On the right side, there is instructional text: 'Enter the mass of the object passing each sensor.' and 'If only one object is used the mass at all sensors will be the same, but with more than one object the mass at each sensor might be different.' At the bottom right of the right panel, it says 'Select Start to begin logging.' with a 'Start' button. The bottom of the dialog features four buttons: 'Help', '< Back', 'Next >', and 'Cancel'.



### 18.14 Match Sensors

When opening a template file, or a worksheet with an associated template, the software attempts to match the connected sensors to the requirements of the experiment (as defined by the template file). If the software has any doubts about the suitability of the connected sensors, the Match Sensors dialogue is displayed.



*Match Sensors (Windows version)*

The left side of the dialogue shows the sensors required for the experiment (as defined by the template file). The right side shows the current sensors or a green tick if the software considers a sensor to be a suitable match.

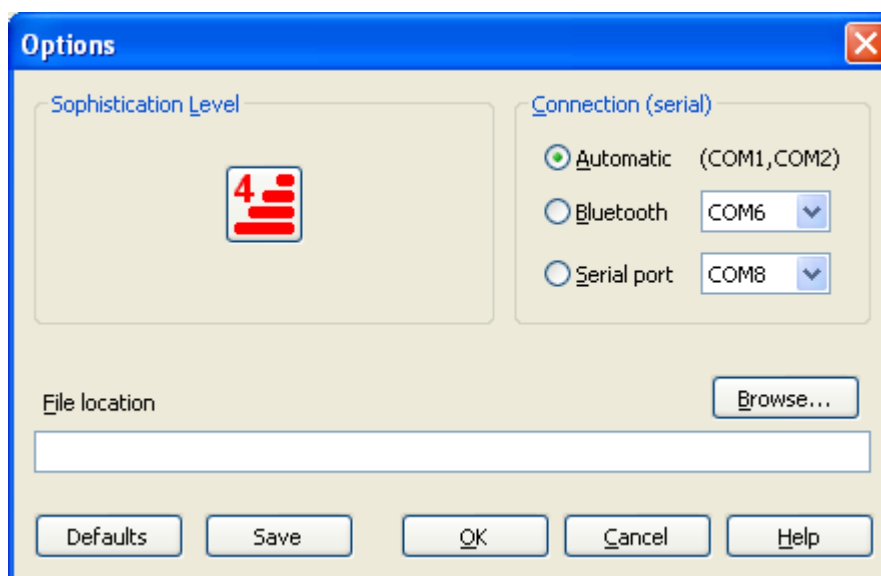
The dialogue continually checks the connected sensors, so the sensors can be adjusted until a match is achieved.

The OK button can be used to continue the experiment even if the sensors are not shown as matching.

### 18.15 Options

This dialogue enables the user to set various options for the rest of the session. The option to save these for use next session is available if the administrator sets “Allow users to save options” from the Administrator's Settings dialogue.

The Options dialogue is available from the Tools menu.



*Options (Windows version)*

The Sophistication Level determines which features are available to the user and the initial presentation style. The Level is set from 1 to 4, with 4 being the most sophisticated. Clicking on the Level icon causes the level to cycle up to the next most sophisticated, or cycle from level 4 around to level 1.

The File location is the initial place offered when opening and saving data files.

Serial and Bluetooth ports used to connect to a data logger can also be set where appropriate. The Windows version supports 'COM' ports for both serial and bluetooth connections. The Mac OS X version supports legacy serial ports (although these have not been available on Mac computers for a long while) and supports 'standard' bluetooth configuration (not using serial port emulation). The Linux version supports TTY devices for serial and RFCOMM devices for bluetooth. For more information on bluetooth see the Bluetooth section of this guide.

### **18.16 SensorLab Evaluation**

SensorLab runs in Evaluation mode with most loggers and sensors until activated.

Evaluation mode enables the software to be evaluated before purchase. The evaluation version can also be downloaded and used to update an earlier installation.

In evaluation mode there are a number of limitations:

- Printouts are defaced
- Logged data can not be saved
- Logging is limited to a maximum of 8 minutes in duration

After activation in Standard mode, it is still possible to evaluate Plus mode. To do this select “Evaluate SensorLab Plus” from the Help menu.

The activation code details can be found on the licence sheet supplied with SensorLab software.

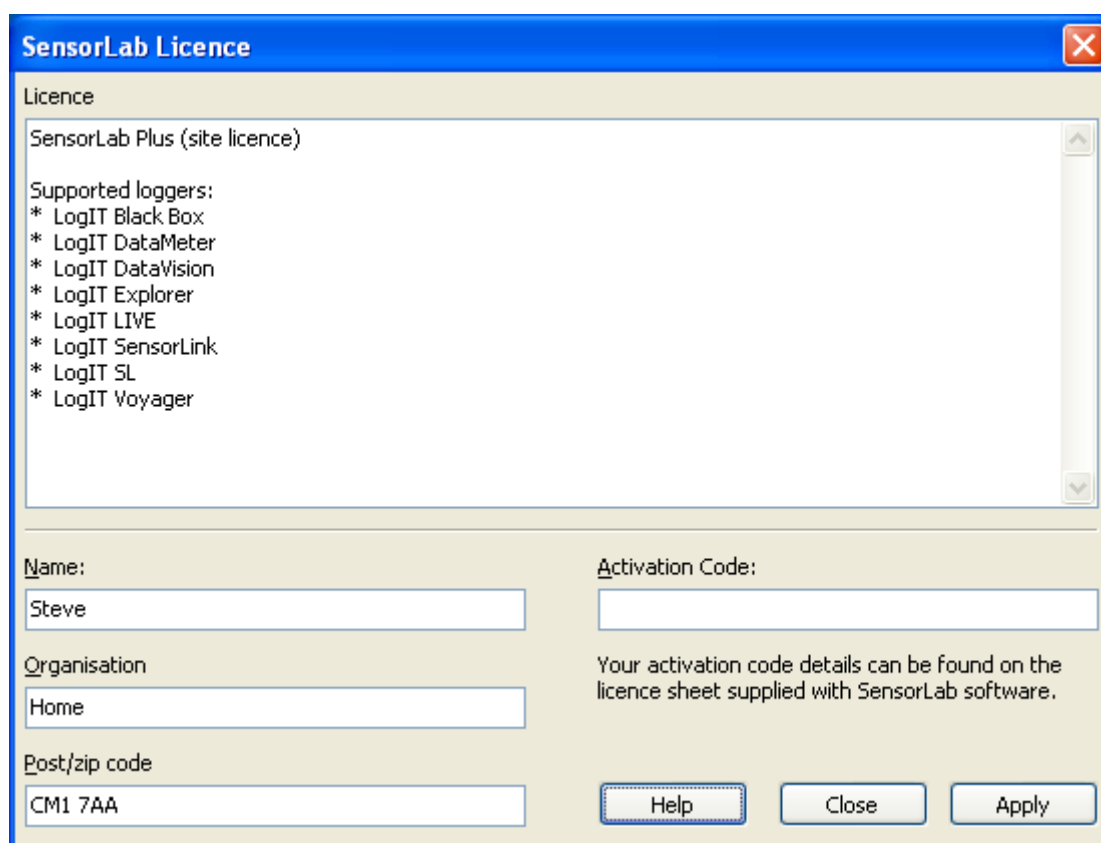
Technical Note:

Activation details are stored in a simple text file. To enable activation for all users of the computer, a second copy of this file needs to be stored in a central location. In some cases this is achieved by a user with Administrator privileges activating the software, in other cases it is necessary to copy the file manually. A prompt is given if this latter method is required. Network administrators may need to distribute the file to all their computers. Further details can be found in the separate installation document.

### **18.17 SensorLab Licence**

The Licence dialogue enables SensorLab activation codes to be entered.

This dialogue is available from the File menu, select Administrator, then Software Activation. This option is only available in Manager mode.



*SensorLab Licence (Windows version)*

The activation code details can be found on the licence sheet supplied with SensorLab software.

Enter a contact name, organisation (eg. School name) and post/zip code. Enter the SensorLab activation code and then click Apply. A notification box will indicate the features enabled by that code.

Several codes can be entered if required. A typical example is a single user licence code followed by a site licence upgrade code. Codes can also be added at a later date.

When all codes have been entered, click the close button. A notification box may then indicate where the licence details have been saved.

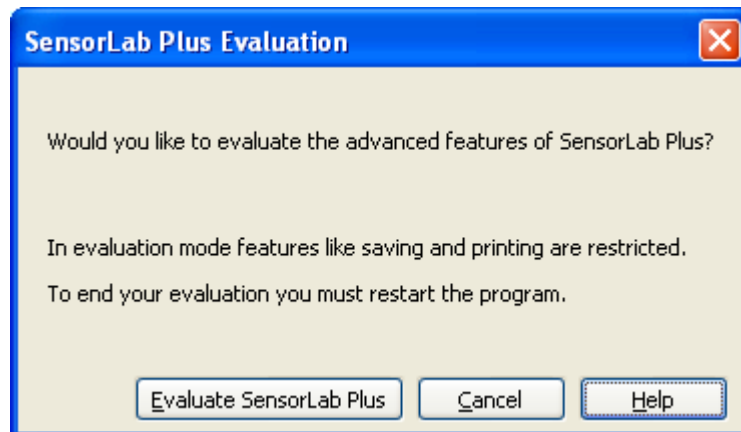
#### Technical Note:

Activation details are stored in a simple text file. To enable activation for all users of the computer, a second copy of this file needs to be stored in a central location. In some cases this is achieved by a user with Administrator privileges activating the software, in other cases it is necessary to copy the file manually. A prompt is given if this latter method is required. Network administrators may need to distribute the file to all their computers. Further details can be found in the separate installation document.

### 18.18 SensorLab Plus Evaluation

After activating SensorLab in Standard edition it is still possible to evaluate the Plus edition.

To evaluate the Plus edition, select Evaluate SensorLab Plus from the Help menu.

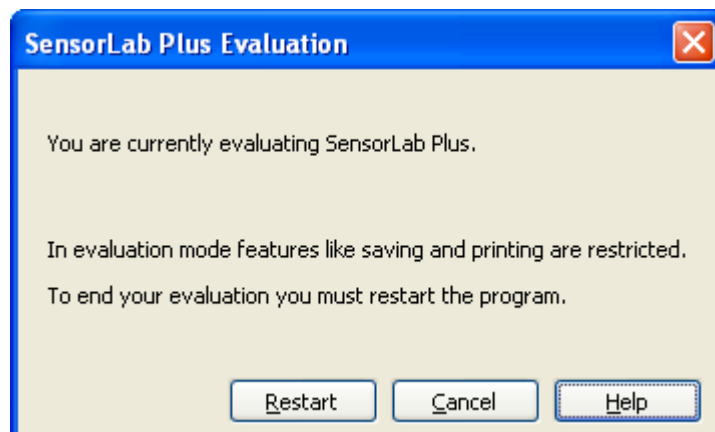


*SensorLab Plus Evaluation (Windows version)*

In evaluation mode there are a number of limitations:

- Printouts are defaced
- Logged data can not be saved
- Logging is limited to a maximum of 8 minutes in duration

To switch back to Standard Edition, de-select Evaluate SensorLab Plus in the Help menu.



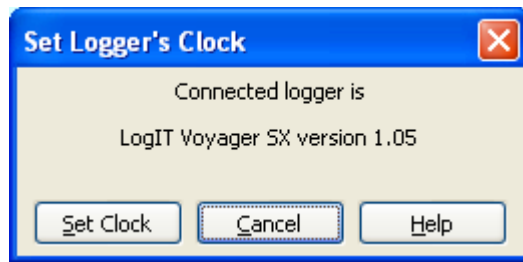
*SensorLab Plus - Restart (Windows version)*

Returning to Standard Edition causes the program to restart, which will discard any unsaved data.

### **18.19 Set Logger's Clock**

Remote data loggers, such as LogIT Voyager, have built in clocks. These clocks provide the start time and date information for remote data logging.

This dialogue is available from the File menu, select Administrator, then Set Logger's Clock.



*Set Logger's Clock (Windows version)*

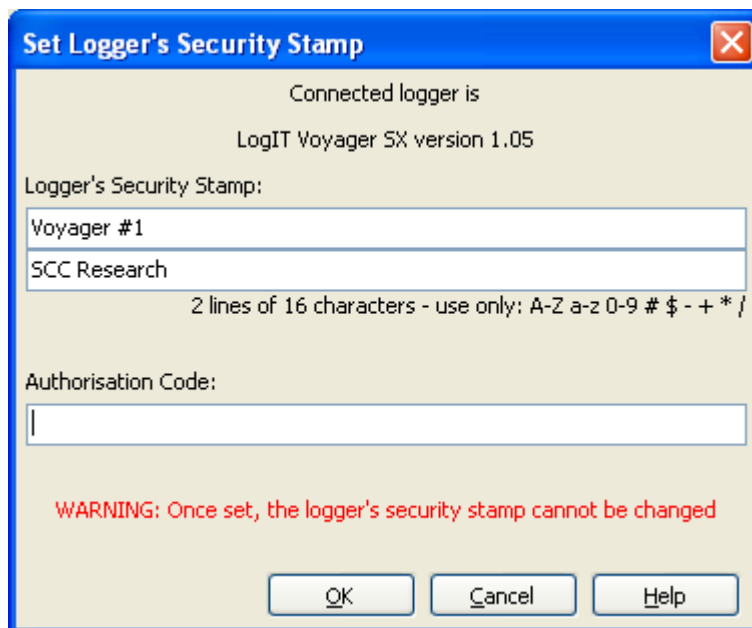
The data logger's internal clock is set to the same time as the computer's clock.

Generally it is not necessary to set the Logger's clock with this feature, as SensorLab checks the clock every time the Logger is connected. If it appears to be wildly wrong it sets the clock automatically.

### **18.20 Set Logger's Security Stamp**

Some loggers have a security stamp feature, allowing a custom message to be displayed. This might, for example, be a name, post code and/or logger number.

Security Stamp is available from the File menu, select Administrator, Set Logger's Security Stamp. This option is only available in Manager mode.



*Set Logger's Security Stamp (Windows version)*

As this feature could be abused, an authentication code must be entered. The security stamp can only be set once with each authentication code, further reducing the chances of a carefully set message from being changed maliciously.

The activation codes are: “ZAPHOD” and “EDISON”.

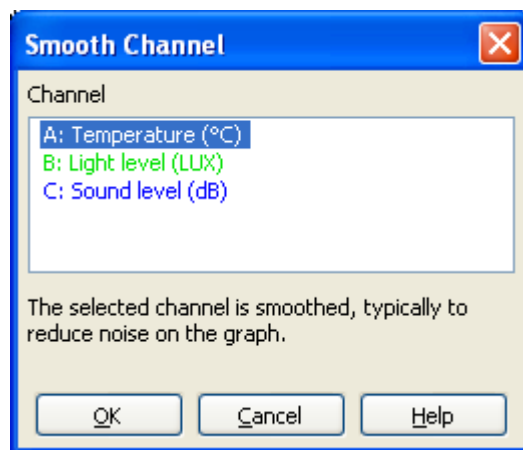
The first code allows the initial stamp setting, while the second code allows the security stamp to be changed once.

Loggers with an internal Bluetooth module, such as LogIT Voyager Air, use the first line of the security stamp as the Bluetooth device name. It is therefore sensible, with these products, to make the first line a unique name.

### 18.21 Smooth Channel

The specified data channel is "smoothed". Smoothing helps remove some of the rapid variations in value giving a more average representation of the sensor readings. This can be particularly useful if a sensor reading includes a significant amount of noise.

The Smooth Channel dialogue is available from the Data menu in SensorLab Standard Edition.



*Smooth Channel (Windows version)*

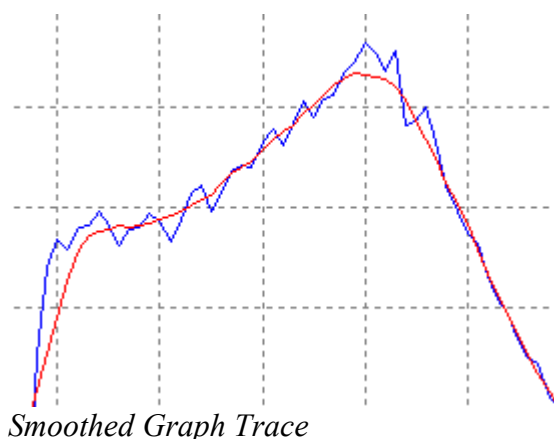
SensorLab Standard Edition provides a simple smooth function. It can be selected more than once to further smooth the data.

SensorLab Plus Edition provides variable smoothing. The smoothing dialogue allows the channel to be selected and a variable amount of smoothing is applied with a slider. Drag the slider right to increase the level of smoothing, and left to decrease it.

### 18.22 Smooth

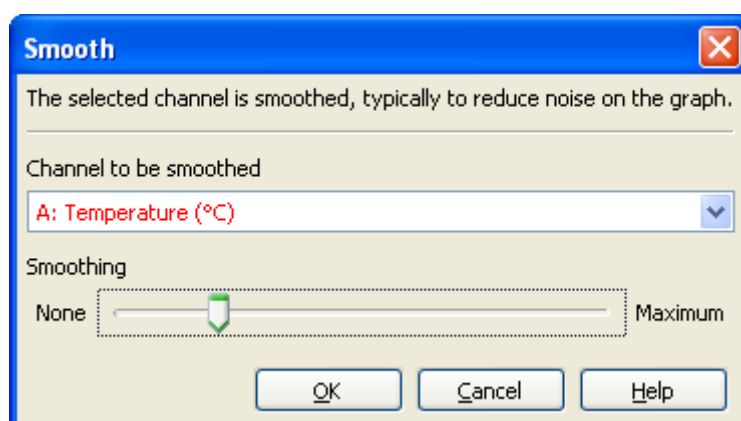
The specified data channel can be "smoothed". Smoothing helps remove some of the rapid variations in value giving a more average representation of the sensor readings. This can be particularly useful if a sensor reading includes a significant amount of noise.

The illustration below shows the noisy data in blue and a smoothed copy in red.



Smoothing is available from the Data menu.

SensorLab Plus Edition provides variable smoothing. The smoothing dialogue allows the channel to be selected and a variable amount of smoothing is applied with a slider. Drag the slider right to increase the level of smoothing, and left to decrease it.



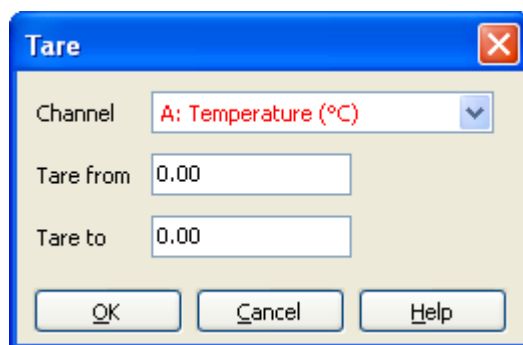
*Smooth - Plus edition (Windows version)*

SensorLab Standard Edition provides a simple smooth function. It can be selected more than once to further smooth the data.

### **18.23 Tare**

Tare adjusts sensor readings to add or remove an offset. Typically used to zero a value such as voltage or to set pH using a buffer solution. It is a simple single point calibration.

Tare is available from the Data menu.



*Tare (Windows version)*

#### For example

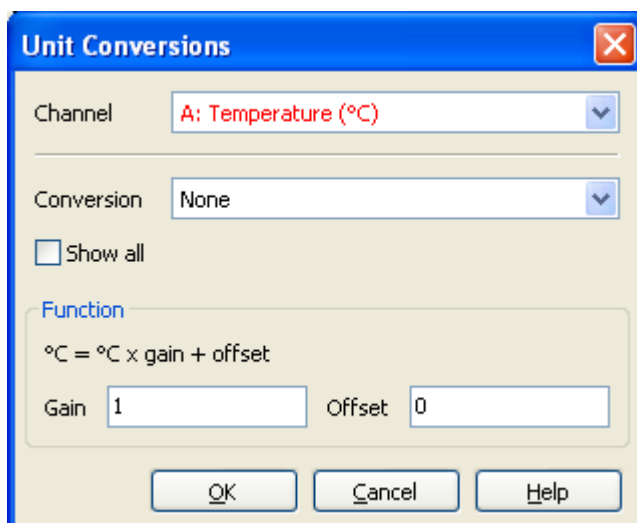
If you want to perform really accurate pH measurements you would normally use a buffer solution and adjust the probe or use the software's Tare facility. This would fine tune the reading at one known point. In this example, a pH 7 buffer solution might give a reading of 7.1 (an error of 0.1). To correct this, enter "7.1" in the "Tare from" box and "7" in the "Tare to" box. All values will then have the correction applied.

Note: This correction is not saved and must be re-entered each time it is required.

### 18.24 Unit Conversions

The Unit Conversions dialogue allows selection from a range of common unit conversions. For example, degrees Celsius to degrees Fahrenheit.

Unit Conversion is available from the Data menu.



*Unit Conversions (Windows version)*

The list of conversions offered initially contains only those which match the current channel units. The "Show all" option adds all available conversions to the list, even those that do not match.

Each conversion is based on a gain and an offset value. To perform the conversion, the computer multiplies each reading by the gain value and adds the offset value.



When the degrees Celsius to degrees Fahrenheit conversion is selected, the gain is 1.8 and the offset is 32. This comes from the time honoured method of multiplying by 9 and dividing by 5 ( $9/5 = 1.8$ ) and adding 32.

If the conversion required is not offered, suitable gain and offset values can be entered.

For example: To convert volt to millivolt, the gain is 1000 ( $1\text{ V} = 1000\text{ mV}$ ) and the offset = 0 ( $0\text{ V} = 0\text{ mV}$ ).

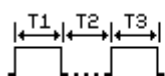
## 19 Timing Explained

This section explains how timing works. Note that this is not the same as LogIT Lab 4.

Some sensors are able to generate time interval data from changes in 'digital' levels. Each time a change occurs it is reported together with the time in microseconds since the previous change. From these event times any complex sequence of events can be timed and calculations applied to work out things like Speed, Acceleration, etc.

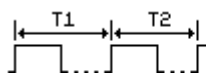
Some loggers can only provide timing data from digital sensors, while others can obtain timing data from analogue sensors as well.

As an object passes a sensor, a series of times is measured, as illustrated in the timing diagram below.



This could be one object passing two sensors or two objects passing a single sensor. This example gives three times: T1, T2 and T3.

By combining pairs of times, such as time 1 and time 2, we get the following result:



This gives greater accuracy as measuring from one leading edge to another tends to cancel any errors in the sensing mechanism.

Obtaining a measurement with the second timing method requires more sensors or an object of a more complex shape.

Objects can be any of these basic shapes:



A simple object with only one 'bar'.



An object with two 'bars'.



A four 'bar' object.

Sensors are arranged such that they can detect the 'bars' which form the object being timed.

Objects which consist of more than just a few bars are often called Picket Fences. By using a picket fence a sequence of measurements can be made, such as the velocity of a trolley as it runs down a slope. The picket fence needs to have a number of bars which is an exact multiple of the number required for a single measurement.

A set of event times can be used to calculate a final useful value, such as Speed or Acceleration. If required the source event times can be displayed to allow the user to calculate the required value manually.

To provide the maximum flexibility, there are also options to determine how to handle multiple sensors. The user may wish to obtain one measurement from each sensor, such as the speed at one sensor and then at a second sensor, or he/she may wish to measure the speed of an object as it moves from one sensor to another sensor.

Timing supports overlay logging.

## 19.1 Single Sensor Measurements

The following measurements can be made with a single sensor:

- Time Difference
- Speed
- Velocity
- Acceleration
- Kinetic Energy
- Momentum
- Simple Harmonic Motion Period

Although only one sensor is required, several sensors may be used to obtain several measurements of these types (except for Simple Harmonic Motion period). This might be used for measuring velocity before and after a collision.

If more than one sensor is available it is possible to make more than one measurement. Here there is a choice of measuring “At any sensor” or “At each sensor”. In both cases a measurement can be made at any available sensor. Each sensor can make an independent measurement which may overlap measurements being made with other sensors.

With the option “At any sensor”, when one measurement is complete it is stored in the relevant channel and the data record is completed. This may result in some channels containing no data value.

With the option “At each sensor”, when one measurement is complete it is stored in the relevant channel, but the data record is not completed until each sensor has made a measurement. Further data from a completed sensor is ignored until the next data record begins.

When Manual Calculation is *not* selected, one data channel is created for each suitable sensor.

When Manual Calculation is selected, one data channel is created for each time value needed to calculate the desired result. For example, Acceleration requires three channels.

When Manual Calculation is selected, only one measurement per record is supported. Thus the option “At each sensor” is disabled.

## 19.2 Dual Sensor Measurements

The following measurements can be made with a pair of sensors (where the time intervals are measured from one sensor to another):

- Time Difference
- Speed
- Velocity
- Acceleration
- Kinetic Energy
- Momentum

The only valid sensor option, when using a pair of sensors for a single measurement, is “From one sensor to another”. However, the other options will still be available if there is more than one suitable sensor has been detected, as the user may wish to specify that they are to be used for separate measurements, as described above in the section “Single Sensor Measurements”.

In all cases only one measurement is made per data record. This measurement is not associated with a specific sensor as more than one sensor is involved.

When Manual Calculation is *not* selected, one data channel is created.

When Manual Calculation is selected, one data channel is created for each time value needed to calculate the desired result. For example, Acceleration requires three channels.

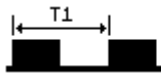
When Manual Calculation is selected, only one measurement per record is supported. Thus the option "At each sensor" is disabled.

### 19.3 Time, Speed, Velocity, Kinetic Energy, Momentum

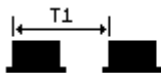
These measurements require only one time value, but this can be obtained in a number of different ways. The different methods are shown below with timing diagrams.



Sensors = 1 (for a single measurement)  
Sensor mode = At any sensor or At each sensor  
Object = 1 bar (for a single measurement)



Sensors = 1 (for a single measurement)  
Sensor mode = At any sensor or At each sensor  
Object = 2 bars (for a single measurement)

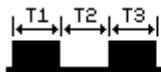


Sensors = 2 (for a single measurement)  
Sensor mode = From one sensor to another  
Object = 1 bar

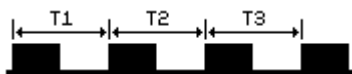
Objects with more than 2 bars, often called 'picket fences', can be used to create a sequence of measurements. The number of bars must be a multiple of the number selected for the specified measurement. Each repeat of the basic timing sequence is stored in its own data record.

### 19.4 Acceleration

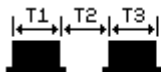
Acceleration is calculated from three times, which can be obtained in any of these ways:



Sensors = 1 (for a single measurement)  
Sensor mode = At any sensor or At each sensor  
Object = 2 bars (for a single measurement)



Sensors = 1 (for a single measurement)  
Sensor mode = At any sensor or At each sensor  
Object = 4 bars (for a single measurement)



Sensors = 2 (for a single measurement)  
Sensor mode = From one sensor to another  
Object = 1 bar

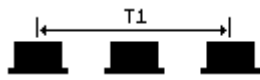
Objects with more than 2 bars, often called 'picket fences', can be used to create a sequence of measurements. The number of bars must be a multiple of the number selected for the specified measurement. Each repeat of the basic timing sequence is stored in its own data record.

In all cases the value of acceleration is determined from the velocities (calculated from time T1 and T2) and the time taken for the velocity to change ( $= T1 / 2 + T2 + T3 / 2$ ).

When Manual Calculation is selected the stored times are T1, T2 and T3 as illustrated above.

### 19.5 Simple Harmonic Motion Period

This measurement is restricted to just one sensor and one method of obtaining the time value.



Sensors = 1  
Sensor mode = At any sensor  
Object = 1 bar

An object passes a single sensor three times as it swings or oscillates. If left running a sequence will be stored, with one 'period' time in each data record.

### 19.6 Manual Calculations

The Manual Calculation option is designed to provide the measured time intervals and allow the user to calculate the end result, rather than have the program do it all for them.

One data channel is created for each time value needed to calculate the desired result. For example, acceleration requires three channels. These are times T1, T2 and T3, as shown in some of the timing diagrams above.

The channel names are “Time 1”, “Time 2”, etc. and the units are “s”.

When manual calculation is selected, only one measurement per record is supported. Thus the option “At each sensor” is disabled.

## 20 Bluetooth

Some data loggers support a wireless Bluetooth connection to the computer. This can be used instead of connecting with a serial or USB cable.

When trying to establish a connection to a Bluetooth equipped LogIT product, please do not forget to turn the logger on and, where appropriate, select Bluetooth. With a Bluetooth equipped LogIT Voyager the Bluetooth connection is selected just after Voyager is turned on by pressing the Blue button when prompted. When using the LogIT Air Link adapter with serial loggers, the logger just needs to be turned on.

With LogIT Voyager the Bluetooth device name is the first line of the Security Stamp message. This can be set from within SensorLab by selecting “Set Logger's Security Stamp” from the File, Administrator's menu.

It is recommended that older LogIT Bluetooth products be updated to support Bluetooth pairing codes. Early LogIT products did not support pairing codes, but recent firmware updates have added this feature. As most recent releases of Bluetooth set up utilities now force the use of pairing codes, it has become necessary to update LogIT firmware.

LogIT Voyager should have firmware version 1.07 or later. The version number can be found by pressing the blue menu button repeatedly until the display shows the version information. Voyager's firmware can be updated by selecting “Reload Logger's System Software” from SensorLab's File, Administrator menu.

The LogIT Air Link serial adapter can be updated by DCP Microdevelopments.

The pairing code number used by LogIT is “0000” (four zeros).

It is difficult to give definitive instructions to set up Bluetooth as this depends on the Bluetooth utilities supplied with the Bluetooth hardware, computer or operating system, and these tend to change over time. An overview is given below of each supported computer platform. For further details consult the documentation and help provided with your Bluetooth hardware, computer or operating system.

In general the following steps may be required to set up and use Bluetooth:

1. Install the Bluetooth interface drivers for your computer's Bluetooth interface. In most cases this is automatic. If your computer includes a built-in Bluetooth interface then the drivers should already be installed.
2. Establish a connection from the computer to the LogIT product. This process is often called pairing. The pairing code number used by LogIT is “0000” (four zeros).
3. Select Bluetooth within SensorLab from the Options dialogue.

The method required for step 1 will depend on the computer, the operating system and the Bluetooth interface in use, and has nothing to do with LogIT hardware or LogIT software.

The method required for step 2 will depend on the operating system and Bluetooth set up utilities in use. This is described below.

Step 3 is performed within SensorLab. Select Bluetooth in the Options dialogue (from the Tools menu) or in the Administrator's Settings dialogue (from the File, Administrator menu). As with other settings in these dialogues, the Options dialogue is available to all users and makes temporary changes

only (unless Saving of settings is enabled), while the Administrator's Settings dialogue enables the settings to be saved as the default for all users of SensorLab.

## 20.1 Linux

The Linux version of SensorLab supports Bluetooth devices named “rfcomm#”, where # is the port number. Usually the port number will be zero, making the LogIT Bluetooth port “rfcomm0”.

Hopefully the Linux distribution you are using has fully graphical tools to establish a paired connection and assign the rfcomm number. If not the following may be useful for assigning the rfcomm number.

Once a pairing is established the command:

```
hcitool scan
```

should give the LogIT product's Bluetooth address. This will be something like “00:80:98:96:49:A5”.

Once you have the Bluetooth address, the following commands should set a temporary rfcomm assignment as “rfcomm0”:

```
sudo rfcomm release 0  
sudo rfcomm bind 0 <bluetooth address> 1
```

To set a permanent assignment, which is established at boot up, you should typically edit the file “/etc/bluetooth/rfcomm.conf” to read:

```
rfcomm0 {  
  bind yes;  
  device <bluetooth address>;  
  channel 1;  
  comment "LogIT Voyager";  
}
```

## 20.2 Mac OS X

The Mac version of SensorLab enables the LogIT bluetooth device to be selected from within SensorLab. There is no need to establish pairing outside SensorLab.

From the Options or Administrator's Settings dialogue, select Bluetooth, then click Search and select the required LogIT device.

## 20.3 Microsoft Windows

Usually when a Windows computer has a Bluetooth interface, a Bluetooth icon is shown in the notification area of the taskbar. Typically this icon enables the following to be achieved.

Using the Bluetooth icon, select Add a Device. This should show a list of devices in range. Select the required LogIT device. When asked for a pairing code, enter “0000” (four zeros).

The icon will usually allow the connected devices to be shown. From here details of the device can be shown, possibly by selecting “Properties”. This will show the Serial service COM port number assigned to the LogIT device. This is the COM port number which needs to be selected in SensorLab's Options or Administrator's dialogue.

## 21 Glossary

### **AutoLog**

AutoLog is a totally automatic data logging mechanism. When started it begins collecting data relatively quickly and then gradually slows down as the experiment progresses. It can be stopped at any time and the data will always be available as regularly stored values. Each sensor has a default measurement type (such as averaged value or frequency) for use with AutoLog.

### **Accuracy**

Accuracy is the degree of agreement between a measured value and the standard or accepted value for that measurement. Often expressed as a percentage of the full scale value or maximum deviation from the accepted value.

### **Channel**

A Channel (or data channel) contains a set of data from one source, typically a sensor, but it can be data entered manually. A channel is shown as one column in the table and one trace on the graph. A channel also contains a name (eg. Distance), units (eg. m) and description (eg. distance up the ramp).

### **Control Device**

A Control Device plugs into a sensor socket and provide an output that can be turned on and off. Currently available devices include a Control relay, buzzer and light (LED). They are compatible with LogIT Live, DataMeter 1000, DataVision CX, LogIT Voyager SX and LogIT Black Box, but not LogIT SL. A special control pack is also available for LogIT Explorer.

### **Data Logger**

A Data Logger is a device used to capture data. For the purposes of this software the term Logger refers to either a real time computer interface (such as LogIT Live) or a remote data logger (such as LogIT DataMeter 1000). Strictly speaking a real time computer interface is not actually logging the data itself and should not be called a data logger.

### **Duration**

Duration is the total time an experiment logs data for.

### **Elapsed Time**

Elapsed time is the time from the start of logging, usually expressed in seconds. The start of logging will thus be at zero seconds and a one minute long experiment will have its last reading stored with an elapsed time of 60 seconds.

### **Experiment**

An Experiment is a test or investigation designed to provide evidence for or against a hypothesis.

### **Interval**

Interval is the time between each reading being logged.

### **Level of Sophistication**

This software supports four pre-defined levels of sophistication (or User Levels), with the aim of offering users appropriate functionality for their ability and experience.

### **Manager Mode**

Manager mode allows access to user settings such as the default location of data files. Some items in the administrator menu are only shown when in manager mode. Manager mode can be



enabled by pressing the key combination Shift/Ctrl/Alt/T and selecting Manager mode in the dialogue displayed.

### **Microsense**

Microsense is the name of the sensor system used by LogIT SL, Live, DataMeter, DataVision, SensorLink, Voyager and Black Box.

### **Noise**

Noise is irregular fluctuations accompanying a transmitted signal but not relevant to it.

### **Oscilloscope**

An oscilloscope is an instrument designed to display waveforms, such as sound waves.

### **Overlay**

Having performed an experiment, you might wish to change one variable and repeat it for comparison. Overlay allows you to do this, combining the new results with the old on the same graph and table.

### **Periodic Logging**

Periodic Logging is when data is stored at regular time intervals throughout an experiment.

### **Pre-trigger**

Pre-trigger is the time just before the logging trigger occurs. Logging normally starts when the user presses the Start button. Triggered logging starts when a sensor detects a trigger level or change. This has the advantage of allowing very fast events to be captured. Triggered logging mode includes the capture of sensors readings just before the trigger occurs, enabling the beginning of the event to be captured. Typically triggered logging supports intervals from 50 microseconds per reading to 10 milliseconds per reading.

### **Probe**

A Probe (or sensor) is a device that responds to an external signal or stimulus, and in this case produces an electrical signal that can be measured by the logger.

### **Real Time Logging**

Real Time Logging is when the results are displayed as they are being collected.

### **Remote Logging**

Remote Logging is when data is collected independently of the computer with a remote data logger. Results can then be read (or fetched) from the logger at a later time.

### **Repeat**

An experiment can be performed again with the same settings as the previous session. Select Repeat from the Logging menu.

### **Resolution**

Resolution expresses the smallest change in a signal that can be distinguished. Temperature sensors typically have a resolution of 0.1 degrees.

### **Security Stamp**

Some data loggers have a Security Stamp feature, allowing a custom message to be displayed on the screen. This might, for example, be a name, post code and logger number.

### **Sensor**

A Sensor (or probe) is a device that responds to an external signal or stimulus, and in this case produces an electrical signal that can be measured by the logger.

## **Smooth**

To have a relatively even and regular surface. Smoothing a data channel helps even out unwanted variations in value, often called noise.

## **Snapshot Logging**

A single value from each input is stored when the user selects Store. This is useful for experiments that are not time dependent, such as measuring magnetic field strength every few degrees around a magnet.

## **SwitchIT**

SwitchIT is a control interface providing four changeover relays that can be turned on and off. It connects between the computer and the logger. SwitchIT is compatible with LogIT SL, Live and DataMeter 1000.

## **Tare**

Tare adjusts sensor readings to add or remove an offset. Typically used to zero a value such as voltage or to set pH using a buffer solution. It is a simple single point calibration.

## **Timing**

Timing is a special form of logging where each measurement is based on the time difference between events. The stored value may be the time difference or some value derived from it, such as Speed.

## **Triggered Logging**

Logging normally starts when the user presses the Start button. Triggered logging starts when a sensor detects a trigger level or change. This has the advantage of allowing very fast events to be captured. Triggered logging mode includes the capture of sensors readings just before the trigger occurs, enabling the beginning of the event to be captured. Typically triggered logging supports intervals or 50 microseconds per reading to 10 milliseconds per reading.

## **USB**

The Universal Serial Bus (USB) is a relatively new connection system, enabling many peripherals to be easily connected to a computer. It has many advantages over the older serial and parallel ports. A special link cable is available to connect LogIT 'serial' data loggers via USB.

## **Wizard**

A Wizard is essentially an intelligent questionnaire that guides you through a set of questions relating to a selected activity. You will only be asked relevant questions, as determined from earlier answers and other external factors. The aim is to simplify tasks that might otherwise seem complex, especially for inexperienced users.

## **22 Acknowledgements and Credits**

### **22.1 Trademarks**

SensorLab and AutoLog are trademarks of SCC Research.  
LogIT and Microsense are trademarks of DCP Microdevelopments Ltd.  
Windows is a trademark of Microsoft Corporation.

### **22.2 Credits**

Some of the graphics used by SensorLab have been provided by generous artists either completely free of restrictions or under the Creative Commons licence. The following link to the sources of the graphics used:

[http://www.visualpharm.com/must\\_have\\_icon\\_set/](http://www.visualpharm.com/must_have_icon_set/)  
<http://www.webappers.com/category/design/icons/page/3/>  
<http://mazenl77.deviantart.com/art/I-like-buttons-3a-113122067?offset=10#comments>

### **22.3 Contributors**

The following developers produced the SensorLab application:  
Martin Williams  
Stephen Cousins

### **22.4 Open Source Tools**

The following open source tools were used in the development:  
wxWidgets                      <http://www.wxwidgets.org/>

### **22.5 Support**

Support for LogIT SensorLab is available from [www.logitworld.com](http://www.logitworld.com)

## 2.Alphabetical Index

Accuracy.....	80	Keyboard.....	36
Activation.....	12	Levels of Sophistication.....	13
Activity Selection Screen.....	15	Licence.....	11, 66
Administrator Sub-menu.....	39	Linux.....	7, 9, 79
Administrator's Settings.....	49	Logging.....	14
Analysis Tools.....	25	Logging Menu.....	46
Annotation.....	58	Logging Setup Wizard.....	60
Area Tool.....	28	Logging Types.....	16
AutoLog.....	16	Mac OS X.....	7, 9, 79
Bluetooth.....	78	Manager Mode.....	80
Calculate.....	50	Match Sensors.....	65
Change Tool.....	27	Measuring and Logging.....	14
Channel.....	80	Microsense.....	81
Channel Details.....	51	Microsoft Windows.....	7, 9, 79
Clock.....	68	Mouse.....	37
Colour Sub-menu.....	39	Noise.....	81
Computer Specification.....	7	Open Source Tools.....	83
Contributors.....	83	Options.....	65
Control.....	52	Oscilloscope.....	16, 21
Control Output Set Up.....	52	Picket Fences.....	74
Credits.....	83	Plus Edition.....	11
Custom Scale.....	53	Position Tool.....	26
Data Menu.....	40	Pre-trigger.....	62, 81
Delete Channel.....	55	Reading Tool.....	26
Derived Data.....	29	Resolution.....	81
Details.....	51	Security Stamp.....	69
Difference Tool.....	27	SensorLab Editions.....	10
Digits.....	38	SensorLab Evaluation.....	66
Duplicate Channel.....	55	SensorLab Licence.....	66
Edit Menu.....	41	SensorLab Plus Evaluation.....	67
Editions.....	10	Set Logger's Clock.....	68
Evaluation.....	66, 67	Set Logger's Security Stamp.....	69
Export Sub-menu.....	41	Set up.....	16
Fetch from LogIT.....	56	Set Up Wizard.....	23
File Menu.....	43	Settings.....	49
Formula.....	30	Setup.....	60
Function.....	57	Shortcuts.....	36
Functions.....	29	Sidebar.....	34
Glossary.....	80	Sidebar Icons (Activity Selection Screen).....	16
Gradient Tool.....	28	Sidebar Icons (Graph Screen).....	20
Graph.....	37	Smooth.....	70
Graph Annotation.....	58	Smooth Channel.....	70
Graph Axis.....	59	Snapshot.....	16
Graph Menu.....	44	Stamp.....	69
Help Menu.....	45	Standard and Plus Editions.....	11
Icons.....	34, 35	Support.....	83
Installing SensorLab.....	9	Supported Operating Systems.....	7
Introduction.....	5	SwitchIT.....	82
Invert Values.....	59	Table.....	37

Tare.....	71	USB.....	82
Templates.....	32	View Menu.....	47
Timing Explained.....	74	Windows.....	7, 9, 79
Toolbar.....	35	Wizard.....	60
Tools Menu.....	46	Worksheets.....	15, 32
Trademarks.....	83	Zoom and Scale.....	25
Unit Conversions.....	72		