

# DS1921 iBUTTON DATALOGGER



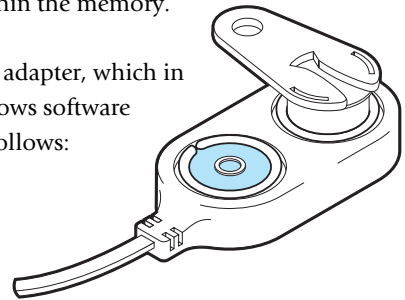
## What is a DS1921 iButton Temperature Datalogger?

The iButton Temperature Datalogger is a coin sized electronic device housed in a robust stainless steel can. This water-resistant stainless steel can houses a battery and a silicon chip that acts as a temperature sensor, a clock/calendar, and electronic memory to record temperature readings.

The thermometer measures temperature from  $-30^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  in  $0.5^{\circ}$  increments, while the clock measures seconds to years accurately to  $+1$  minute per month from  $0^{\circ}\text{C}$  to  $45^{\circ}\text{C}$ . The recyclable iButton logs data for more than 10 years or up to 1 million temperature measurements. Each iButton has a unique identification number so that each device can be individually identified. It is also possible to store user information like the product description or the operators name within the memory.

The iButton is initialised by clipping it into a Blue Dot adapter, which in turn is connected to a computer. The easy to use Windows software allows the configurable 'mission' options to be set as follows:

1. Set the internal clock to make sure it is accurate.
2. Set the sample rate (1 minute to 255 minutes).
3. Set the upper and lower temperature alarm threshold values.
4. Set the mission start delay (time before the mission starts – up to 45 days).



The iButton is then removed from the Blue Dot adapter and placed in the logging position. The iButton is so small (smaller and lighter than a UK pound coin) you can attach it unobtrusively to any container surface or wall—on bottles, boxes, crates, pallets, air cargo containers, refrigerators, refrigerated trailers, etc. The iButton's stainless steel can withstands dirt, water and rough treatment – you can even stamp on the device in a puddle without damaging it!

When the mission is complete the iButton is retrieved and clipped back into the Blue Dot adapter. The computer software is then used to extract the data. Reports and graphs can be generated within the software, and the data can also be exported for use in other applications (e.g. Microsoft Excel).

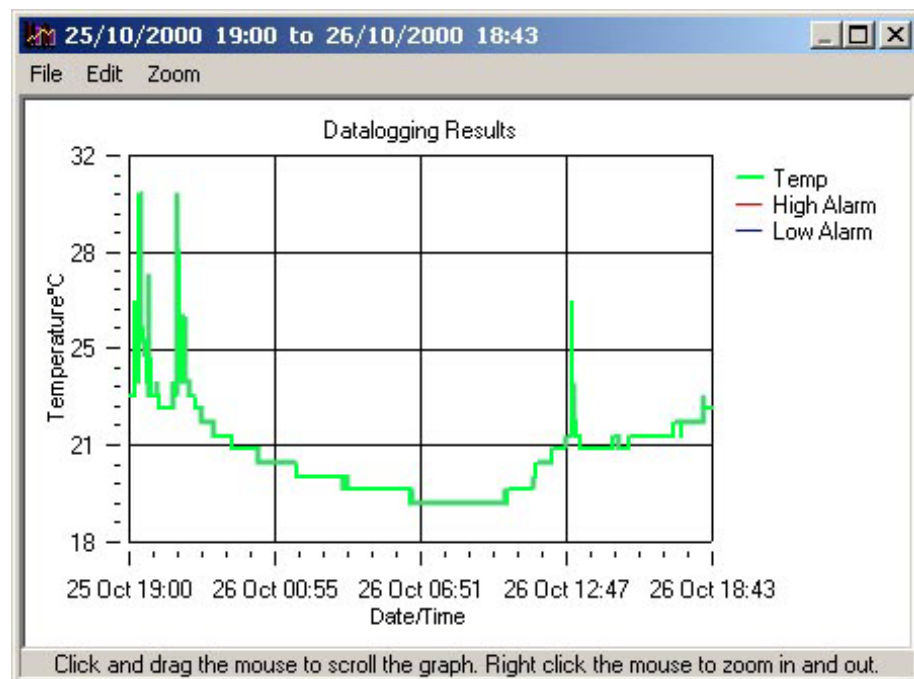
## Data Storage: Log and Histogram Formats

The iButton stores data in three different ways that serve different application needs.

### 1) Temperature Logging

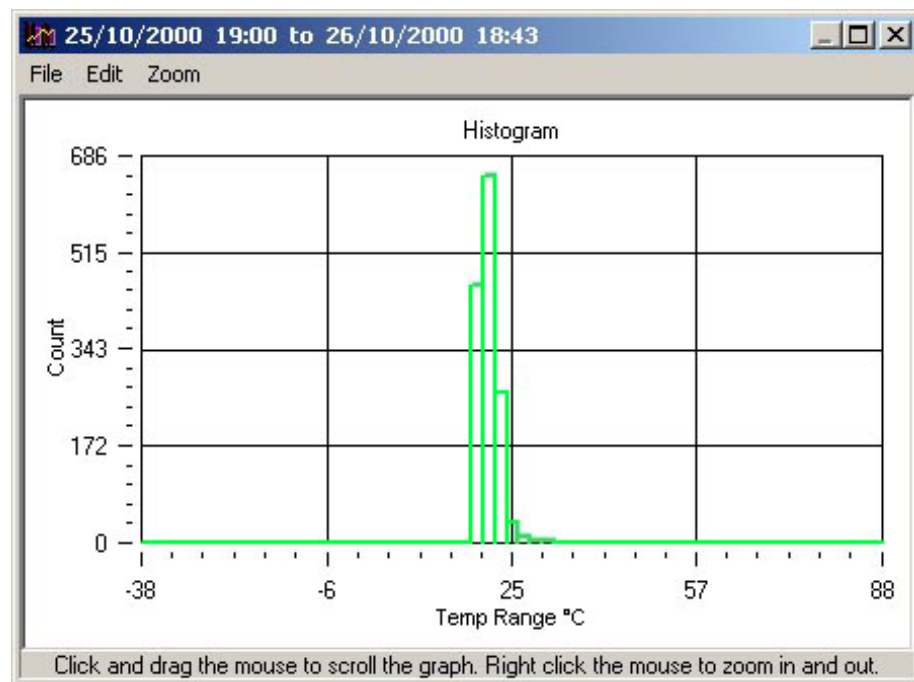
The iButton can take 2048 time and date stamped temperature readings at equal intervals (between 1 and 255 minutes). At a 1 minute interval this equates to about 1.4 days, at a 255 minute interval this equates to almost a year of continuous operation.

To fully utilize the recording mission, the user chooses the time to begin temperature taking, sets a sampling rate, sets high and low alarm thresholds, and determines whether to 'rollover' when 2048 time and temperature readings are completed (or to simply stop logging at that point).



## 2) Histogram Bins

Secondly the iButton also simultaneously stores each temperature sample in a histogram. The histogram memory consists of 56 bins in 2-degree increments; each bin can hold up to 65,500 temperature readings. The histogram method of data storage serves applications that require long-term monitoring or the ability to instantly assess whether a minimum or maximum threshold has been compromised. For instance, when storing blood or other biomedical products, it is critical to know that the thresholds were exceeded, the actual time that they were exceeded is not so critical. The histogram instantly reveals whether user-defined high or low temperature thresholds have been exceeded, and for how long.



## 3) Threshold Alarms

Finally it is possible to also set an upper and lower threshold alarm. If the iButton temperature exceeds these thresholds at any point an alarm time/date stamp will be recorded. This reveals exactly when, and for how long, an alarm threshold was exceeded.

## Temperature Datalogging 'Missions'

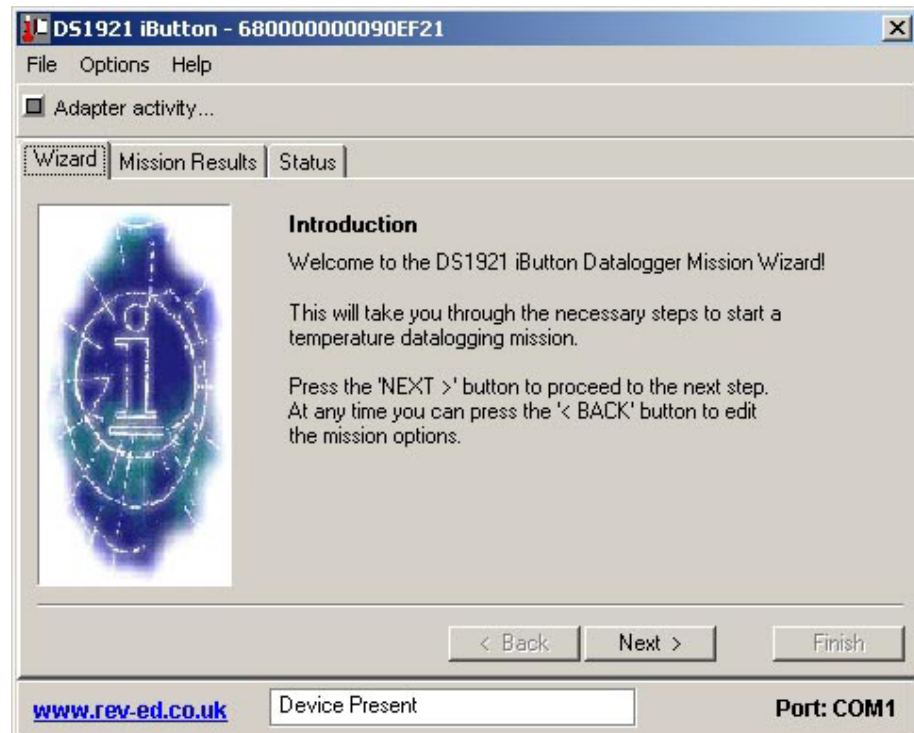
To start a temperature recording 'mission' or to extract data from an existing mission, the iButton is connected via a 'blue-dot' adapter to a computer.

There is no need to stop the mission when collecting the data, so the data can be collected from the iButton whilst it is still on a mission.

To start a mission the computer software is used to:

1. Set the internal clock.
2. Set the sample rate.
3. Set the upper and lower temperature alarm thresholds.
4. Set the mission start delay (time before the mission starts – up to 45 days).

This is carried out by a simple step-by-step software 'Wizard' that allows easy access by non-technical operators.



## Frequently Asked Questions

### What minimum temperature can be measured?

The iButton comes in three grades that operate down to different lower temperatures. Although exceeding these temperatures will not damage the iButton, the accuracy of the measurement below the lower threshold is not guaranteed. The grade of iButton is etched on the face of the stainless steel can.

Cans marked DS1921-F51 operate down to  $-10^{\circ}\text{C}$  (supplied in starter pack).

Cans marked DS1921-F52 operate down to  $-20^{\circ}\text{C}$ .

Cans marked DS1921-F53 operate down to  $-30^{\circ}\text{C}$ .

### How robust is the iButton?

The iButton is so small (smaller and lighter than a UK pound coin) you can attach it unobtrusively to any container surface or wall—on bottles, boxes, crates, pallets, air cargo containers, refrigerators, refrigerated trailers. The iButton's stainless steel can withstands dirt, water and rough treatment. You can step on it, splatter it with fish entrails, or drop it into an ice water bath—it continues to log effortlessly. Underneath the stainless steel case, a single silicon chip integrates a digital thermometer, clock/calendar and protected memory. The stored data is designed to be resistant to tampering from unscrupulous intermediaries. Attempts to alter the logged thermal history will be detected electronically.

### What happens if the lower temperature limit of $-40^{\circ}\text{C}$ is exceeded.

Extensive tests have shown that the iButton will 'recover' and continue working normally once the external temperature rises back above the minimum threshold.

### What happens if the upper temperature limit of $+85^{\circ}\text{C}$ is exceeded?

The iButton datalogger contains a lithium battery. At temperatures above the upper threshold the battery can become damaged and will start to degrade.

### What is the life span of the iButton?

Either 10 years or 1 million measurements (at  $50^{\circ}\text{C}$  or less), whichever comes first.

### How do you know when the lithium battery is low or nearly exhausted?

You can check the software that shows how many conversions the iButton has made in its lifetime. This shows how close to the 1 million threshold you are.

### What does 'water-resistant' mean for the iButton?

The iButton's grommet creates a seal that is water-resistant but not waterproof (hermetic). Under conditions where the iButton is submerged to a depth greater than 10 feet for an extended period of time, the pressure may force water into the iButton. If you are simply swimming in the ocean with an iButton or the iButton is on equipment that gets exposed or splashed with fresh or salt water, there should be no problem. Just wipe it clean before touching it to the Blue Dot adapter.

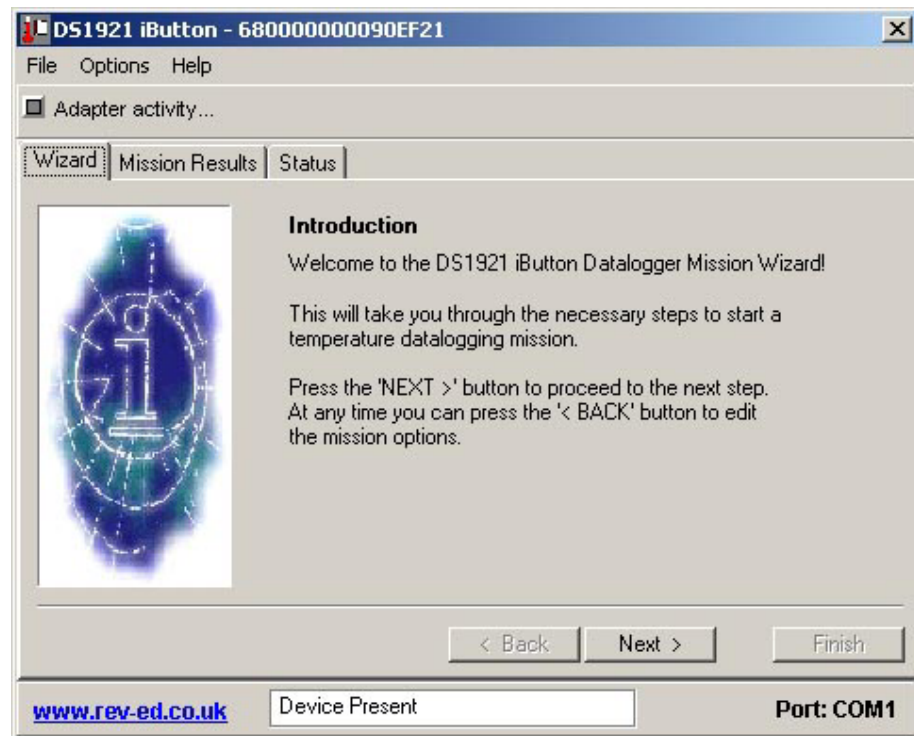
### How do I turn off the iButton?

You can stop the current mission from taking samples with the 'Stop Mission' command under the 'Options menu' in the software.

## Datalogger Software

The Datalogger software is a software application to initialise, and download the temperature data from, a DS1921 Temperature Datalogging iButton.

Initialising the iButton is referred to as sending it on a 'mission'. There are several options when starting a mission. To go through each of these options, the datalogger software offers a 'Mission Wizard'. If the device is not currently on a mission, then the datalogger software automatically defaults to display the wizard first.

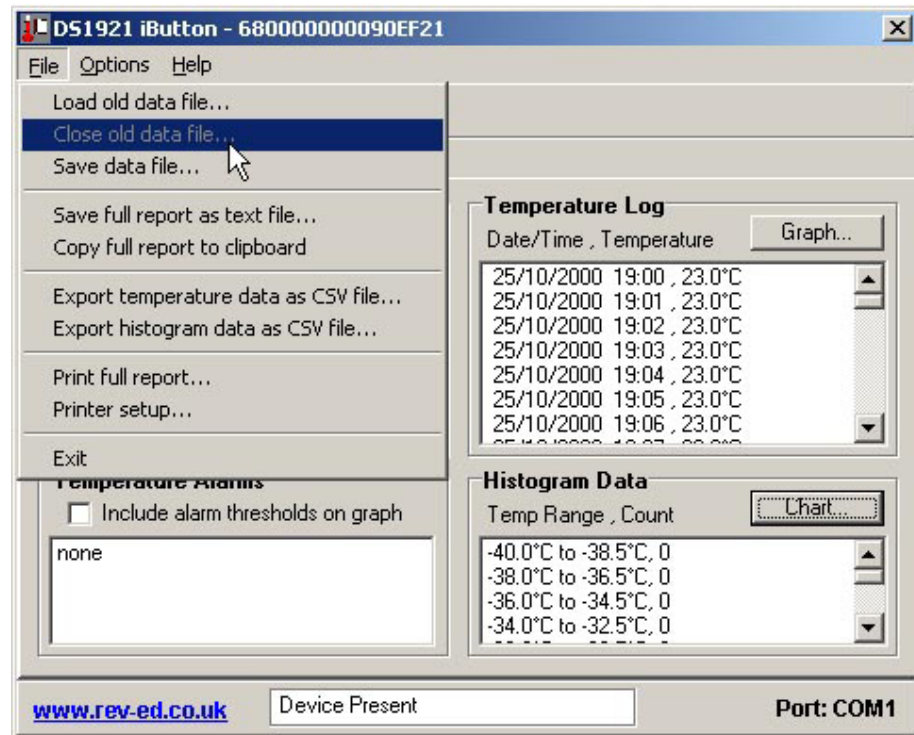


The viewer has two other main tabs: 'Mission Results' and 'Status'.

'Status' will display the current settings in the iButton such as if a mission is in progress, the number temperature readings taken, etc. The 'Mission Results' will contain the log of temperature readings and histogram. The bottom of the viewer contains a status message describing the current operation being performed.

## Menu Options

There are several menu options available. They can be accessed by clicking on the menu groups at the top of the viewer.



### File / Load Old Data File

This option allows viewing of a previously saved data file. When an old file is opened the software goes into 'offline mode' and does not detect any activity with the Blue Dot Adapter. It is necessary to close the old data file to go back 'online'.

### File / Close Old Data File

This option closes any old data file that has been opened. This operation puts the software back 'online'.

### File / Save Data File

This option saves the current on-screen data as a data file. This file can then be opened in the future for further analysis.

### File / Save Report as Text File

This option allows the full report to be saved as a text file, which can be viewed in any word processing application.

### File / Copy Full Report to Clipboard

This option copies the full report to the Windows clipboard, so that it can be pasted into another application. This may be more convenient than saving the data to a text file before importing it into another program.

**File / Export Temperature Data as CSV File**

This option saves the Temperature Data Log records as a comma separated variable (CSV) file. This is a universal spreadsheet format that can be opened in applications such as Microsoft Excel.

Note that the data is saved in the format displayed within the Mission Results page. For graph drawing in a third party software application it is recommended to select the 'Minute Offset' option before exporting the temperature data.

**File / Export Histogram Data as CSV File**

This option saves the Histogram records as a comma separated variable (CSV) file. This is a universal spreadsheet format that can be opened in applications such as Microsoft Excel.

**File / Print Full Report**

This option prints out a full report on the default printer.

**File / Printer Setup**

This option allows configuration of the printer.

**File / Exit**

This option will close this viewer and any open graphs.

**Options / Fahrenheit and Celsius**

The temperature mode options select whether all of the temperatures in this viewer are displayed as Fahrenheit or Celsius. Click on the desired format. This format will also be used in all graphs and export data.

**Options / Show F/C on Temperatures**

This option toggles whether the temperatures displayed throughout the viewer have the F or C appended to indicate the temperature display mode. It is sometimes desirable to not have the letter displayed for easier import into other applications.

**Options / Stop Current Mission**

This option will end a mission if one is currently in progress.

**Help / Contents**

This option starts the online help.

**Help / Home Page**

This option provides an internet link to the Datalogging support home page.

**Help / Technical Support**

This option provides an internet link to the technical support forum.

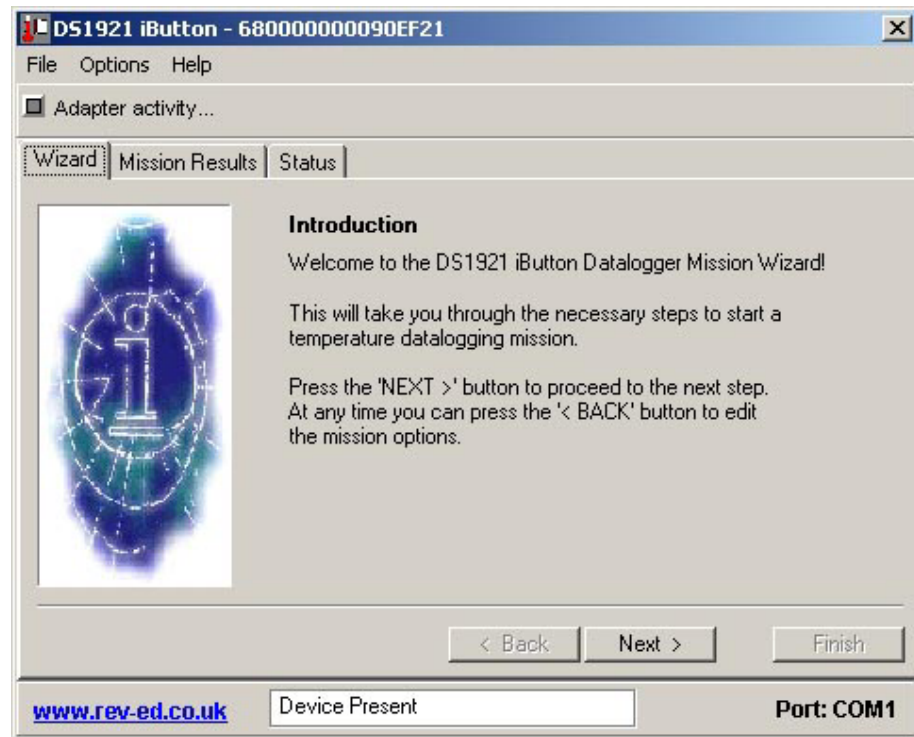
**Help / About**

This option displays the software version details.



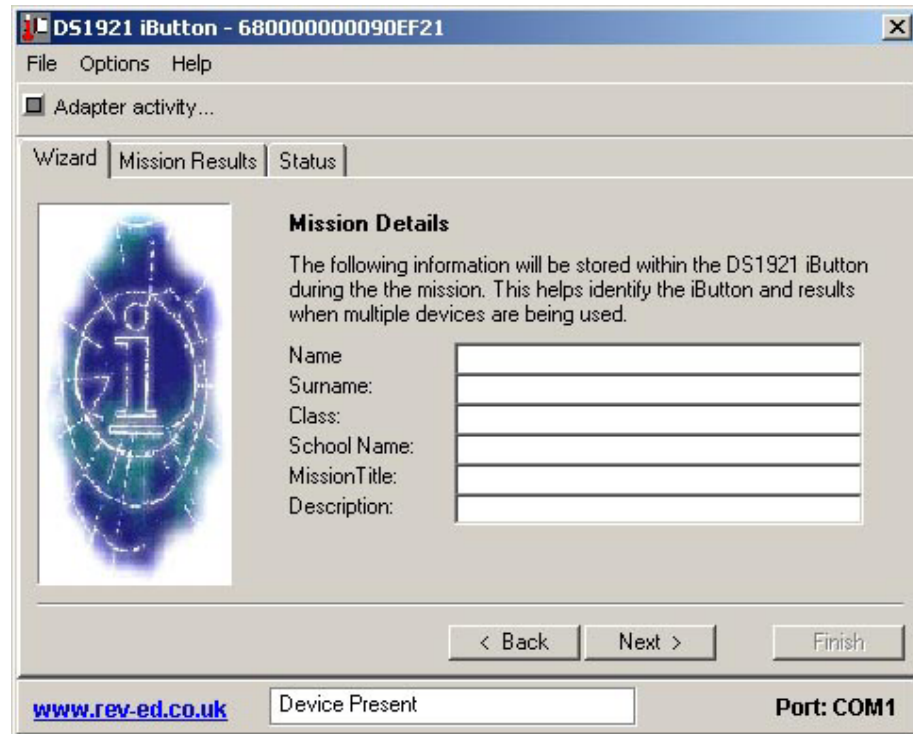
## 'Mission' Wizard

The Mission Wizard can be started at any time by clicking on the 'Wizard' tab and proceeding through the options by clicking on 'NEXT >' button. At any time, previous options can be re-addressed by clicking on the '< BACK' button.



### Mission Details

The Mission Details are user information that is stored within the iButton. Each section can contain a text string up to 32 characters long.



The title of each section can be renamed by editing the file 'titles.ini', which is found in the iButton Datalogger folder.

### Real-Time Clock Set

The next Wizard screen will optionally set the iButton's real-time clock from the PC clock. To help with this decision, the current device and PC clock time is displayed. The time display will be updated approximately every 3 seconds. The time is displayed in 24-Hour format. Clicking on the check box at the bottom will toggle whether the time will be set from the PC.



### Time Alarm

The time alarm will select the time at which the iButton will start responding to a conditional search.

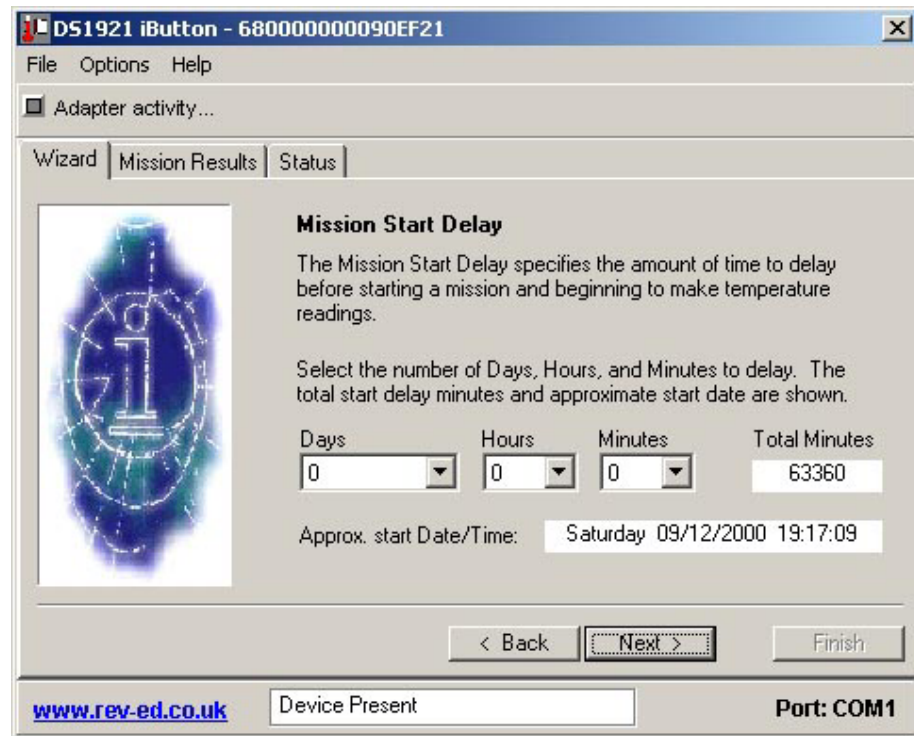
This is an advanced feature not required with most datalogging experiments.



The conditional search is a way to service only the device's that need attention in a multi-device network. The alarm can occur weekly, daily, hourly, minutely, or every second. The top drop-down box will select the mode. The lower drop-down boxes will select the relevant times. Some of the lower drop-down boxes will not be visible in some alarm modes. For example the 'Day' drop-down will not be visible when alarming hourly. The bottom check-box selects whether the device will respond to a conditional search when a Time alarm has occurred. Since the Time alarm cannot be disabled, selecting the alarm mode of 'none' will set a 'Weekly' alarm. The check-box at the bottom selects whether the device responds to a conditional search when a Time alarm occurs.

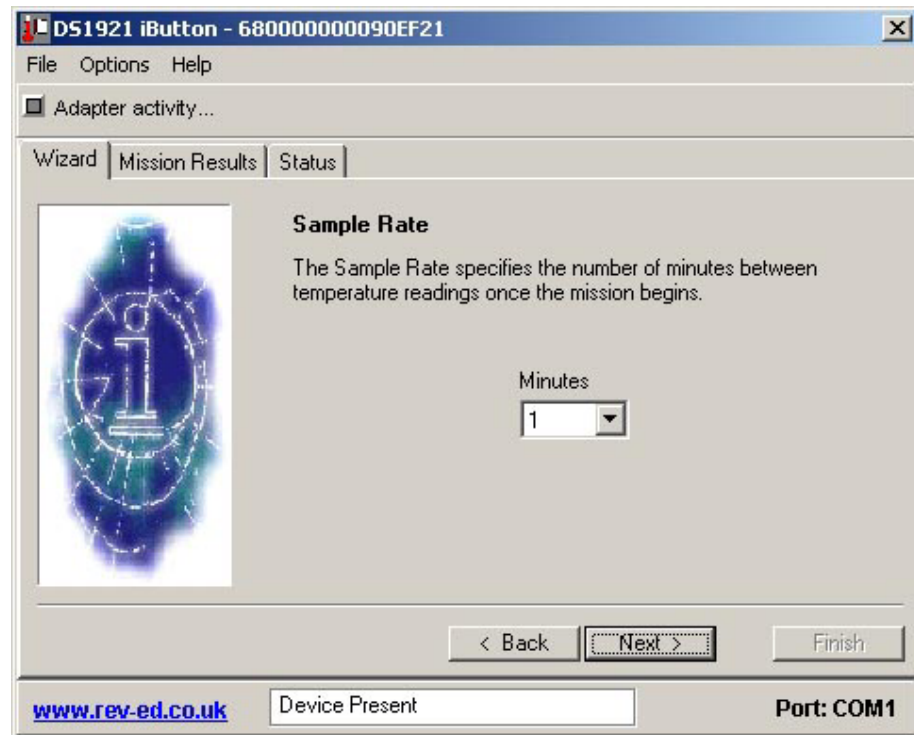
### Mission Start Delay

The iButton can delay a specified number of minutes before it begins taking temperature readings. This feature can be used to prevent needless readings before the target time frame or to space several iButton's at staggered intervals. As a convenience, drop-down boxes are used to select a number of days, hours, and minutes. The total minutes and approximate start time is displayed. The iButton has a maximum start delay of 65536 minutes or about 45.5 days. The drop-down boxes allow a maximum selection of 44 days, 23 hours, and 59 minutes giving a total of 64799 minutes.



### Sample Rate

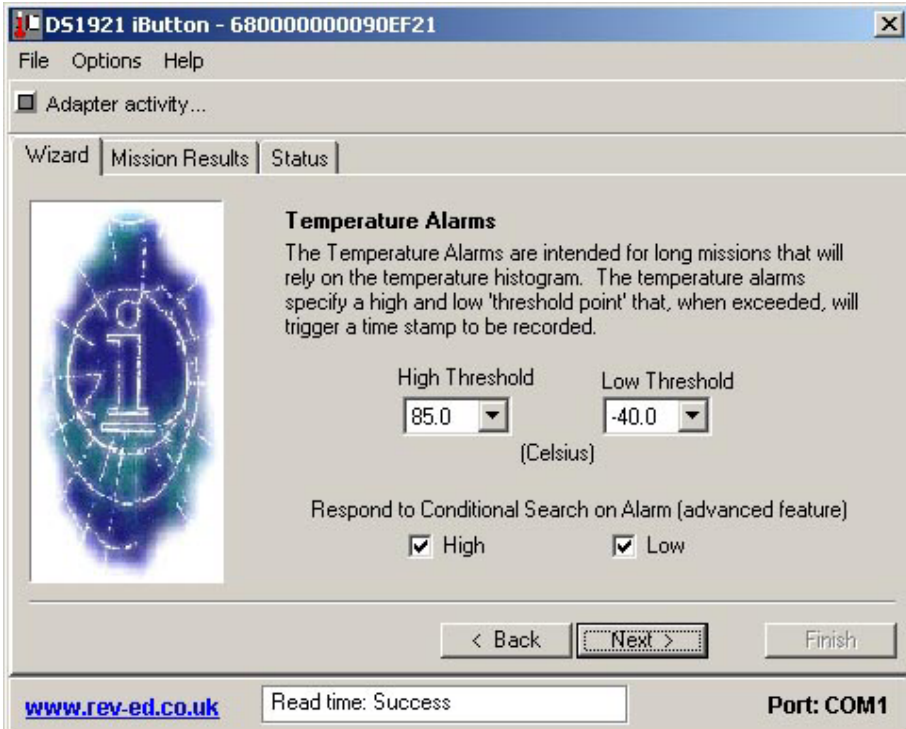
The Sample Rate specifies the number of minutes between each temperature reading. The iButton can store 2048 time stamped temperature readings. Setting the sample rate will affect how long it takes for the memory to fill up or optionally rollover. The sampling rate can be from 1 to 255 minutes.



## Temperature Alarms

Certain temperature extreme readings can be tracked by the iButton even after the 2048 time-stamped temperature readings have already been done. The start and duration of the violation of temperature bounds is recorded. The maximum duration for each event is 255 readings. The device can accommodate 12 separate high events and 12 low events.

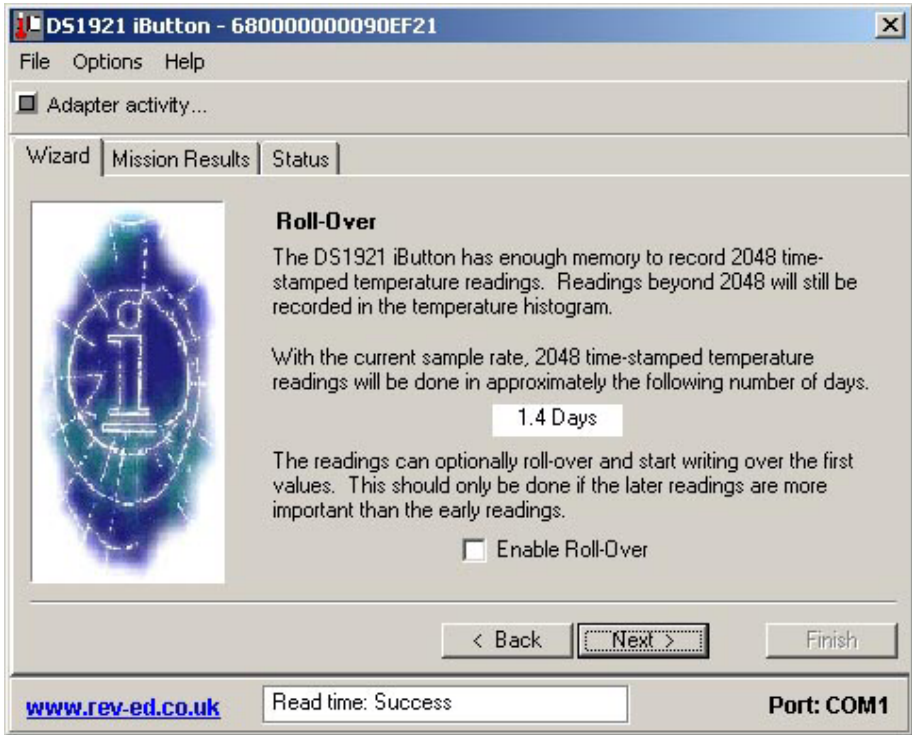
The check box at the bottom selects whether device responds to a conditional search when a High or Low temperature alarm occurs. This is an advanced feature not required with most Datalogging experiments.



The screenshot shows a software window titled "DS1921 iButton - 68000000090EF21". The window has a menu bar with "File", "Options", and "Help". Below the menu bar is a section for "Adapter activity...". The main area is divided into tabs: "Wizard", "Mission Results", and "Status". The "Wizard" tab is active, displaying the "Temperature Alarms" configuration screen. On the left is a blue and green glowing iButton icon. The text reads: "The Temperature Alarms are intended for long missions that will rely on the temperature histogram. The temperature alarms specify a high and low 'threshold point' that, when exceeded, will trigger a time stamp to be recorded." Below this, there are two input fields: "High Threshold" set to "85.0" and "Low Threshold" set to "-40.0", with "(Celsius)" centered below them. Underneath, the text "Respond to Conditional Search on Alarm (advanced feature)" is followed by two checked checkboxes: "High" and "Low". At the bottom of the wizard are three buttons: "< Back", "Next >" (highlighted), and "Finish". The footer of the window contains the URL "www.rev-ed.co.uk", a "Read time: Success" status box, and "Port: COM1".

**Roll-Over**

There is a maximum of 2048 time-stamped temperature readings. This Wizard panel indicates the amount of time it will take to fill up this memory, depending on the sample rate. The behaviour of the iButton can optionally be set to begin overwriting the early readings when the memory is filled. If this sample period is too small, use the '< BACK' button to go back to the sample rate selection and picks lower sample rate. Note that any readings beyond 2048 are still recorded in the histogram data.

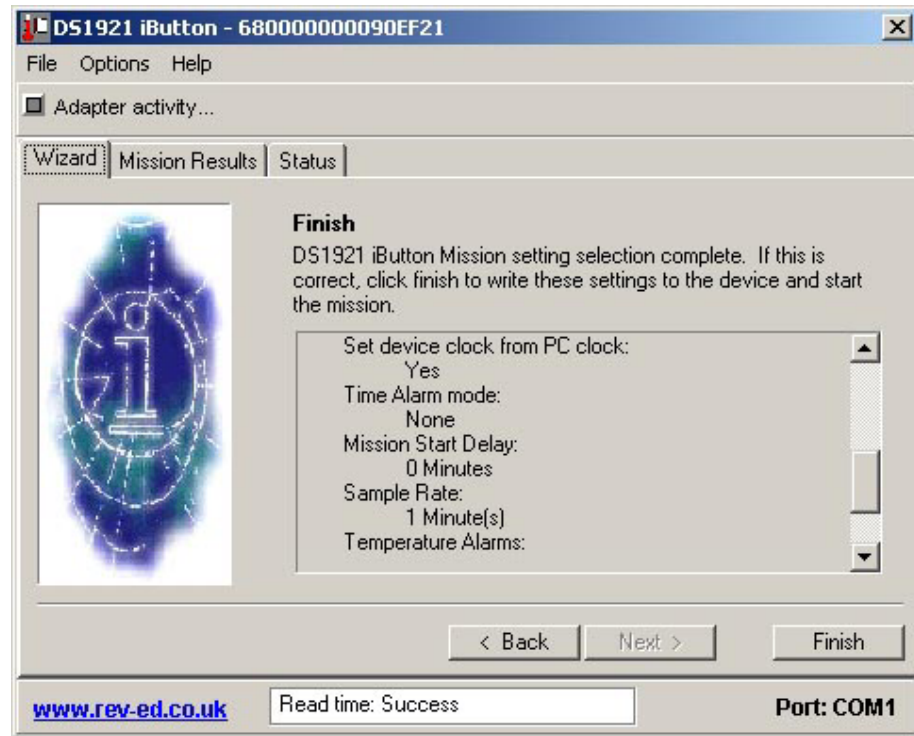




### Finish

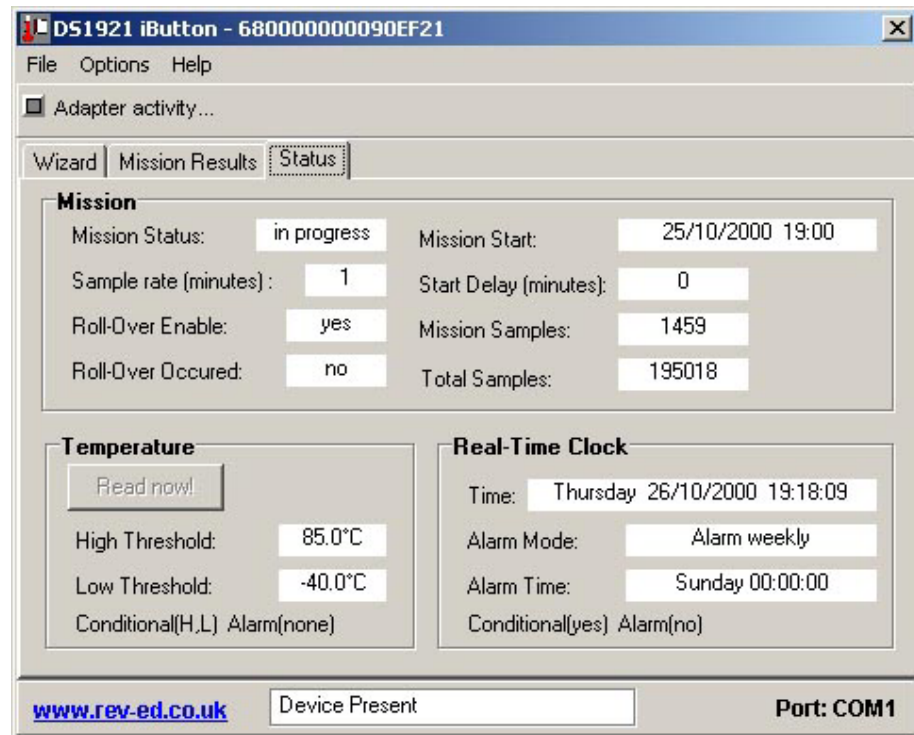
The final panel of the Wizard displays all of the options selected. If any of these settings is not desired, use the '< BACK' button to revisit the different options. The box at the bottom of the panel may not be able to display all of the options. Use the scroll bar to view all of the options. When satisfied, click on the 'FINISH' button.

The mission settings will then be written to the DS1921 and the mission will begin. To show the state of the new mission, the viewer will automatically switch to the 'STATUS' tab.



## Status Display

The Status Tab displays the current iButton status. If an old data file is being viewed offline the status is the condition of the iButton when the data file was saved.



### Mission Status

The Mission Status will indicate 'in progress' if a mission is currently running. It will display 'ended' if there is no mission.

### Mission Start

The Mission Start is the date/time stamp of the beginning of temperature readings. Note that this is the start time after the start delay has expired and the first reading has been taken. While the start delay is counting down the Mission Start will be displayed as 'not started yet'. The mission start is displayed in 24-hour format.

### Roll-Over Enabled

Roll-Over Enabled will say 'yes' if the device has been missioned to overwrite early readings after the 2048 time-stamped readings have been done. It will say 'no' if roll over is not enabled.

### Mission Samples

The Mission Samples indicates the number of temperature samples that have been taken during the current mission.

### Roll-Over Occurred

Roll-Over Occurred will say 'n/a' for not-applicable if roll-over is not enabled. If roll-over is enabled, then this box will display 'yes' if more than 2048 readings have been made, or 'no' if the number of readings is less than 2048.

**Total Samples**

Total Samples indicates the total number of temperature samples that have been taken on the device.

**Read Now!**

If there is no current mission, the Read Now! button is enabled. Clicking this button instructs the iButton to read the current temperature. The temperature will be displayed to the right of the button after a few seconds. The Force Read button is disabled if a mission is currently running.

**High Threshold**

High Threshold indicates the upper bound temperature maximum. If during a mission the temperature reading goes above this value, an alarm event will occur and the time and duration of this event will be recorded.

**Low Threshold**

Low Threshold indicates the lower bound temperature minimum. If during a mission the temperature reading goes below this value, an alarm event will occur and the time and duration of this event will be recorded.

**Temperature Threshold Status**

The Temperature Status statement below the 'Low Threshold' will indicate the settings and the state of the temperature threshold violations. There are two parts to the statement: 'Conditional' and 'Alarm'. The 'Conditional' part indicates the settings for the device to respond to a conditional search on an alarm condition. A value of (H,L) indicates both High and Low thresholds will enable a conditional search response. 'H' indicates High threshold is used and 'L' the Low threshold. 'none' indicates that neither of the thresholds will cause a response to a conditional search. In the same manner, the 'Alarm (H,L)' indicates if there is currently an alarm condition with either threshold.

**Time**

Time displays the current real-time-clock value from the iButton. This value is updated every 3 seconds, except during the download of the mission results. It is displayed in 24-hour format.

**Alarm Mode**

The Alarm Mode indicates the period at which the time alarm can occur. The possible alarm modes are: 'Alarm weekly', 'Alarm daily', 'Alarm hourly', 'Alarm minutely', and 'Alarm every second'. If no alarm mode was selected in the Wizard then the default mode is 'Alarm weekly'.

**Alarm Time**

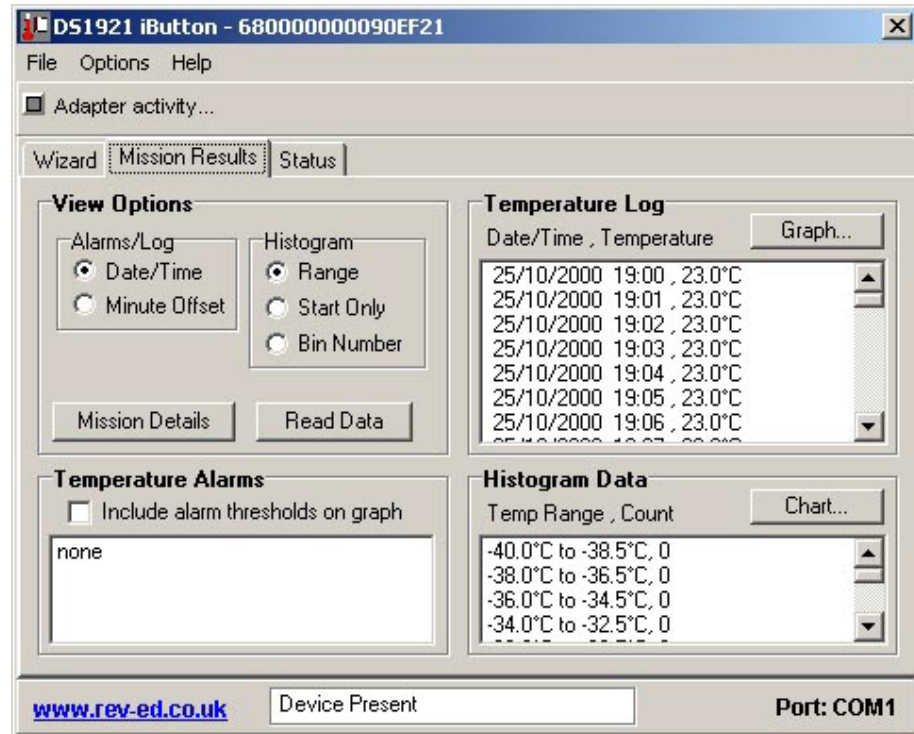
The Alarm Time will indicate the relevant time in the alarm mode when the time alarm will occur. The format of this will depend on the alarm mode.

**Alarm Time Status**

The Alarm Time Status below the 'Alarm Time' will indicate the settings and the state of the conditional search on a time alarm. There are two parts to the statement: 'Conditional' and 'Alarm'. The 'Conditional' part indicates the settings for the device to respond to a conditional search on an alarm condition. A value of (yes) indicates the device will respond to a conditional search on an alarm event. (no) indicates that it will not respond to a conditional search. In the same manner, the 'Alarm (yes)' part indicates in the same format if there is currently a time alarm condition.

## Mission Results

The Mission Results tab displays the temperature reading results from the current or last mission. The mission results are automatically downloaded when the datalogger software is started if there is a mission running. If the mission has been ended, then results can still be downloaded using the 'Read Data' button. The 'Read Data' button can also be used to refresh the result contents if the device has been connected long enough for a mission reading to take place.



### View Options

The View Options modify how the temperature reading results are displayed. The 'Alarms/Log' radio control selects displaying a true time/data or a minute offset from the beginning of the mission. This option affects the Log and Temperature alarms results.

The 'Histogram' radio control selects the histogram display options. The 'Range' option shows a temperature range for each bin in the histogram. 'Start Only' displays only the starting value for each bin. 'Bin Number' displays a number 0 to 55 to indicate the bin number.

The View options will be used in the full reports, CSV file exports and graphs.

**Mission Details**

The 'Mission Details' button provides the user information stored within the iButton user memory.

**Read Data**

The 'Read Data' button will force the viewer to re-read the mission results. This can be used to refresh the result data if a mission is currently running and it has made new measurements.

**Log**

The Log displays the time-stamped temperature readings in a listbox. The format for the entries is displayed above the listbox (see View Options). The 'Graph' button in the Log box will display a line graph of the data collected. The line graph will also show the alarm limits if the 'Include thresholds on graph' option is checked.

To pan the graph use the mouse to click and drag the image. To zoom in and out right click the mouse (or use the 'Zoom' menu). The window can also be resized to ease viewing of the data.

By using the menu options the graph can be printed, copied to the clipboard, or saved as a Windows enhanced meta file (emf) graphic file for importation into other applications (e.g. Microsoft Word).

**Temperature Alarms**

The Temperature Alarms box displays the temperature alarm events. An alarm event is created when the temperature read during a mission goes outside the specified thresholds. There can be up to 12 high and 12 low alarm events. Each event lists the event type (High, Low) and the start and end time. A time/date stamp or minute offset will represent the time range depending on the view options.

The 'Log' line graph will show the alarm limits if the 'Include thresholds on graph' option is checked.

**Histogram**

The Histogram box displays the temperature history as defined by 56 bins. Each bin represents a temperature range. When a temperature reading is made, the associated bin is incremented. Each bin can hold up to 65536 readings. The 56 bins are listed in a listbox in the format specified by the view options. The 'Chart' button displays the bar graph of the histogram data. The labels on the bar graph are in the format specified by the view options.

To pan the graph use the mouse to click and drag the image. To zoom in and out right click the mouse (or use the 'Zoom' menu). The window can also be resized to ease viewing of the data.

By using the menu options the graph can be printed, copied to the clipboard, or saved as a Windows enhanced meta file (emf) graphic file for importation into other applications (e.g. Microsoft Word).