



The Actiwatch User Manual

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This manual is designed to be read in conjunction with
'The Actiwatch Guide to Getting Started'

Regulatory Information - CE Notice (European Union)

Actiwatch - Medical Device Information:

The Actiwatch is a Class I Medical Device conforming to the essential safety & health requirements and provisions of EC Council Directives 93/42/EEC, Annex I and VII.

Manufacturer:

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Applicable Standards:

E60601-1:2001	Medical electrical equipment – General requirements for safety.
E60601-1-2:2002	Medical electrical equipment – Part 1-2: General requirements for safety – Collateral standard: Electromagnetic compatibility – Requirements and tests. Group 1 equipment / Class B – (emissions only)
E60601-1-2:2002	Medical electrical equipment – Part 1-2: General requirements for safety – Collateral standard: Electromagnetic compatibility – Requirements and tests. Non life supporting equipment (immunity section only)
E60601-1-4:1997	Medical electrical equipment – Part 1-4: General requirements for safety – Collateral standard: General requirements for programmable electrical medical systems.



Waste Electrical & Electronic Equipment (WEEE) The EU requires, under the Waste Electrical and Electronic Equipment Directive 2002/96/EC, that manufacturers and/or distributors of Electronic and/or Electrical Equipment manage and pay for the collection and further handling of WEEE products, as well as provide WEEE-related information to their customers.

CamNtech has taken the following approach to complying with this Directive:

- CamNtech has registered with an approved producer compliance scheme (PCS) in accordance with the requirements of the WEEE Directive.
- CamNtech will provide free recycling for all of its WEEE products when returned.
- CamNtech WEEE products will be designed with recycling, reuse and waste management as a consideration.
- CamNtech WEEE products will be labeled or stamped with the WEEE marking in accordance with European Standard EN 50419.

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1. Introduction

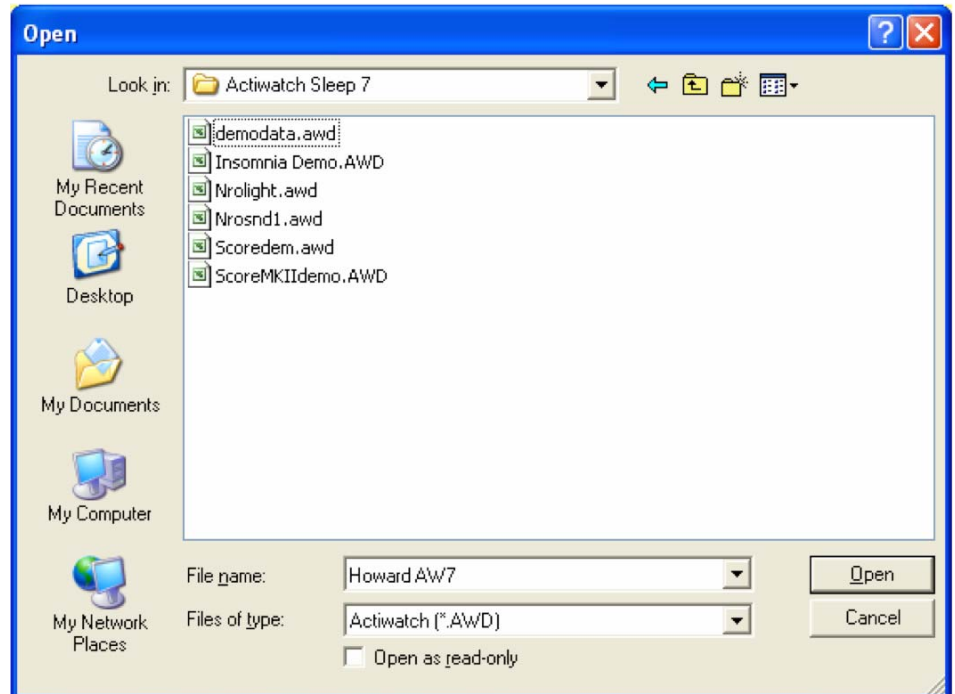
The **Actiwatch User Manual** is designed to be read in conjunction with the **Actiwatch Guide to Getting Started**. Both the **User Manual** and the **Guide to Getting Started** are supplied on the Actiwatch software CD. The **Guide to Getting Started** is also supplied in printed form with each copy of Actiwatch software supplied.

The **Guide to Getting Started** contains all the information required to enable the user to install the Actiwatch software and to setup and download an Actiwatch. It also contains an overview of the Actiwatch range and analysis options. The **Actiwatch User Manual** is a detailed guide to the Actiwatch software and covers the functionality of that software tab by tab.

2. File Menu

2.1 Loading Files

In order to view or analyse an Actiwatch file, the relevant file has to be loaded. Selecting 'File' and then 'Load' brings up the following screen:



This shows all of the available files which can be viewed or analysed. The default file path for storage of Actiwatch files is within the Actiwatch Sleep 5/7 folder. For further details on saving Actiwatch files, please see **Section 2.2**. Clicking on the required file and then selecting 'Open' or double clicking on the required file will load it into the program for analysis.

2.1.1 File types

There are 2 different types of Actiwatch file; Actiwatch AWD files and Actiwatch AWF files. When loading an Actiwatch file ensure that the correct type of file is selected in the 'Files of type' field.

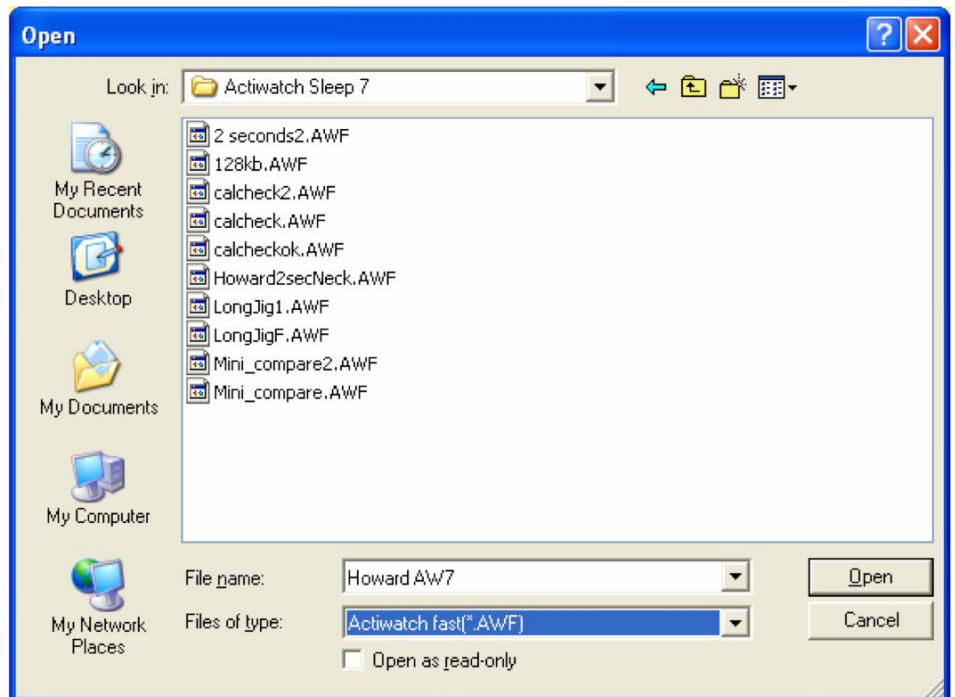
2.1.2 AWD files

Actiwatch data files are saved by default as Actiwatch (.AWD) files. This should not be altered otherwise the files may not be recognised by the Actiwatch software. The only exception to this is if a file has a 2, 5 or 10 second epoch. In this case the user has the option to save these files as AWF files. For full details on AWF files, please see **Section 2.1.3**.

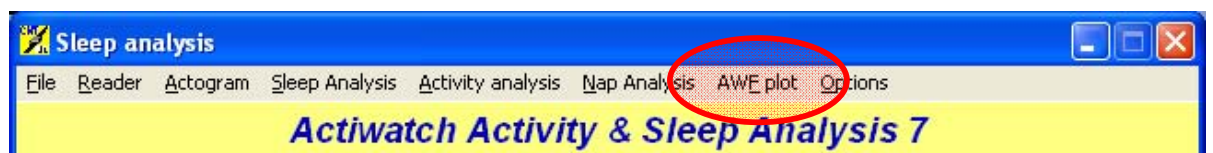
2.1.3 AWF files

When an Actiwatch has been set up with either a 2, 5 or 10 second epoch, it is possible to save the file as either an AWF file or as an AWD file. Full information on AWD files is given in **Section 2.1.2**.

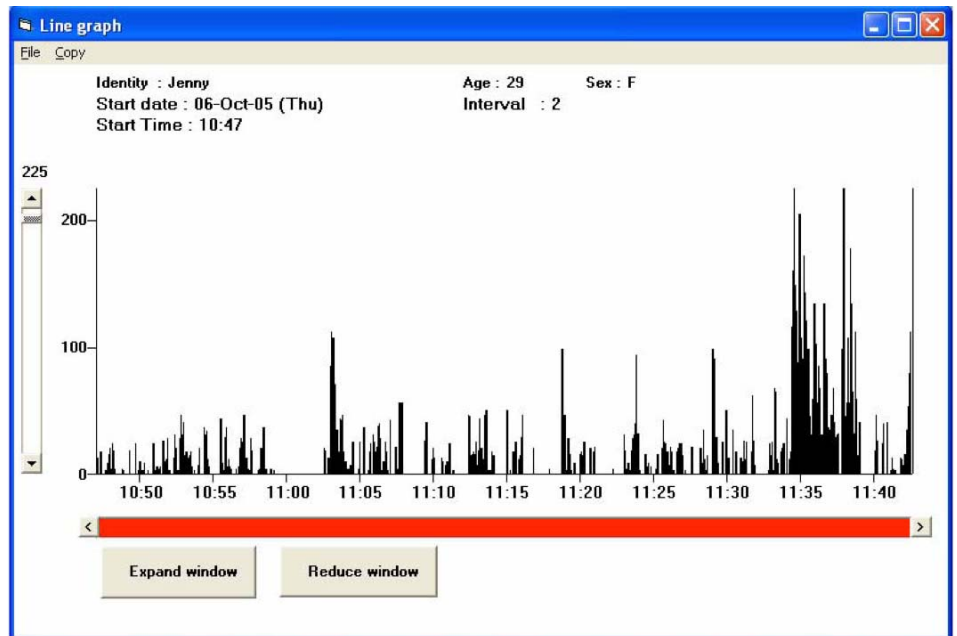
AWF files are high resolution activity data files recorded at either a 2, 5 or 10 second epoch. Selecting 'Open' and then 'Files of type – AWF' will bring up any available AWF files as shown below:



Once an AWF file has been loaded, the main software screen will show a dropdown menu for 'AWF_plot' as shown below:



Selecting 'AWF_plot' brings up the following screen:

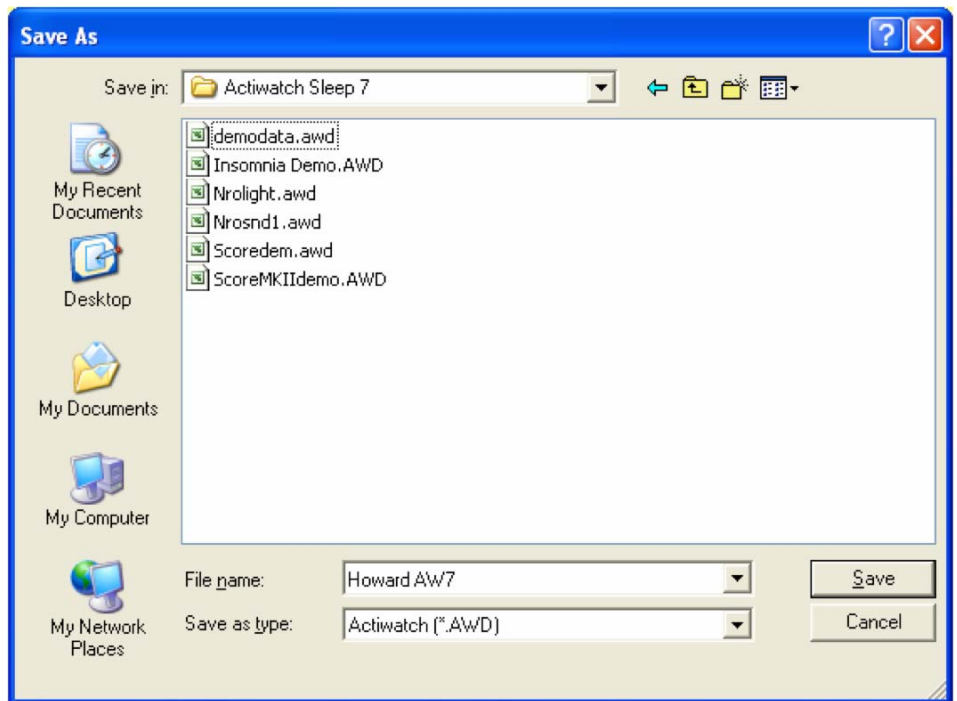


2.1.4 AWF Plot on screen controls

- The 'File' menu allows the user to print the screen shown above
- The 'Copy' menu puts the raw data onto the clipboard for use in a third party program such as Excel
- 'Expand window' allows the user to increase the amount of time viewed i.e. decrease the resolution
- 'Reduce window' allows the user to decrease the amount of time viewed i.e. increase the resolution
- The scale can be altered using the slider to the left of the screen as shown above
- It is possible to scroll through the data either using the scroll bar shown at the bottom of the screen or using the mouse to click and drag on the data

2.2 Saving Files

Clicking on 'File' and then 'Save' brings up the following screen:



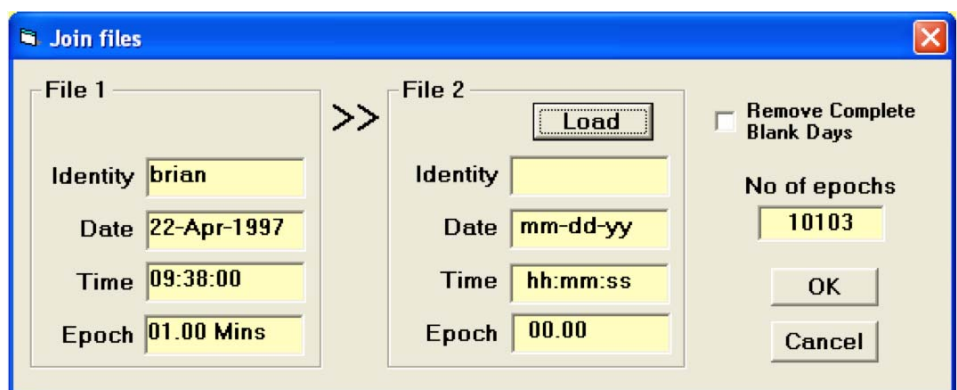
This allows the user to save the file currently loaded with the file name required.

2.3 Join files

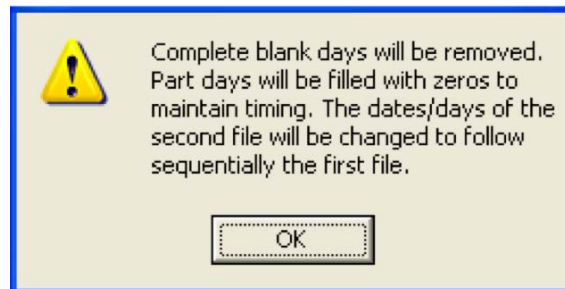
It is possible to join two Actiwatch AWD files together. It is important to note that when joining files, the epoch lengths of the 2 files joined must be the same. Ideally the files should also be from the same Actiwatch.

To join two files it is necessary to follow the following steps:

- Firstly load the earlier of the 2 files to be joined (this must be the file with the earlier date).
- Selecting 'File' and then 'Join files' brings up the following screen:



- Clicking on 'Load' then lists the files available for joining to the previously loaded file.
- Selecting the tick-box 'Remove Complete Blank Days' brings up the following message. When this option is selected, complete blank days are removed and part days are filled with zeros to maintain timing. If this option is selected then the 2 files will be displayed sequentially ignoring the start date of the second file:



- If compatible, the two files will be joined and the following message displayed:



- The new file has then been created and named 'joined.awd'

It is important to note that each time a new joined file is created, it is named 'joined.awd' and the previous joined file is overwritten. To avoid this it is important to re-name joined files as soon as they are created.

2.4 Edit file

Selecting 'File' and then 'Edit file' brings up the following screen:

The screenshot shows a Windows-style dialog box titled "Edit data file". It contains the following elements:

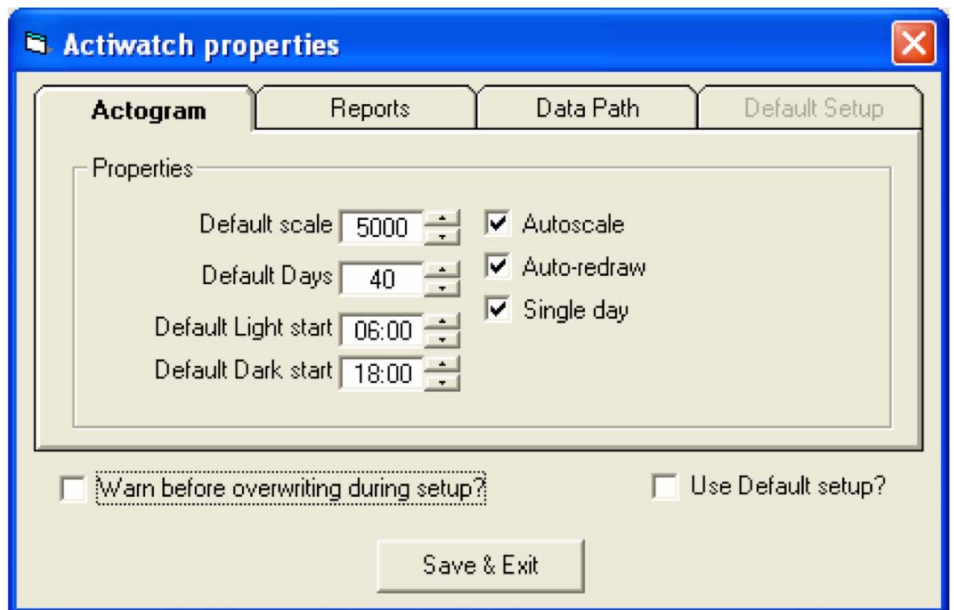
- Day:** A spinner box set to "1".
- Date:** A text box showing "Tue 22-Apr-1997".
- Start:** A time spinner box set to "00:00".
- End:** A time spinner box set to "00:00".
- Replace Activity With:** A checked checkbox. Below it are three radio button options:
 - Zero:** Selected.
 - Day Average:** With a text box containing "141".
 - Fixed Value:** With a text box containing "0".
- Replace Light With:** A checked checkbox. Below it are three radio button options:
 - Zero:** Selected.
 - Day Average:** With a text box containing "120".
 - Fixed Value:** With a text box containing "0".
- Buttons:** "Replace Data" and "Exit" at the bottom.

This allows the user to edit AWD files. The procedure for doing this is as follows:

- Select the day/date of the file to be edited
- Enter the start and end times required (all times are in 24 hour format)
- Select the format to replace the activity data with. This can be one of three things:
 - 1.** Zero
 - 2.** Day average for the selected day
 - 3.** User enterable fixed value
- Click on 'Replace' to replace the value
- Edited files are saved as 'filename (edited).awd' to differentiate them from the original files
- The Actogram for the edited file can now be displayed

2.5 Properties

Selecting 'File' and then 'Properties' brings up the following screen:



2.5.1 Actogram tab

The Actogram tab allows the user to alter the following parameters:

2.5.1.1 Default scale

This is the default scale used when an Actogram is displayed. The software default value is 5000 which is the maximum allowable value.

2.5.1.2 Default Days

This is the number of days shown when an Actogram is displayed. The software default is 40 days and the maximum allowable value is 60.

2.5.1.3 Default Light start

This is the default for the 'lights on' value shown on the left hand side of the Actogram screen. The software default value is 06.00.

2.5.1.4 Default Dark Start

This is the default for the 'lights off' value shown on the left hand side of the Actogram screen. The software default value is 18.00.

2.5.1.5 Warn before overwriting during setup

It is possible to activate a warning which is shown before an Actiwatch is downloaded. By ticking the box 'Warn before overwriting during setup' the following warning message is displayed when an Actiwatch is being downloaded:



Selecting 'Yes' allows the user to proceed with the setup.
Selecting 'No' aborts the setup procedure.

2.5.1.6 Use Default setup

It is possible to specify a default setup for certain parameters by ticking the 'Use default setup' tick box. For further information, please see **Section 2.5.4** on the default setup tab.

2.5.2 Reports tab

The reports tab allows the user to select what information is included on printed reports. This includes the option to include:

- User name – free text field
- Date/Time – selected by tick box
- Watch serial number - selected by tick box
- User name – selected by tick box
- Actiwatch read date – selected by tick box

2.5.3 Data Path tab

The Actiwatch data path tab allows a default data path to be selected for saving Actiwatch files to. The software default path is C:\program files\actiwatch sleep 5. This should only be changed if necessary.

2.5.4 Default Setup tab

It is possible to select certain parameters which appear as default parameters when an Actiwatch is set up. These are:

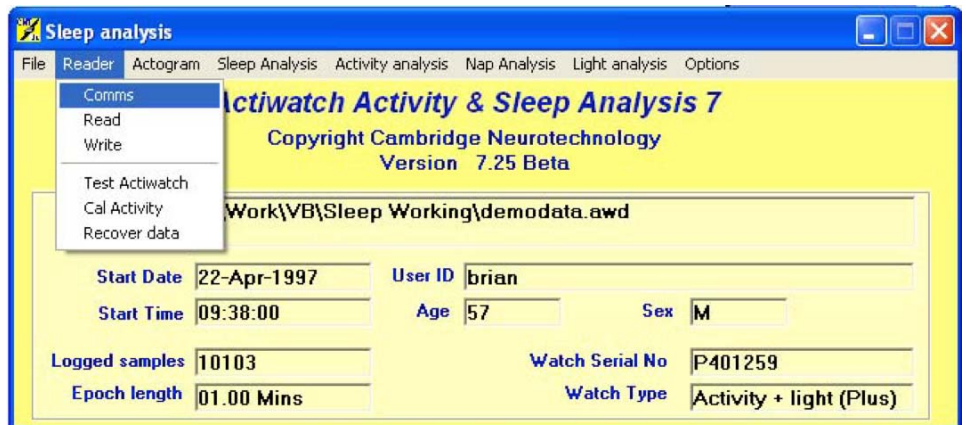
- Epoch
- Start Time
- Gender
- Age

When the 'Use default setup' box is ticked, this tab is accessible and these parameters can be set by the user. When this function is enabled, it is not possible to alter these parameters during the Actiwatch setup procedure.

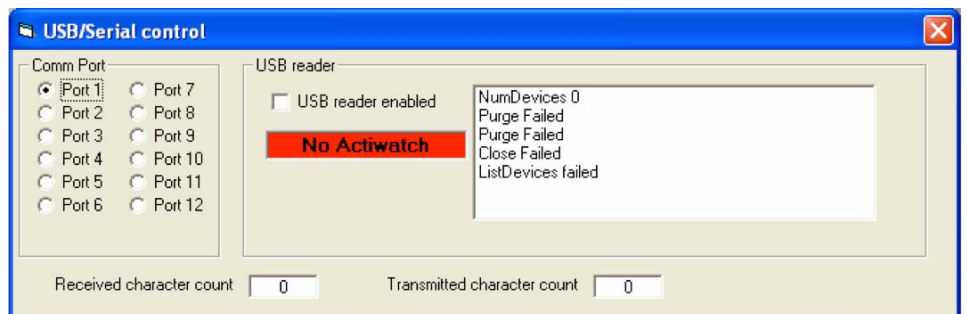
3. Reader Menu

3.1 Comms

Select 'Reader' and then 'Comms' from the main screen:



The following form will be shown:



It is important to ensure that the USB reader is correctly installed before attempting to either set-up or download an Actiwatch. For further information on installing the USB reader, please see **Section 2.7 to 2.10** of the **Actiwatch Guide to Getting Started**.

3.2 Read

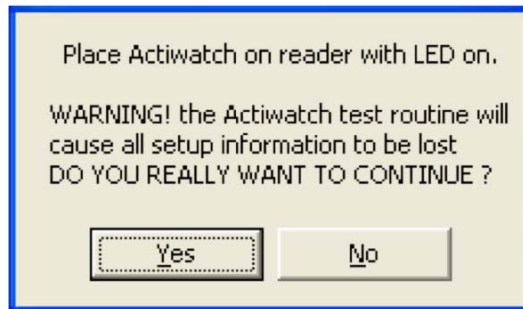
For full details on using the 'Read' function, please see **Section 5** of the **Actiwatch Guide to Getting Started**.

3.3 Write

For full details on using the 'Write' function, please see **Section 3.1** of the **Actiwatch Guide to Getting Started**.

3.4 Test Actiwatch

Selecting 'Reader' and then 'Test Actiwatch' brings up the following message:



This function should normally only be accessed under instruction from CamNtech. If technical support is required, please call +44 (1) 480 831223.

3.5 Cal Activity

The 'Cal Activity' tab is normally an engineering function and should only be used either under instruction from CamNtech or by users familiar with this function. For further information or technical support, please call (+44) 1 480 831223.

3.6 Recover data

Selecting 'Reader' and then 'Recover data' brings up the following screen:

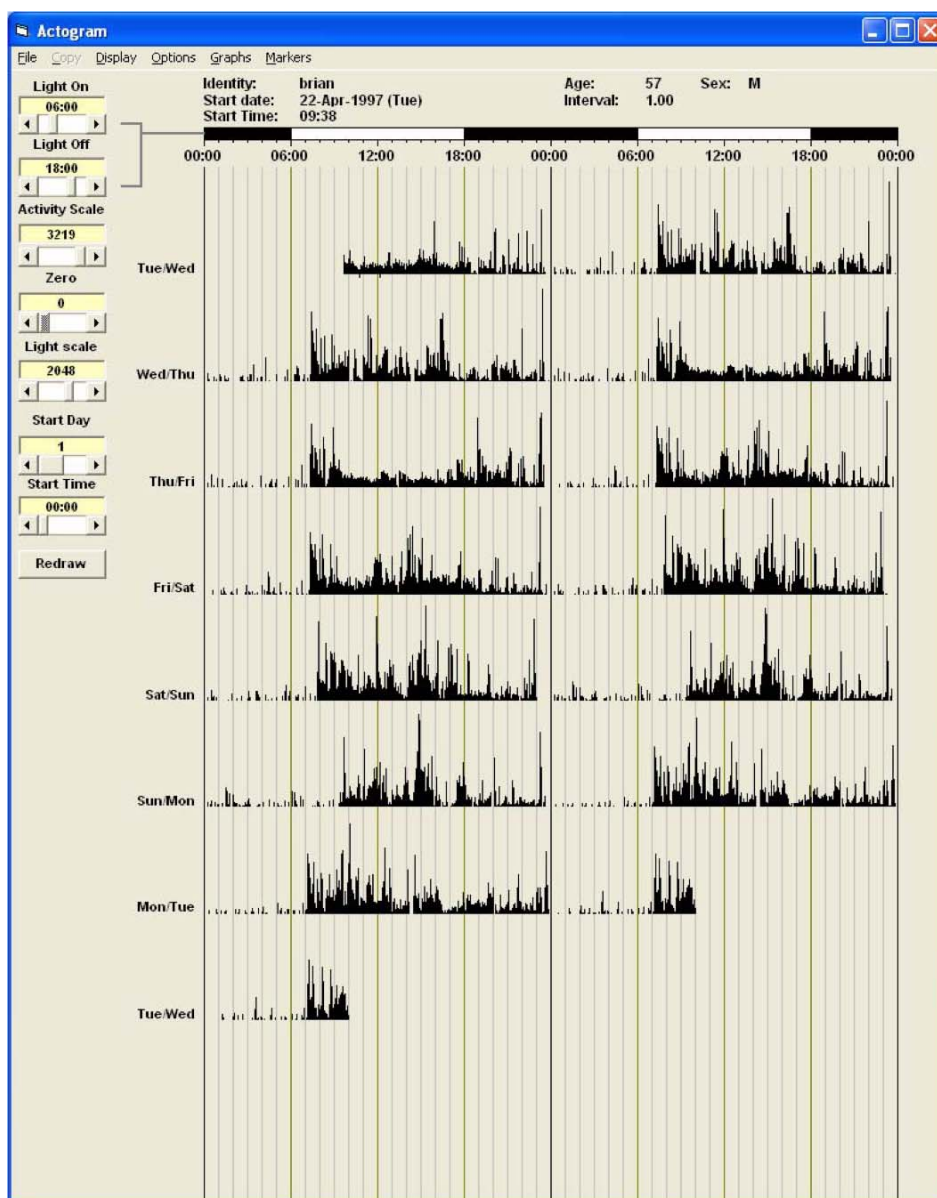


This option should also only be used **under instruction from CamNtech.**

4. Actogram Menu

The Actogram menu allows the user to view a visual display of the activity-rest patterns over the entire length of an experiment. The identity, sex, age, start date, start time and epoch are displayed at the top of the screen. The Actogram can either be shown as a single day or dual day plot. Which of these is shown by default can be selected from the properties menu (see **Section 2.5**). For further information on single and double day plots, please see **Section 4.3.3**.

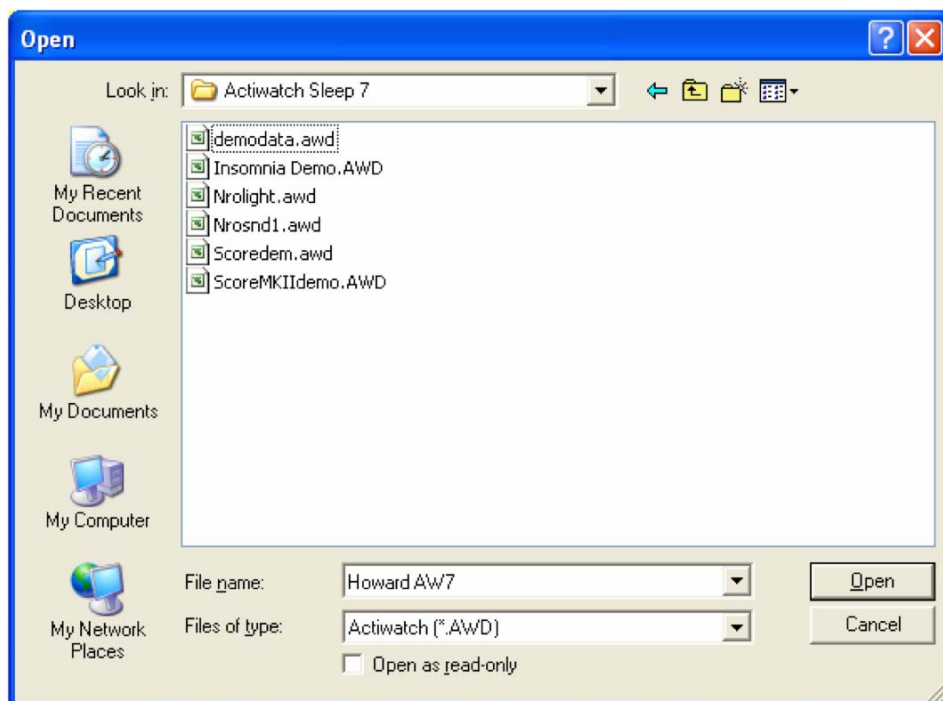
The double day plot Actogram as shown in the example below is particularly useful for the visualisation of data collection over a long time period such as in chronobiological experiments.



4.1 File

4.1.1 Load

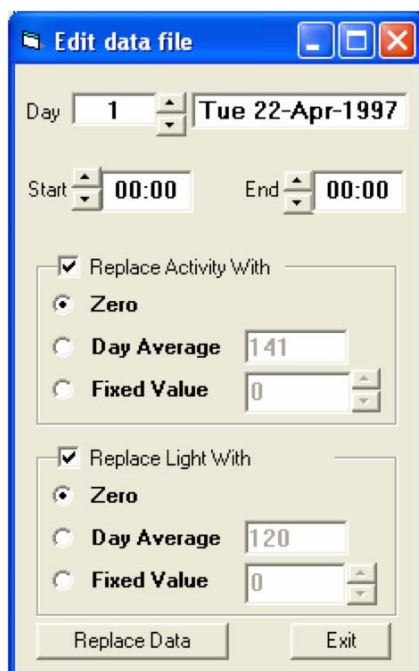
Selecting 'File' and then 'Load' brings up the following screen:



It is then possible to select a file for viewing by double clicking on it.

4.1.2 Edit data

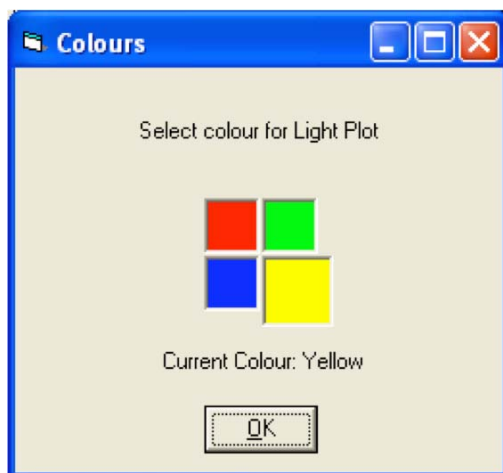
Selecting 'File' and then 'Edit data' brings up the following screen:



It is then possible to edit the Actiwatch data. Full details are given in **Section 2.4**.

4.1.3 Colours

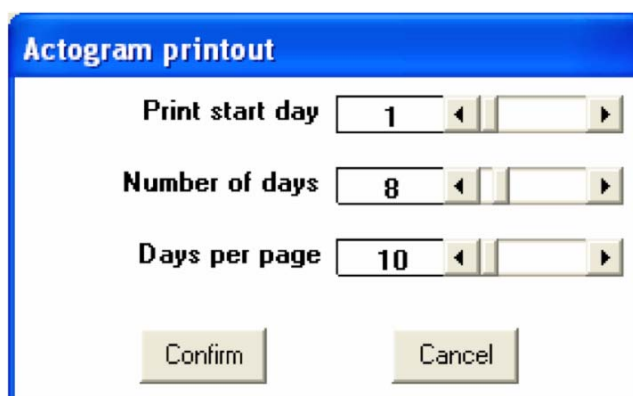
If a light file is displayed, it is possible to change the colour in which the light data is displayed. For full details on using light files, please see **Section 8** on Light Analysis. Selecting 'File' and then 'Colours' brings up the following screen:



The default colour is yellow. Selecting a different colour and clicking on 'OK' will change the colour used to display the light data.

4.1.4 Print

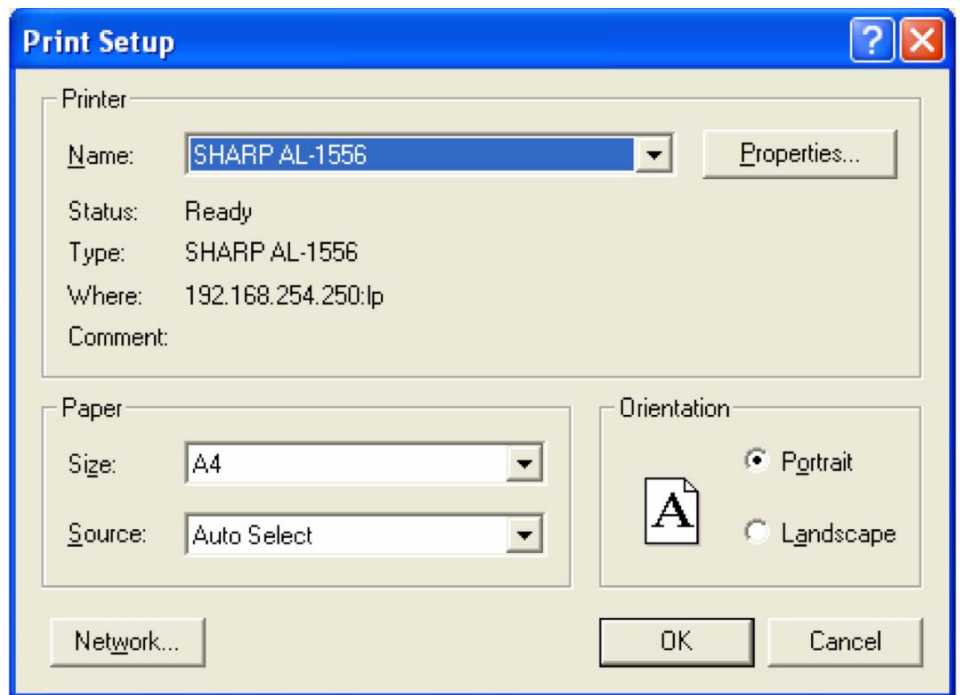
Selecting 'Print' from the file menu brings up the following screen:



This allows the user to specify the parameters to be printed. Correctly setting these parameters and then selecting 'Confirm' will print the selected parameters.

4.1.5 Printer setup

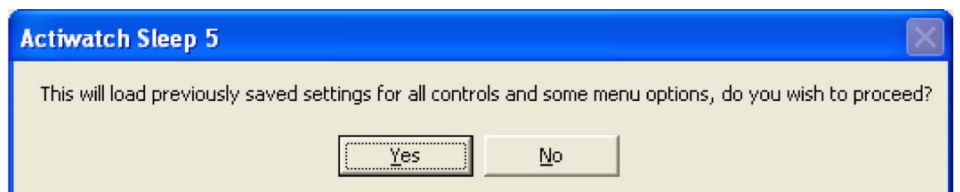
Selecting 'Printer Setup' brings up the following screen:



This allows the user to select which printer is used for printing (if applicable) and to alter the page setup when printing.

4.1.6 Load setup

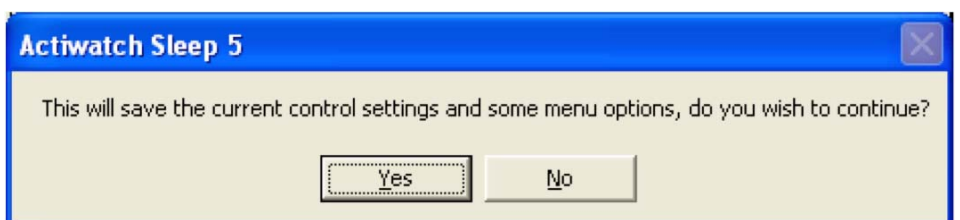
Selecting 'Load setup' brings up the following message:



This function loads previously saved settings for controls and menu options if they have been saved by the user. For a full list of these settings please see **Section 4.1.7**.

4.1.7 Save setup

Selecting 'File' and then 'Save setup' brings up the following screen:

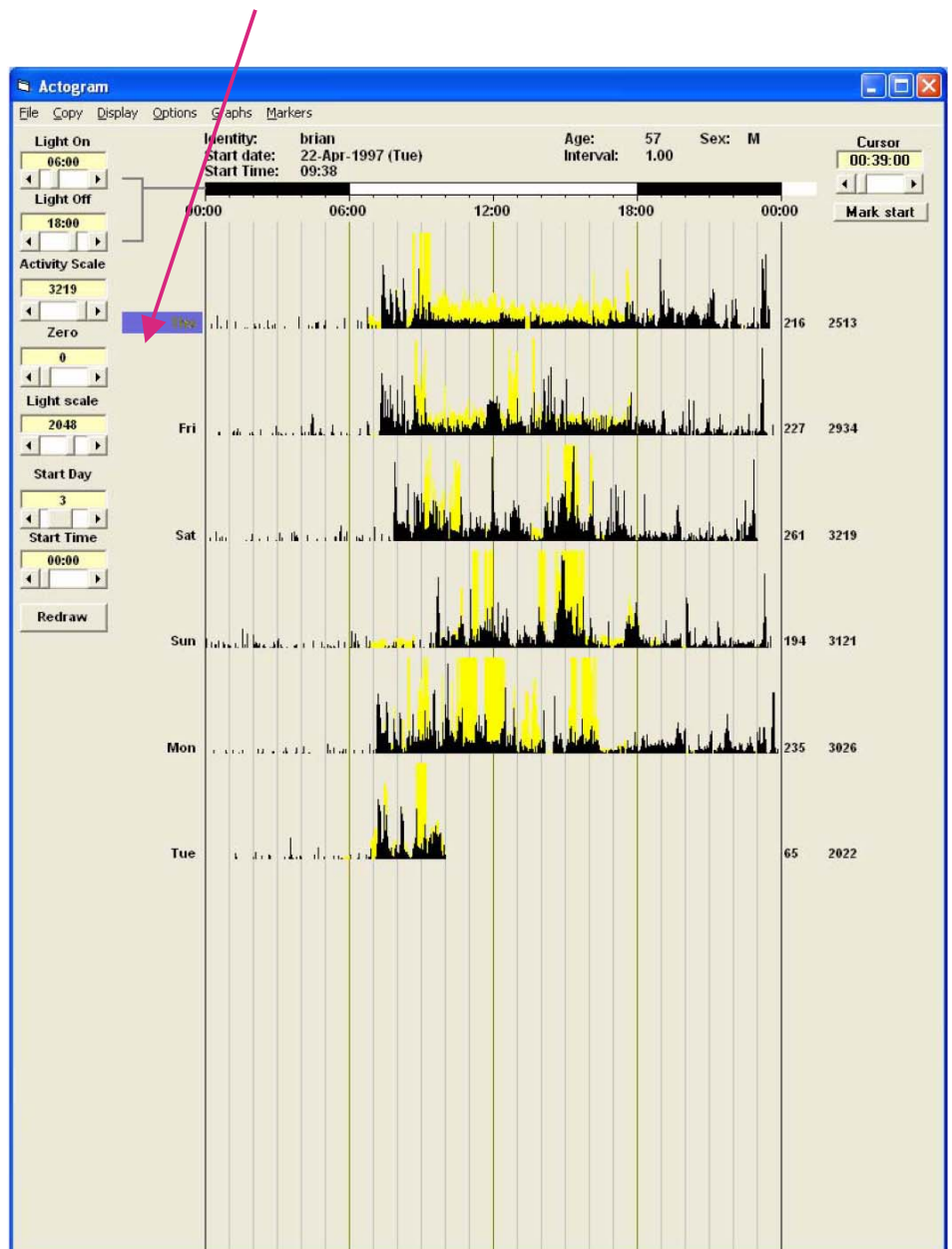


Selecting 'Yes' saves the current control settings defined by the user. The parameters that can be set are as follows:

- Light on
- Light off
- Activity scale
- Zero
- Start day
- Start time
- Time bars (on/off)
- Graticule (on/off)
- Length (20 days/60 days/auto)
- Single day/dual day plot as default
- Day/date displayed as default

It is possible to copy parts of the Actogram either a day at a time or in a block of 7 or 14 days. To do this, click on the Actogram to the left of the required day as shown below:

4.2 Copy



The required day is highlighted in blue. It is then possible to access the 'Copy' menu. Selecting 'Copy' brings up the following options:

- Single day – copies activity data for the selected day to the clipboard
- 7 days – copies activity for the selected day and the following 6 days
- 14 days – copies activity for the selected day and the following 13 days

4.3 Display

4.3.1 Redraw

Selecting 'Redraw' re-displays the Actogram for the file currently loaded. This function is duplicated by a button on the left hand side of the Actogram screen.

4.3.2 Length

Selecting 'Display' and then 'Length' allows the user to select the number of days displayed in the Actogram. The options are:

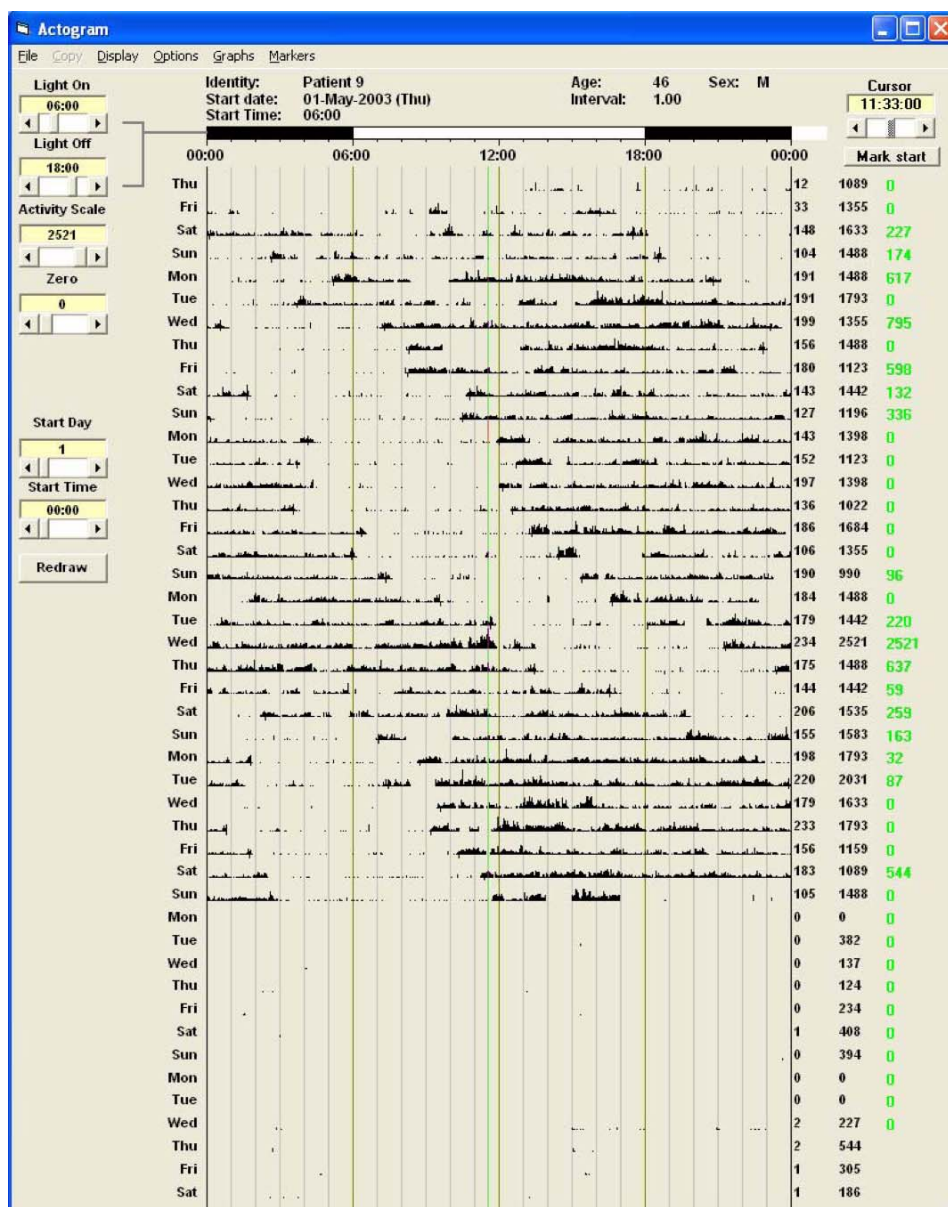
- Auto (this is the factory default setting and is recommended by CamNtech)
- 60 days – allows up to 60 days to be displayed in the Actogram
- 20 days – allows up to 20 days to be displayed in the Actogram

4.3.3 Type

The 'Type' function allows the user to select either a single day display or a dual day display.

4.3.3.1 Single day display

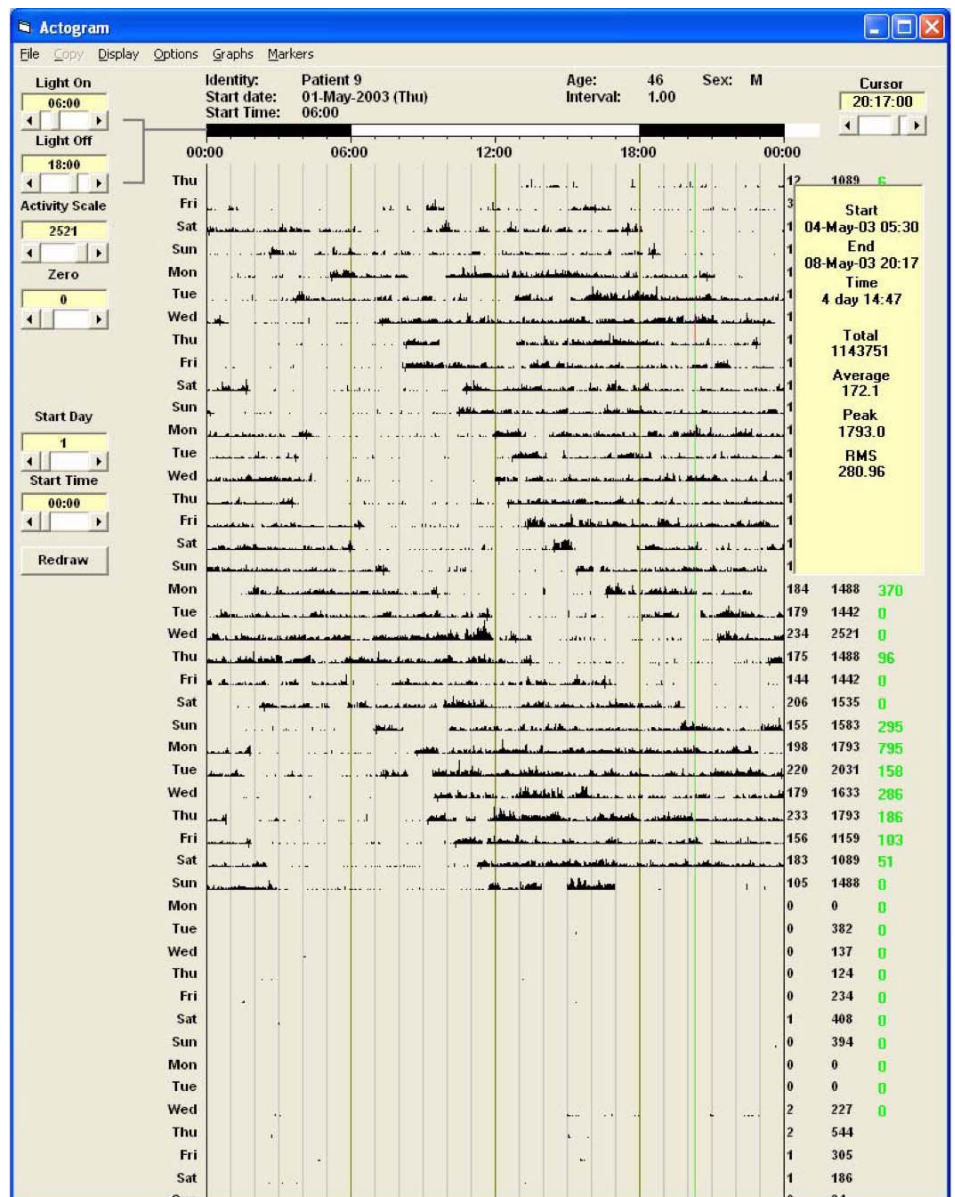
The single day display plots each day on a single line from midnight to midnight. An example of a single day plot is shown overleaf:



The single day display allows the user to look in more detail at specific parts of the data. The following information is available:

- Average activity value per epoch – shown on the right of each day
- Peak activity for each day – shown in the second column to the right of each day
- Activity at a given time each day can also be displayed by clicking on the required time. These are the figures shown in green on the far right hand side of the Actogram screen.

- It is also possible to mark a specific part of the single day plot for more detailed analysis. To do this click on the required start time and select 'Mark start'. Then click on the required end point and select 'Mark end'. This will then bring up the following screen:

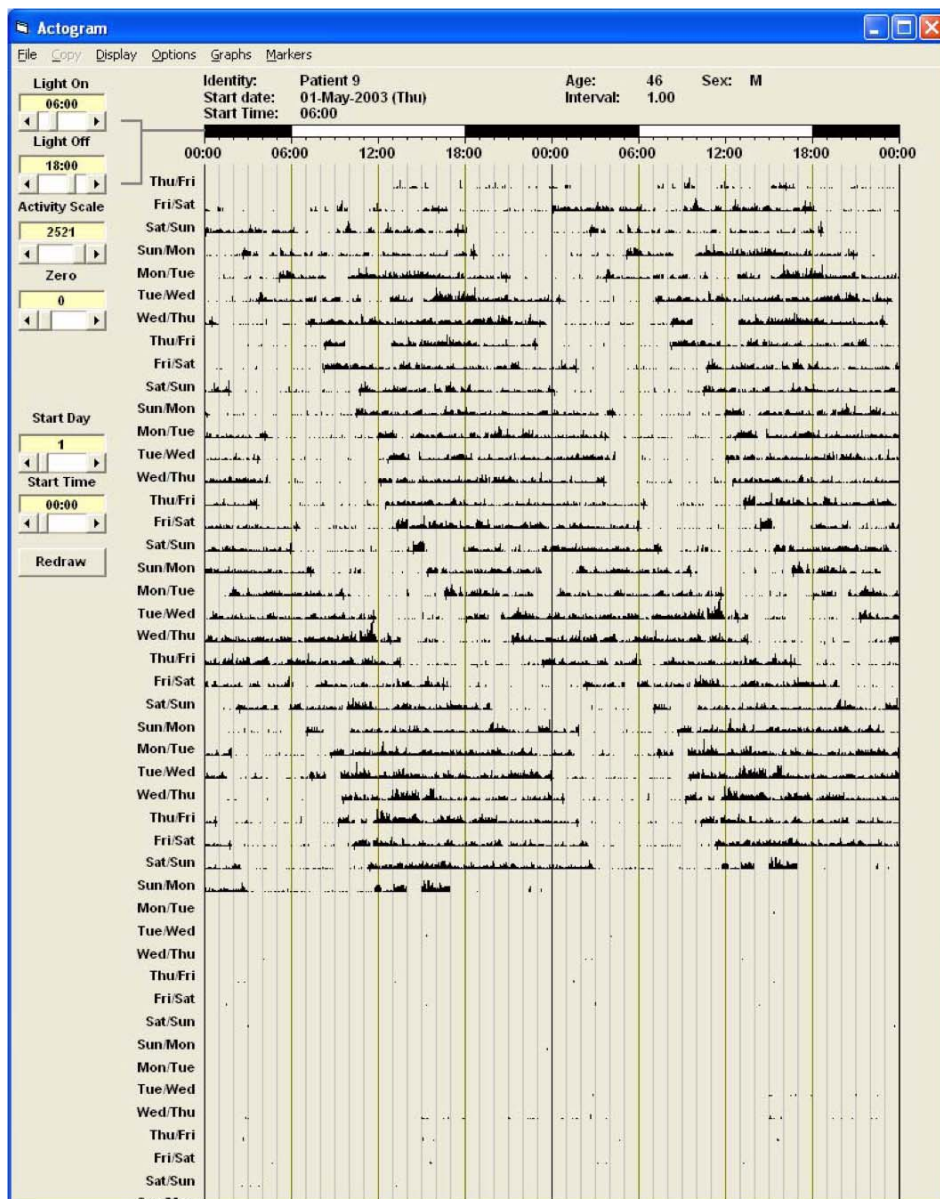


This screen shows the following information:

- Start and end times of the analysis period
- Total time in the analysis period
- Total activity in counts during the analysis period
- Average activity per epoch during the analysis period
- Peak activity (in any epoch) during the analysis period
- RMS (a measure of deviation)

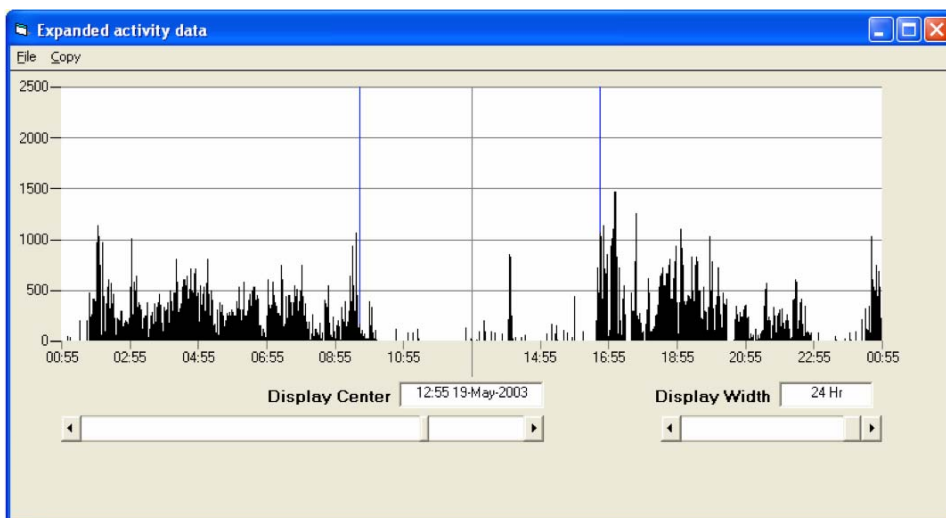
4.3.3.2 Dual day display

As previously mentioned the dual day plot is useful for visually representing longer periods of recording. The example below is the dual day version of the Actogram shown above and shows a clear circadian rhythm shift:



4.3.3.3 Expanded activity display

It is possible to expand a certain part of the Actogram display by double clicking on it. This brings up a screen like the following example:



It is possible to alter the following parameters and perform the following functions:

- Display centre (marked by the central line above)
- Display width (defaults to 24 hours but adjustable between 24 hours and 5 minutes)
- Selecting 'File' and then 'Print' allows the user to print the expanded data
- Selecting 'Copy' copies the data from the expanded display window to the clipboard for use in a third party program such as Excel.

4.3.4 Day

Selecting 'Display' and then 'Day' allows the user to select either the day of the week or the date to be shown on the left hand side of the Actogram.

4.3.5 Activity

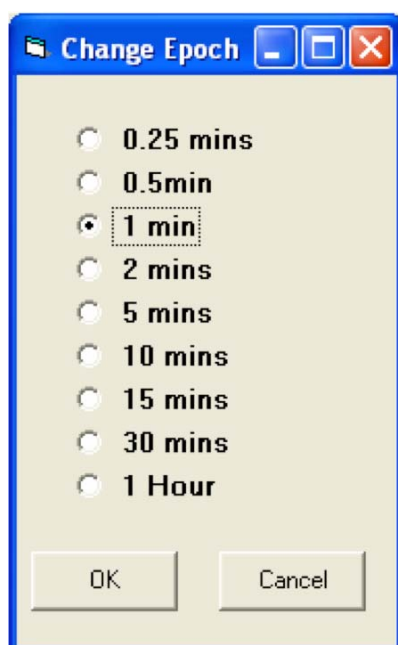
If a light file is loaded then the option to turn off the activity data and only view the light data will be available by clicking on 'Activity' in the 'Display' tab.

4.3.6 Light

If a light file is loaded then the option to turn off the light data and only view the activity data will be available by clicking on 'Light' in the 'Display' tab.

4.3.7 Change Epoch

Selecting 'Change Epoch' brings up the following screen:



It is possible to change the post hoc analysis epoch to one greater than that with which the recording was made. For example, it is possible to load a recording made with 1 minute epochs with a 1 hour epoch and in this case 60 one minute epochs would be combined to produce a 1 hour epoch.

Please note that this action should only be performed once as it is not possible to, for example, go from 1 minute to 1 hour and then back to 1 minute. Should this be required, it is necessary to re-load the original file. Changing the analysis epoch does not alter the original data.

4.4 Options

4.4.1 Time bars

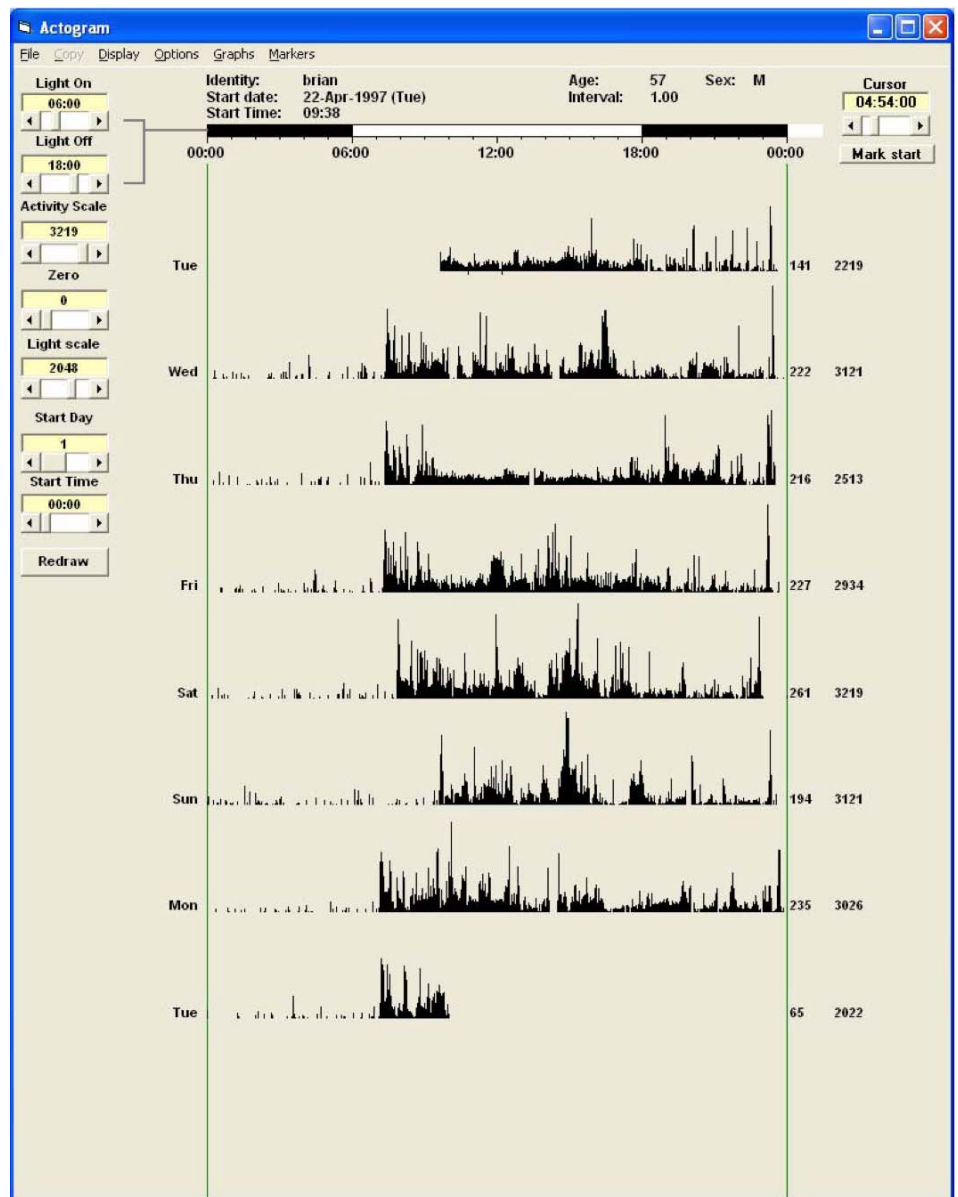
The 'Time bars' function on the 'Options' menu allows the user to select to either view or hide the time bars shown at the top of the Actogram screen.

4.4.2 Tau Line

This option allows a free running rhythm (Tau) value to be calculated from the data loaded, if it is suitable. Select 'Tau Line' then click and drag with the left mouse key to mark the start and end of the Tau line where required (usually activity onset or offset). A value for Tau, which will automatically be updated as the line is moved, will be displayed at the top of the screen. Selecting the 'Redraw' option at the bottom left of the screen will refresh the Actogram and remove the line and the Tau value from the display.

4.4.3 Graticule

By selecting 'Options' and then 'Graticule' the graticule lines on the Actogram can be switched on and off. An example of an Actogram plot with the graticule lines switched off is shown below:

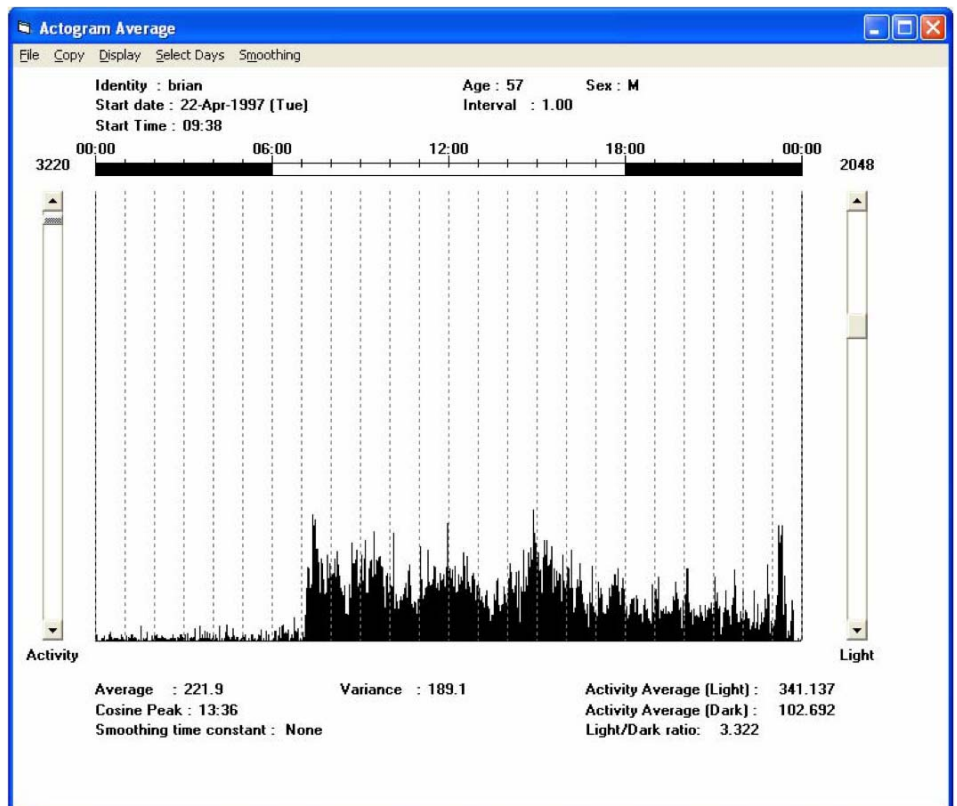


4.5 Graphs

It is possible to graphically represent the activity data in a number of different ways.

4.5.1 Average

Selecting the 'Average' option produces a screen similar to the one shown below:



This is a graphical representation of the average activity in each epoch over all or selected days of the recording. The data can be manipulated in the following ways:

4.5.1.1 Copy

The 'Copy' function allows the user to copy the data in one of three ways:

- Raw average data – copies the raw average data for the selected days of the recording
- Smoothed data – copies the processed data if smoothing has been applied to the raw data
- Statistics – copies a summary of the statistics shown at the bottom of the screen

An example of each type of copied data is shown below:

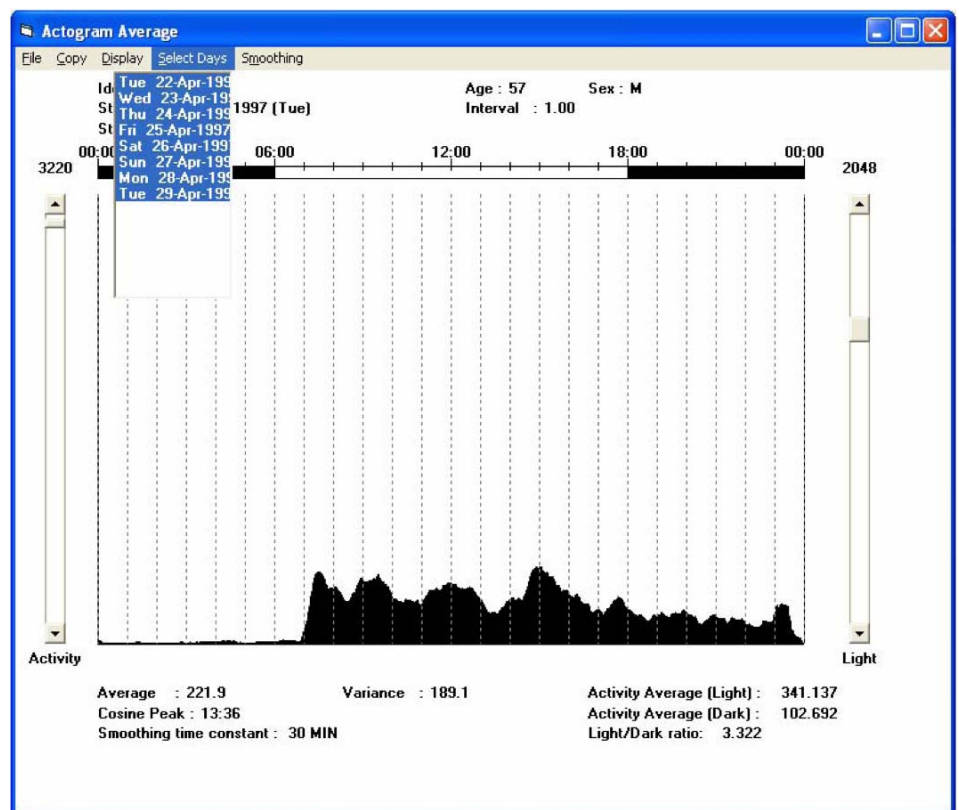
Brian	Raw average		Brian	Smoothed		Brian	Statistics
00:00:00	67		00:00:00	37		Average	221.9
00:01:00	0		00:01:00	35		Deviation	189.1
00:02:00	46		00:02:00	34		Cosine	13:36
00:03:00	0		00:03:00	32		Light Ave.	341.1
00:04:00	0		00:04:00	30		Dark Ave	102.7
00:05:00	1		00:05:00	28		L/D Ratio	3.3

4.5.1.2 Display

If a light file is loaded, then it is possible to select to view just the average activity data or just the average light data.

4.5.1.3 Select Days

Clicking on 'Select Days' brings up the following screen:



This allows the user to select the days for inclusion in the graphical analysis.

4.5.1.4 Smoothing

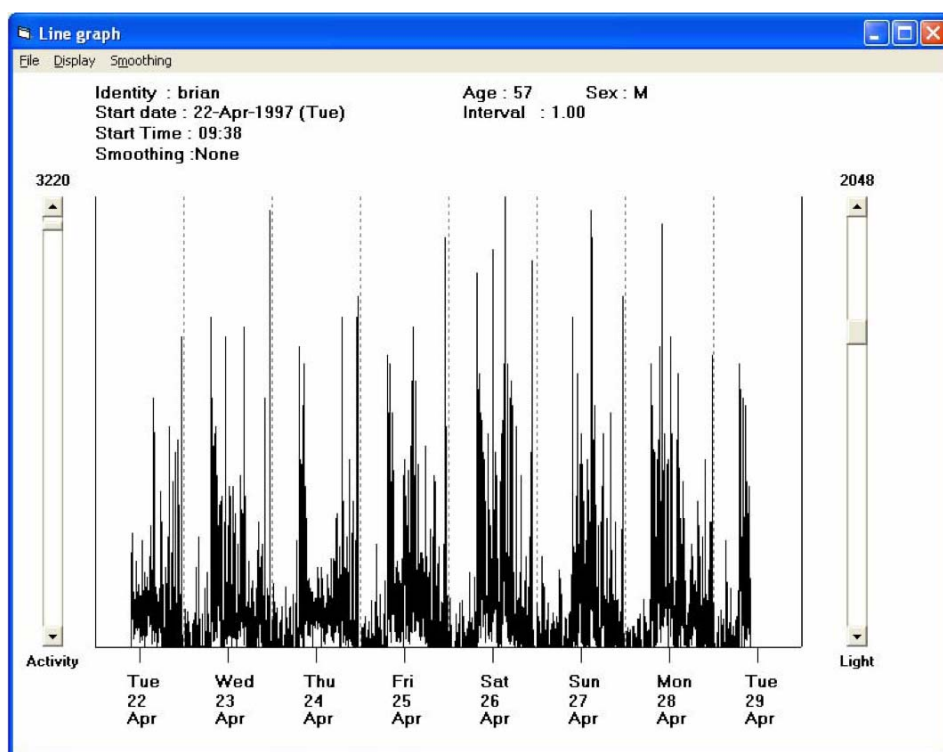
It is possible to smooth the data to better delineate trends. The smoothing factor applied can be between 2 minutes and 1 hour.

4.5.1.5 Scale

It is possible to alter the activity (and light if applicable) scale to best represent the data. This is done by altering the slide bars shown on either side of the screen.

4.5.2 Line

Selecting 'Graphs' and then 'Line' brings up the following screen:



This shows each or selected days of data drawn end to end. It is possible to manipulate the data in the same way as described in the section on average data. Please see **Section 4.5.1** for further details.

4.5.3 FFT

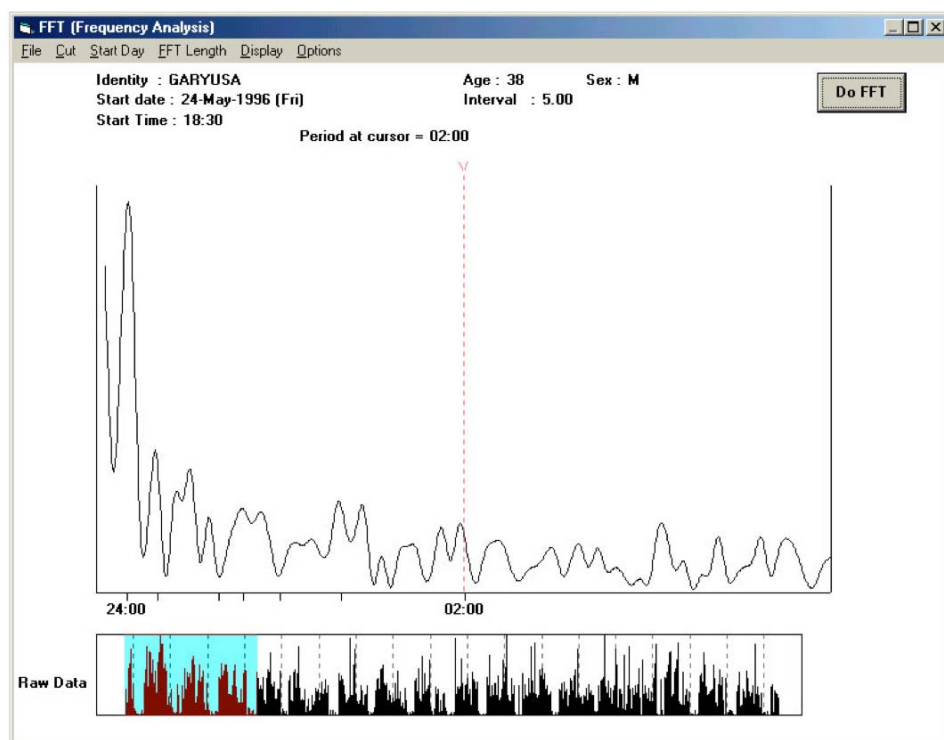
This option provides a plot of the frequency distribution of events for selected data. Select the 'Start Day' for the analysis, (this defaults to the first day of the study). Select the 'FFT Length' from the options displayed and the time base from the 'Display' menu (1 minute to 12hrs). A longer FFT length will provide a more accurate plot. A representation of the data to be analysed is displayed across the bottom of the screen. Click on the 'Do FFT' button to perform the analysis; the plot will be redrawn.

The peaks on the plot show a correlation of the rhythmicity of activity. For example, a 24-hour circadian rhythm will show a strong peak on the FFT plot at 24 hrs.

A cursor line may be placed at any point on the plot by use of the left mouse button. The right mouse button moves the cursor at fixed intervals across the screen. The period at the cursor is displayed above the plot.

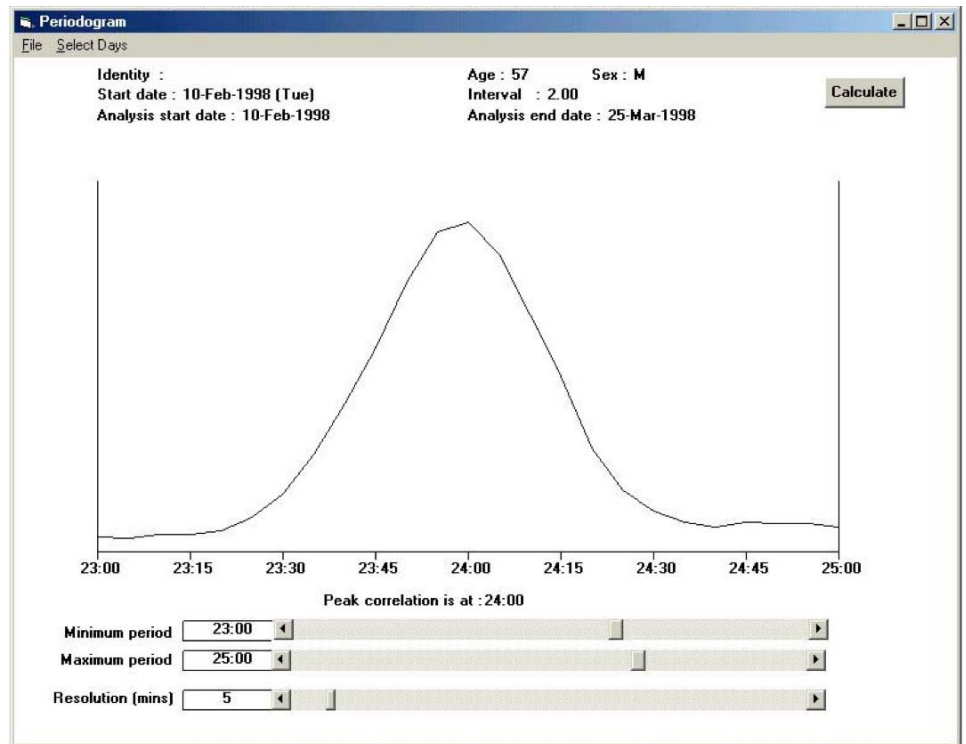
The 'Options' menu allow a Cosine window or cubic spline filtering to be applied to the data to minimise end effects.

An example of the FFT plot is shown below:



4.5.4 Periodogram

This plot allows the user to view the best correlated time period for the data sets loaded. Three scroll bars are provided below the plot that allow the user to set the maximum period, minimum period and the resolution (in minutes). Choose the data to be included in the analysis from the 'Select Days' menu (4 or more consecutive days are required). The Periodogram will be plotted showing a peak and the correlated best fit for the time period displayed. An example is shown overleaf:



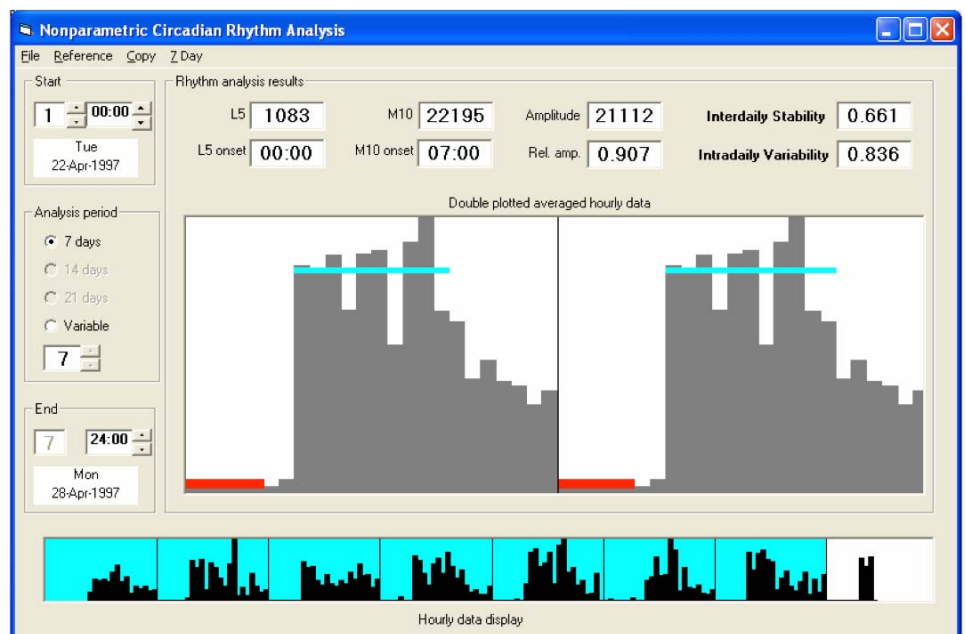
4.5.5 NPCRA

NPCRA (Non-Parametric Circadian Rhythm Analysis) is based on a complex circadian rhythm analysis. The function and reasoning behind what is contained in an NPCRA bulletin is available from CamNtech as an Adobe Acrobat document. To read this file, the host pc will require Adobe Acrobat Reader which can be downloaded free of charge from:

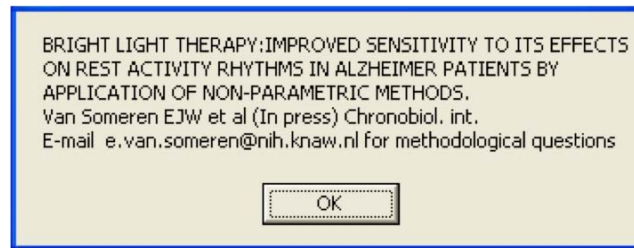
<http://www.adobe.com/uk/>

Please contact admin@camntech.co.uk for a copy of this bulletin.

Selecting 'Graphs' and then 'NPCRA' brings up the following screen:



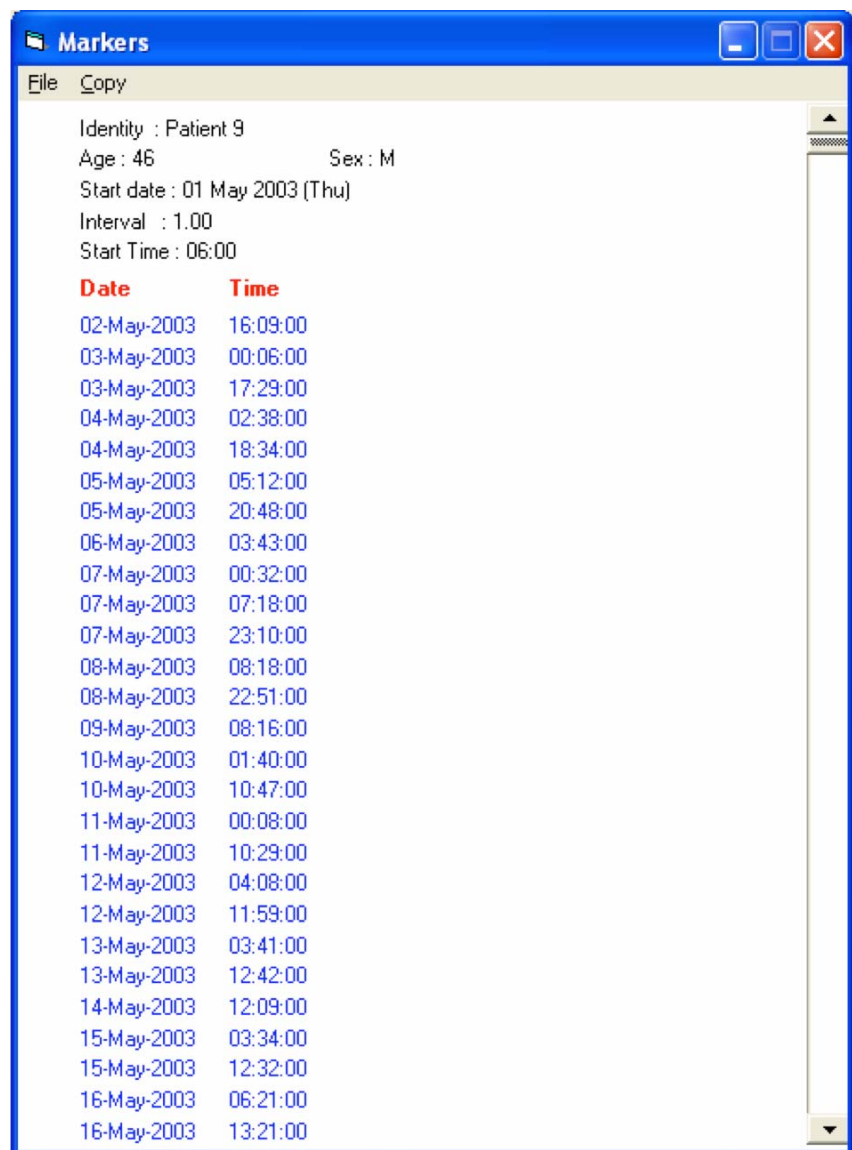
Clicking on 'Reference' brings up the following screen:



This is the reference to the original paper published by Dr Eus Van Someren and contains Dr Van Someren's email address for any methodological queries about this part of the software.

4.6 Markers

Clicking on 'Markers' brings up the following screen:



This shows a list of all the times when the marker button has been pressed by the user. For further information on the Actiwatch maker button, please see **Section 4.2** of the **Actiwatch Guide to Getting Started**.

4.7 Actogram on screen controls

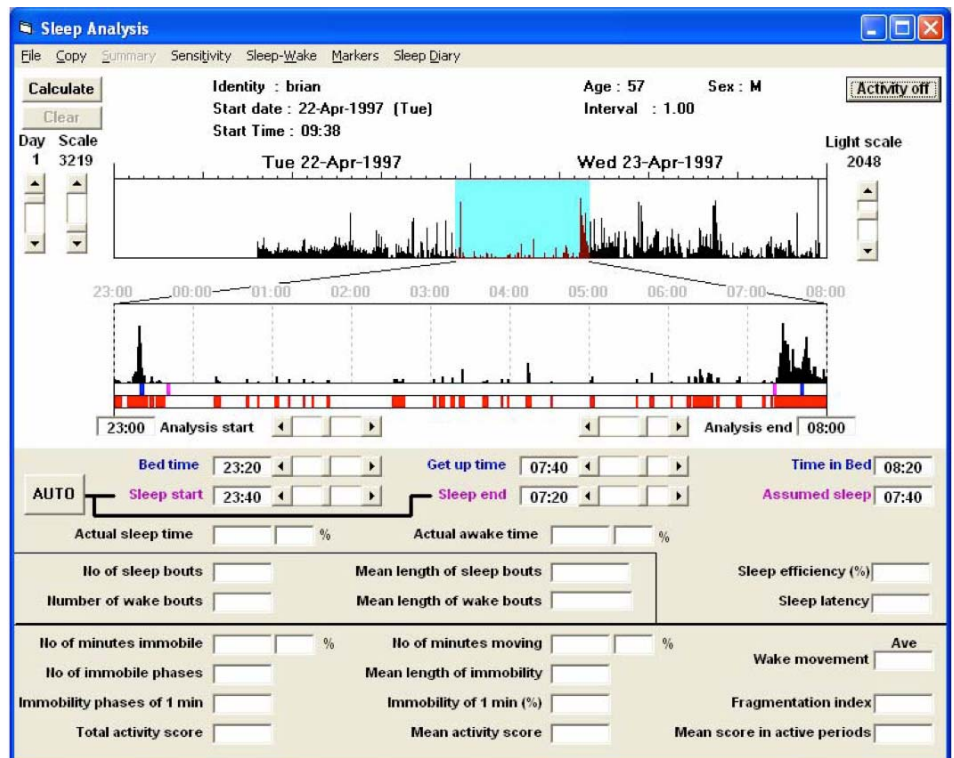
- **Light on** - used in the calculation of light and dark average activity (average graph)
- **Light off** - used in the calculation of light and dark average activity (average graph)
- **Activity scale** – automatically set by the software to best display the activity data. This may be used to clip the upper end of the data by reducing the value
- **Zero** – sets the minimum value – may be used to clip the lower end of the data
- **Start day** – may be used to plot the Actogram starting at any day during the recording
- **Start time** - may be used to plot the Actogram starting at any time during the recording
- **Redraw** – refreshes the Actogram (also found in the display menu)

5. Sleep Analysis Menu

The Actiwatch can be used to quantitatively measure sleep quality and has been validated against polysomnography for use in sleep studies. For further information on validation of the Actiwatch please see the **Technical Appendix**.

5.1 Analysing and scoring sleep data – preparing for sleep analysis

Opening the Sleep Analysis section of the software brings up the following screen:



In order to analyse a sleep file, it is necessary to perform the following actions:

- Ensure that the correct data file is currently loaded (file details are shown above the plot area). If another data file is to be analysed, use the 'Load File' option from the 'File' menu.
- It is important to remember that only data collected with epoch lengths (logging intervals) of 15 seconds (0.25 minute), 30 seconds (0.5 minute), 1 or 2 minutes can be analysed by this program. For accuracy it is recommended that epoch lengths of 1 minute or shorter are used.
- With the required data file loaded, select the day for which the analysis is to be performed (relative to the start day of the study data) by using the 'Day' slider control.
- The maximum value of the plotted data may be adjusted by using the 'Scale' control (minimum value is 50, maximum is equal to the maximum value of the data).

The upper plot provides an overall view of two days of activity with an analysis window (highlighted in blue) covering the period of data to be analysed. The lower plot provides an expanded view of the analysis window and will also show marker events (where used) as vertical blue lines.

The expanded analysis window plot has two further data bars just below the plot area. The upper bar shows the bed time/get up times (blue lines) and sleep start/sleep end times (pink lines). The lower bar represents periods of sleep as white areas and periods of wakefulness as red areas.

5.1.1 Setting the Analysis Window period

Set the start time for the analysis by clicking on the upper activity plot with the LEFT mouse button until the blue highlighting starts at the required time. Set the end time for the analysis by clicking on the upper activity plot with the RIGHT mouse button until the blue highlighting ends at the required time.

Scroll bars are provided below the expanded activity plot to allow further adjustment of the analysis start/end times as required.

The Analysis Window may be set to between 1 and 24 hours in length. The Analysis Window must be of sufficient duration to encompass the sleep periods of the subjects and this should be consistent for each day within the data file if possible.

5.1.2 Setting Bed and Get Up Times

These times (or the equivalent such as lights on and lights off) have to be set by the operator and are indicated by the small dark blue lines underneath the Expanded Analysis Window. These can be moved by using a LEFT mouse click or by use of the slider bars for fine adjustment. They can also be set automatically by use of the Event Marker in the Sleep Diary routine (see **Section 5.1.8**). The corresponding time in bed is shown in the box at the right of this information.

5.1.3 Setting Sleep Start and Sleep End

These times have to be set by the operator and are indicated by the small pink lines underneath the Expanded Analysis Window. These can be moved by using a RIGHT mouse click or by use of the slider bars for fine adjustment (note these times must fall within the region encompassed by the blue bed and get up time lines).

Alternatively, the Sleep start/end times may be set automatically by clicking on the 'Auto' button thus allowing the sleep-wake scoring algorithm to calculate the times. The bedtime and get up time must be set before selecting the 'Auto' option. The amount of assumed sleep will be shown in the box at the right of this information.

5.1.4 Performing the sleep analysis

When the correct periods have been selected, click on the 'Calculate' button to perform the analysis. The Actiwatch sleep-wake scoring algorithm will calculate the Sleep-Wake and movement information for the period between sleep start and end times. The results will be displayed in the lower part of the screen.

Please note that where actual times are involved they are expressed in terms of the 24-hour clock and calculated times, unless indicated, in terms of hours, minutes and seconds.

5.2 File

5.2.1 Load file

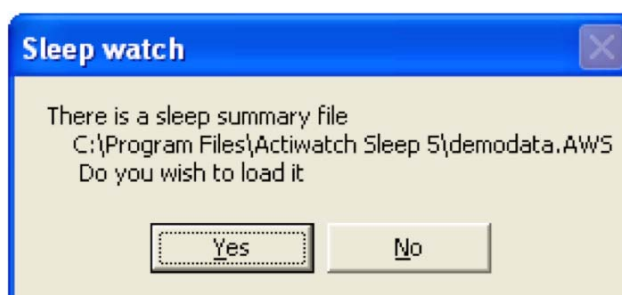
Selecting 'File' and then 'Load file' allows the user to load a file for analysis.

5.2.2 Save summary

When all or selected days of sleep data have been analysed, it is possible to save the results as an AWS file. Selecting 'File' and then 'Save summary' brings up the following message:



Selecting 'OK' saves the sleep summary file to the file location chosen. Once a sleep summary file has been saved, the next time the recording is opened, the following message is displayed:



Selecting 'Yes' loads the sleep summary file for viewing or further analysis.

5.2.3 Colours

If the file loaded contains light data, it is possible to change the colour in which the light data is displayed. For further details on selecting display colours please see **Section 4.1.3**.

5.2.4 Print

Selecting 'Print' prints the current screen including the Actogram plot for that day and the sleep statistics for the selected night.

5.3 Copy

5.3.1 Expanded raw data

Selecting 'Copy' and 'Expanded raw data' copies data from the analysis period epoch by epoch. The raw activity in counts is shown along with information as to whether the epoch has been scored as wake or sleep.

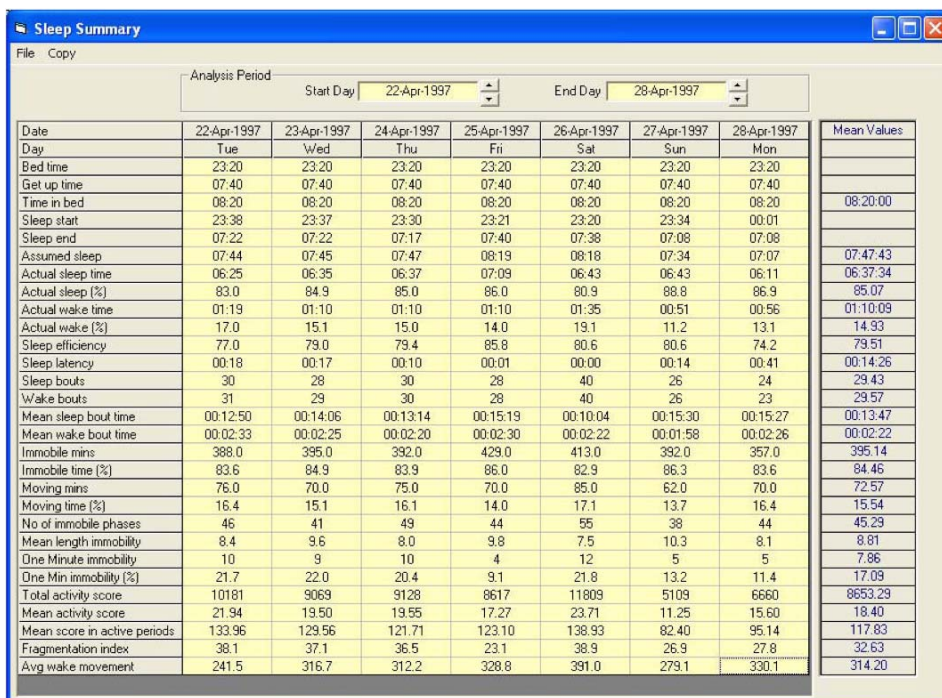
5.3.2 Calculated data

Selecting 'Copy' and then 'Calculated data' copies all of the calculated data to the clipboard. This function only works when sleep data has been analysed. Each parameter for the selected day is reported.

5.4 Summary

5.4.1 Display summary

It is possible to display a summary of all parameters in the sleep analysis. Clicking on 'Display summary' produces the following screen:



The screenshot shows a window titled "Sleep Summary" with a menu bar (File, Copy) and an "Analysis Period" section with "Start Day" (22-Apr-1997) and "End Day" (28-Apr-1997). The main area is a table with columns for each day and a "Mean Values" column. The table lists various sleep parameters such as Bed time, Get up time, Time in bed, Sleep start, Sleep end, Assumed sleep, Actual sleep time, Actual sleep (%), Actual wake time, Actual wake (%), Sleep efficiency, Sleep latency, Sleep bouts, Wake bouts, Mean sleep bout time, Mean wake bout time, Immobile mins, Immobile time (%), Moving mins, Moving time (%), No. of immobile phases, Mean length immobility, One Minute immobility, One Min immobility (%), Total activity score, Mean activity score, Mean score in active periods, Fragmentation index, and Avg wake movement.

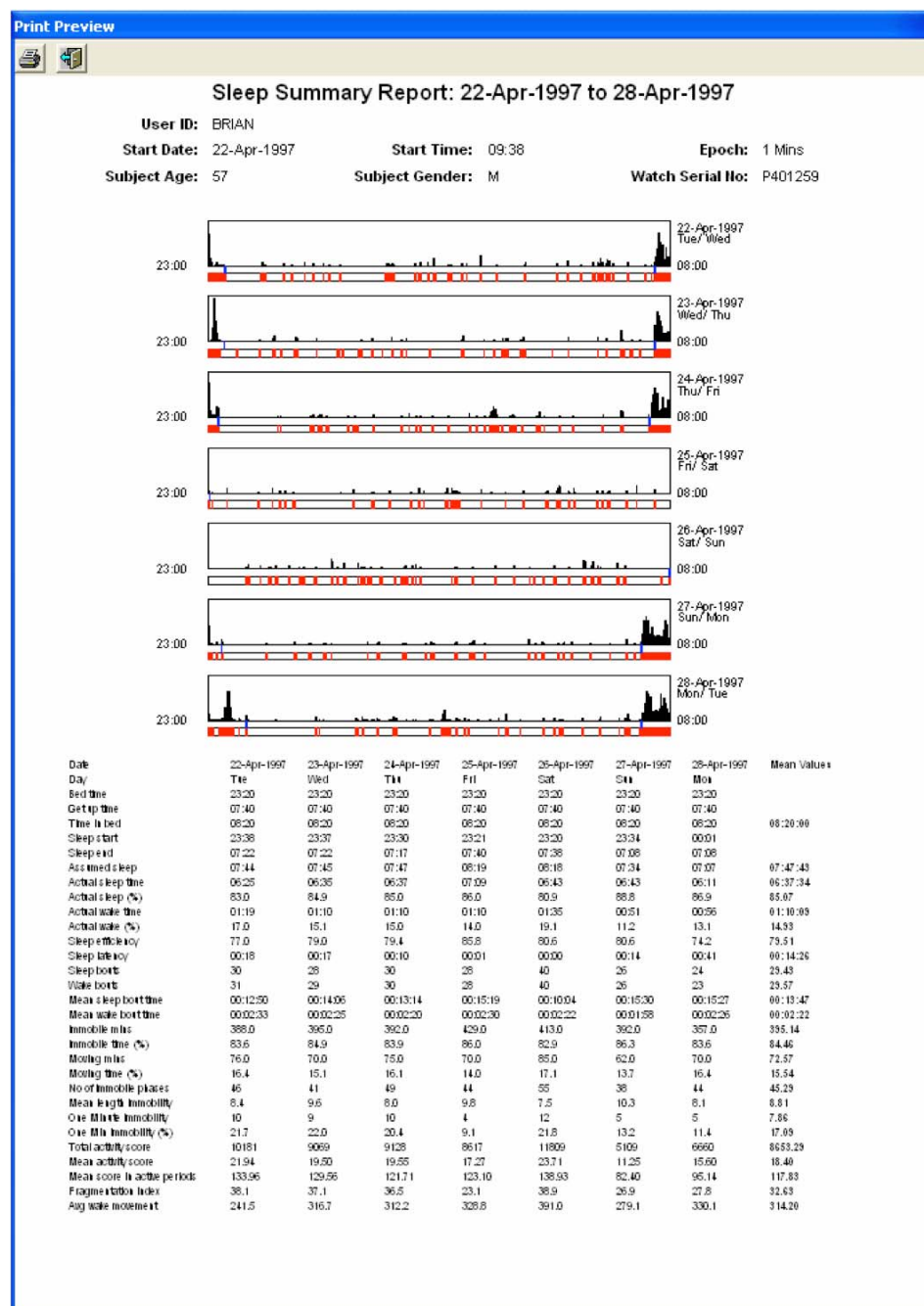
Date	22-Apr-1997	23-Apr-1997	24-Apr-1997	25-Apr-1997	26-Apr-1997	27-Apr-1997	28-Apr-1997	Mean Values
Day	Tue	Wed	Thu	Fri	Sat	Sun	Mon	
Bed time	23:20	23:20	23:20	23:20	23:20	23:20	23:20	
Get up time	07:40	07:40	07:40	07:40	07:40	07:40	07:40	
Time in bed	08:20	08:20	08:20	08:20	08:20	08:20	08:20	08:20:00
Sleep start	23:38	23:37	23:30	23:21	23:20	23:34	00:01	
Sleep end	07:22	07:22	07:17	07:40	07:38	07:08	07:08	
Assumed sleep	07:44	07:45	07:47	08:19	08:18	07:34	07:07	07:47:43
Actual sleep time	06:25	06:35	06:37	07:09	06:43	06:43	06:11	06:37:34
Actual sleep (%)	83.0	84.9	85.0	86.0	80.9	88.8	86.9	85.07
Actual wake time	01:19	01:10	01:10	01:10	01:35	00:51	00:56	01:10:09
Actual wake (%)	17.0	15.1	15.0	14.0	19.1	11.2	13.1	14.93
Sleep efficiency	77.0	79.0	79.4	85.8	80.6	80.6	74.2	79.51
Sleep latency	00:18	00:17	00:10	00:01	00:00	00:14	00:41	00:14:26
Sleep bouts	30	28	30	28	40	26	24	29.43
Wake bouts	31	29	30	28	40	26	23	29.57
Mean sleep bout time	00:12:50	00:14:06	00:13:14	00:15:19	00:10:04	00:15:30	00:15:27	00:13:47
Mean wake bout time	00:02:33	00:02:25	00:02:20	00:02:30	00:02:22	00:01:58	00:02:26	00:02:22
Immobile mins	388.0	395.0	392.0	429.0	413.0	392.0	357.0	395.14
Immobile time (%)	83.6	84.9	83.9	86.0	82.9	86.3	83.6	84.46
Moving mins	76.0	70.0	75.0	70.0	85.0	62.0	70.0	72.57
Moving time (%)	16.4	15.1	16.1	14.0	17.1	13.7	16.4	15.54
No. of immobile phases	46	41	49	44	55	38	44	45.29
Mean length immobility	8.4	9.6	8.0	9.8	7.5	10.3	8.1	8.81
One Minute immobility	10	9	10	4	12	5	5	7.86
One Min immobility (%)	21.7	22.0	20.4	9.1	21.8	13.2	11.4	17.09
Total activity score	10181	9069	9128	8617	11809	5109	6660	8653.29
Mean activity score	21.94	19.50	19.55	17.27	23.71	11.25	15.60	18.40
Mean score in active periods	133.96	129.56	121.71	123.10	138.93	82.40	95.14	117.83
Fragmentation index	38.1	37.1	36.5	23.1	38.9	26.9	27.8	32.63
Avg wake movement	241.5	316.7	312.2	328.8	391.0	279.1	330.1	314.20

A full list of all parameters available from the sleep software is given in **Section 5.9**.

5.4.1.1 File

The 'File' menu allows the user to perform the following actions:

- Print 7 day report – prints a complete summary for all parameters for 7 days
- Print 7 day report with graphs – prints a complete summary for all parameters for 7 days complete with sleep graphs for each day. An example is shown below:



5.4.1.2 Copy

It is possible to copy all or selected days of summary data to the clipboard for use in a third party program such as Excel.

5.5 Sensitivity

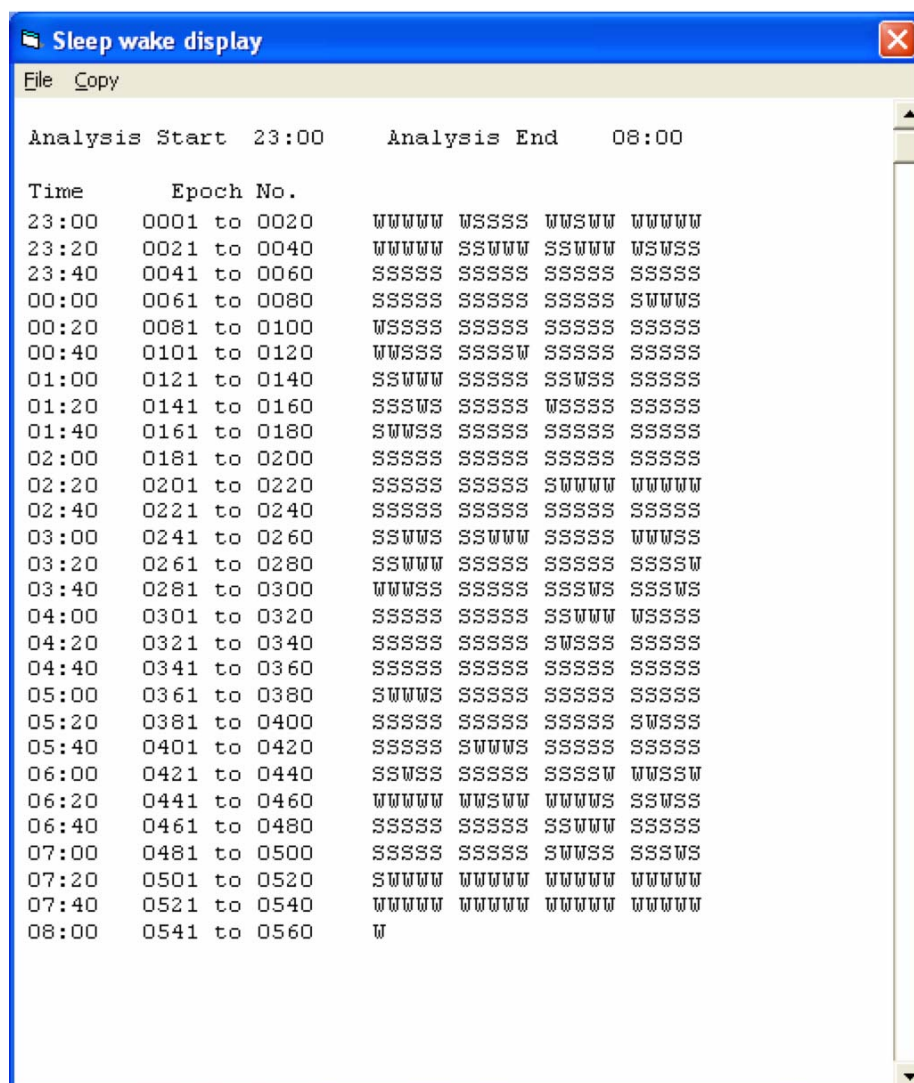
The Actiwatch system can be set with one of 4 sensitivity values. These are:

- Low
- Medium
- High
- Auto

The default value is 'Medium' and this is the value which was used in the validation study by Kushida et al. Full details on the different sensitivity settings are given in the **Technical Appendix**.

5.6 Sleep-Wake

Clicking on 'Sleep-Wake' brings up the following screen:



The screenshot shows a window titled "Sleep wake display" with a menu bar containing "File" and "Copy". The window displays a table of sleep and wake data. The table has four columns: "Time", "Epoch No.", and two columns of sleep/wake status (represented by 'w' for wake and 's' for sleep). The data spans from 23:00 to 08:00. The "Analysis Start" is 23:00 and the "Analysis End" is 08:00.

Time	Epoch No.	Wake	Sleep
23:00	0001 to 0020	wwww	ssss
23:20	0021 to 0040	ssss	ssss
23:40	0041 to 0060	ssss	ssss
00:00	0061 to 0080	ssss	ssss
00:20	0081 to 0100	ssss	ssss
00:40	0101 to 0120	ssss	ssss
01:00	0121 to 0140	ssss	ssss
01:20	0141 to 0160	ssss	ssss
01:40	0161 to 0180	ssss	ssss
02:00	0181 to 0200	ssss	ssss
02:20	0201 to 0220	ssss	ssss
02:40	0221 to 0240	ssss	ssss
03:00	0241 to 0260	ssss	ssss
03:20	0261 to 0280	ssss	ssss
03:40	0281 to 0300	ssss	ssss
04:00	0301 to 0320	ssss	ssss
04:20	0321 to 0340	ssss	ssss
04:40	0341 to 0360	ssss	ssss
05:00	0361 to 0380	ssss	ssss
05:20	0381 to 0400	ssss	ssss
05:40	0401 to 0420	ssss	ssss
06:00	0421 to 0440	ssss	ssss
06:20	0441 to 0460	ssss	ssss
06:40	0461 to 0480	ssss	ssss
07:00	0481 to 0500	ssss	ssss
07:20	0501 to 0520	ssss	ssss
07:40	0521 to 0540	ssss	ssss
08:00	0541 to 0560	ssss	ssss

This enables the user to see which epochs during the night have been recorded as wake (w) and which have been recorded as sleep (s). For further details on how the software scores wake and sleep, please see the **Technical Appendix**.

5.7 Markers

Clicking on markers brings up a complete list of the times when the Actiwatch marker button has been pressed. For more information on the Actiwatch maker button, please see **Section 4.2** of the **Guide to Getting Started**. For an example of a list of markers, please see **Section 4.6**.

5.8 Sleep Diary

It is possible to load information for each day of the study from the 'Sleep Diary' command. Clicking on 'Sleep Diary' brings up the following screen:

The screenshot shows a window titled "Sleep diary" with a menu bar containing "Exit" and "Print diary". The window contains a table with the following structure:

Day	Date	Analysis Window		Bed time	Get up time
		Start	End		
1	Tue 22-Apr-97	23:00 Tue	08:00 Wed	23:20 Tue	07:40 Wed
2	Wed 23-Apr-97	23:00 Wed	08:00 Thu	23:20 Wed	07:40 Thu
3	Thu 24-Apr-97	23:00 Thu	08:00 Fri	23:20 Thu	07:40 Fri
4	Fri 25-Apr-97	23:00 Fri	08:00 Sat	23:20 Fri	07:40 Sat
5	Sat 26-Apr-97	23:00 Sat	08:00 Sun	23:20 Sat	07:40 Sun
6	Sun 27-Apr-97	23:00 Sun	08:00 Mon	23:20 Sun	07:40 Mon
7	Mon 28-Apr-97	23:00 Mon	08:00 Tue	23:20 Mon	07:40 Tue

At the bottom of the window, there are several buttons: "< Back", "Next >", "Next week >>", "OK", and "Read markers".

The following functions are available:

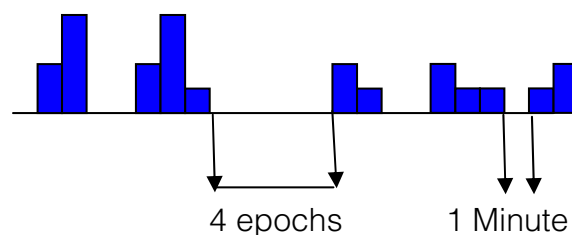
- The Analysis Window start and end times can be set for each day of the recording
- The bed time and get up time can be set for each day of the recording
- If the marker button has been used to demarcate bed time and get up time, then the 'Read markers' button can be used to automatically load the bed time and get up time for each day of the study
- The option to print summary data from the sleep diary by selecting 'Print diary'

5.9 Sleep Parameters

A full list of all the available sleep parameters is given below:

- **Bed Time** – Inserted time when lights are switched off. This is set by the operator or set automatically by the analysis software reading an event marker.
- **Get Up Time** – Inserted time when lights are switched on. This is set by the operator or set automatically by the analysis software by reading an event marker.
- **Time in Bed** – The difference between the Get Up and Bed times.
- **Sleep Start** – The start of sleep as set by the operator or determined automatically by the sleep algorithm. Please see the technical appendix for further details.
- **Sleep End** – The end of sleep as set by the operator or determined automatically by the sleep algorithm. Please see the technical appendix for further details.
- **Assumed Sleep** – The difference between sleep end and sleep start.
- **Actual Sleep Time** – The amount of sleep as determined by the algorithm and is equivalent to assumed sleep minus wake time.
- **Actual Awake Time** – The amount of time spent awake as determined by the algorithm.
- **Actual Sleep and Wake Time Percentages** – These are displayed to the right of the Actual Sleep and Actual Wake boxes.
- **Sleep Efficiency** – Actual Sleep Time /Time in Bed.
- **Sleep Latency** – The latency before sleep onset following bed time.
- **Number of Sleep Bouts** – The actual number of episodes of sleep.
- **Number of Wake Bouts** – The actual number of episodes of wakefulness.
- **Mean Length of Sleep and Wake Bouts** – These figures are determined by dividing the total duration of sleep and wake by the corresponding number of sleep and wake bouts.

- **Number of Minutes Immobile** – The total number of minutes during the assumed sleep period where the counts per minute are below a predetermined “immobility” threshold. See below.
- **Number of Minutes moving** – The converse of the above being the total number of minutes where scores greater than the “immobility” threshold were recorded during the assumed sleep period.
- **Percentage of Minutes Immobile** – Number of Minutes Immobile/Assumed Sleep period.
- **Percentage Minutes Moving** – Number of Minutes Moving/Assumed Sleep period.
- **The Number of Immobile Phases** – The number of periods of continuous periods made up of consecutive epochs where the counts are < than the “immobility” threshold. E.g. suppose a score < 4 was recorded in 4 consecutive epochs. This is classed as one Immobile Phase. In the example below there are 4 immobile phases.



- **The Number of Immobile Phases of 1 Minute** – The number of immobile phases where the duration is no more than 1 minute. In the example above there is one Immobile Phase of 1 Minute.
- **Percentage Immobility** – The Number of Immobile Phases of 1 Minute as a proportion of the Number of Immobile Phases. In the example above the percentage immobility is 25%.
- **Fragmentation Index** – The addition of Percentage Minutes Moving and Percentage Immobility. This is used as an indicator of restlessness.

IMPORTANT

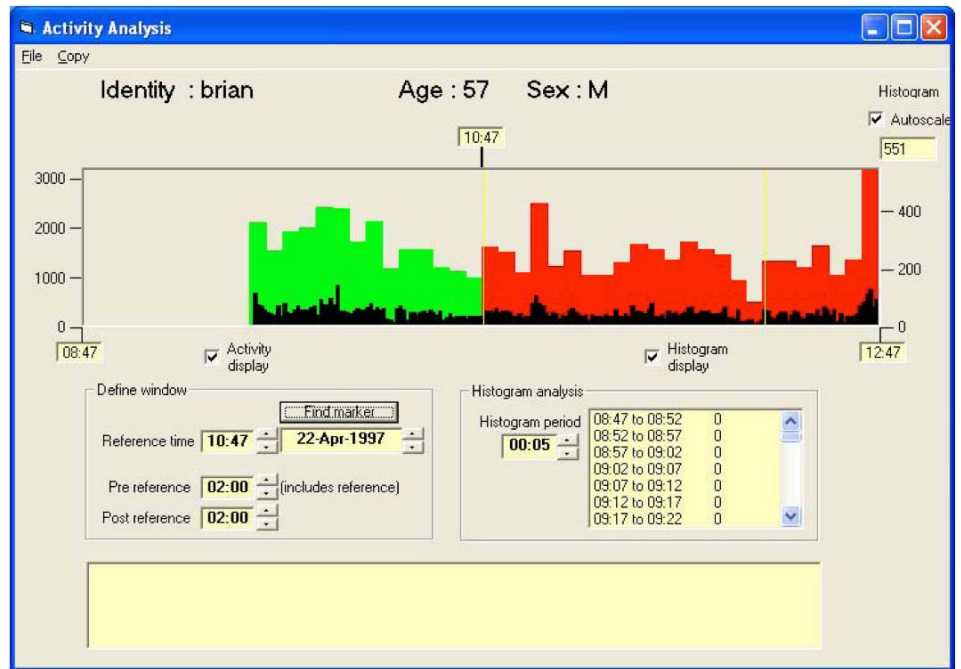
The above three parameters are only valid if the epoch is set to 1 minute.

6. Activity Analysis Menu

The activity analysis section of the software is designed to allow the user to analyse a period of activity in more detail. It is ideal for examining activity pre and post administration of a drug or therapy. Up to 24 hours prior to and following a reference time can be analysed.

6.1 Analysing a file using Activity Analysis

Selecting 'Activity Analysis' brings up the following screen:



In order to analyse a file it is necessary to set the following parameters:

- **Reference time** – either set from the scroll bar or by clicking on 'Find marker'
- **Pre reference time** – set by the scroll bar
- **Post reference time** – set by the scroll bar
- **Histogram period** – set by the scroll bar

Once these parameters have been set, the average activity per epoch within each histogram period is shown in the box on the lower right hand side of the screen.

6.2 File

Allows the user to close the Activity Analysis window.

6.3 Copy

6.3.1 Histogram data

This option copies only the histogram data in counts. No time data is displayed. An example of copied data is shown in column A below.

6.3.2 Times and data

Selecting 'Copy' and then 'Times and data' copies both the histogram data in counts and the time covered by the histogram period. An example is shown in column B below.

6.3.3 Activity data

Selecting 'Activity data' copies the activity data for each epoch along with the time of the epoch. An example is shown column C below.

6.3.4 Daily activity data

Selecting 'Copy' and 'Daily activity data' copies the time stamped activity data for each epoch for each day. An example is shown in Column D below.

6.3.5 Examples of copied activity data

A	B		C		D				
						22-Apr	23-Apr	24-Apr	25-Apr
415	10:02 to 10:07	415	10:00:00	415	10:00:00	415	0	245	237
297	10:07 to 10:12	297	10:01:00	554	10:01:00	554	0	245	45
367	10:12 to 10:17	367	10:02:00	429	10:02:00	429	0	228	47
198	10:17 to 10:22	198	10:03:00	813	10:03:00	813	0	280	70
269	10:22 to 10:27	269	10:04:00	289	10:04:00	289	0	163	110
269	10:27 to 10:32	269	10:05:00	280	10:05:00	280	4	330	207
206	10:32 to 10:37	206	10:06:00	262	10:06:00	262	6	186	245
190	10:37 to 10:42	190	10:07:00	245	10:07:00	245	6	299	609
170	10:42 to 10:47	170	10:08:00	280	10:08:00	280	6	341	309

6.4 Activity Analysis on screen controls

6.4.1 Reference time

This is set to demarcate the pre and post reference times and is shown on the top of the screen shot above.

6.4.2 Pre reference

This is set to define the pre reference analysis period. It can be set up to 24 hours before the reference time.

6.4.3 Post reference

This is set to define the post reference analysis period. It can be set up to 24 hours after the reference time.

6.4.4 Find marker

If the marker button has been used to mark the reference time, the 'Find marker' control can be used to load the reference time.

6.4.5 Histogram period

The histogram period is user selectable and a value greater than 1 min can be selected. The activity data is averaged for the epochs in the histogram period.

6.4.6 Activity display

When the 'Activity display' box is ticked, the activity data is displayed in black as shown on the screen shot above. If this is un-ticked then the activity data is not displayed.

6.4.7 Histogram display

When the 'Histogram display' box is ticked, the histogram data is displayed in red and green as shown on the screen shot above. If this is un-ticked then the histogram data is not displayed.

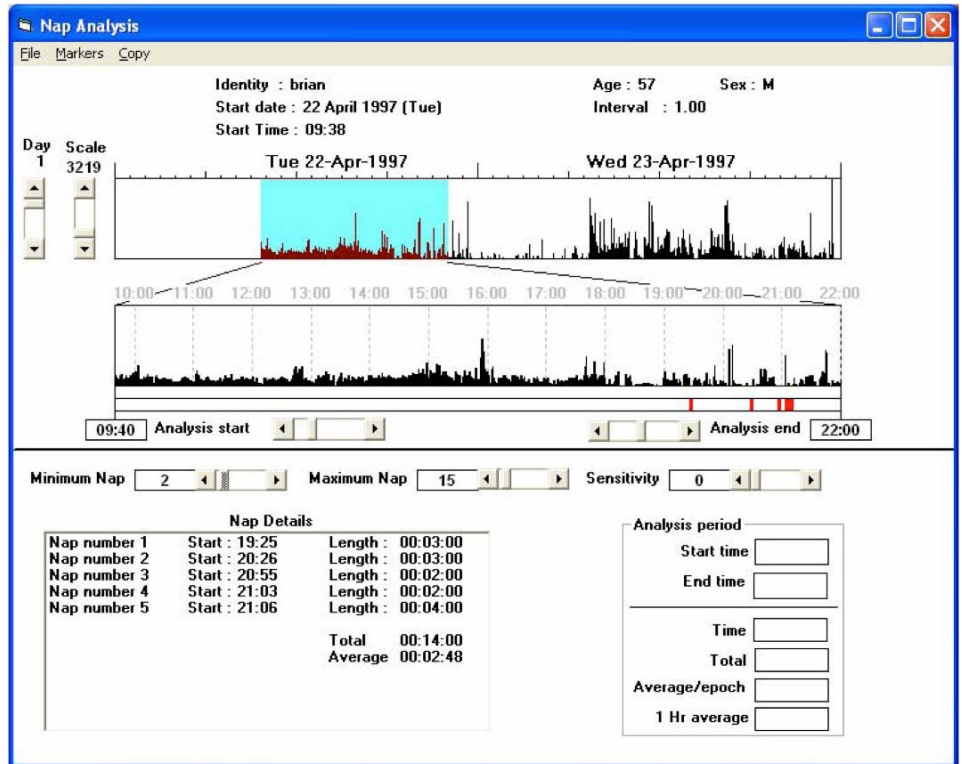
6.4.8 Autoscale

Leaving the 'Autoscale' box ticked allows the software to best display the data loaded. It is recommended that this box is left ticked.

7. Nap Analysis Menu

The Nap Analysis section of the Actiwatch sleep and activity software is designed to allow the user to look for periods of activity below a user definable threshold.

Clicking on 'Nap Analysis' from the main menu brings up the following screen:



7.1 File

The 'File' menu allows the user to print the nap summary as shown in the screen shot above.

7.2 Markers

Selecting 'Markers' displays a list of all the times the marker button has been pressed.

Further information on the marker button is given in **Section 4.2** of the Actiwatch **Guide to Getting Started**.

7.3 Copy

7.3.1 Nap details

Selecting 'Copy' and 'Nap details' copies the information displayed in the 'Nap Details' box as shown in the screen shot above to the clipboard for use in a third party program such as Excel.

7.3.2 Analysis

Selecting 'Copy' and then 'Analysis' places the information from the 'Analysis period' box onto the clipboard for use in a third party program such as Excel. Please note that in order to be able to copy analysis data, an analysis period must previously have been selected. Please see **Section 7.6** for details.

7.4 Nap analysis on screen controls

7.4.1 Day

It is possible to scroll through the days of the analysis in order to select the day required for nap analysis using the 'Day' bar located to the left of the nap analysis main screen.

7.4.2 Scale

The scale slider, located on the left hand side of the nap analysis screen, is used to alter the scale of the activity data. The software autoscales the data when it is displayed and reducing the scale shows the lower data values so the plots appear larger when viewed.

7.4.3 Minimum Nap

The user can define the minimum period of inactivity required to be scored as a nap. This can be set to a value of between 1 minute and 20 minutes.

7.4.4 Maximum Nap

It is also possible to define the maximum amount of time to be scored as a nap. This value can be set to between 6 minutes and 3 hours but must be >5 minutes higher than the minimum nap figure.

7.4.5 Sensitivity

The sensitivity value can be set between 0 and 100. This is the threshold below which inactivity is scored as a nap. It is equivalent to the number of counts in the epoch. For example if the sensitivity value is set to 5 then if an epoch has fewer than 5 counts in it then that epoch is scored as napping. Please note that in order to avoid periods of low activity such as television viewing being scored as napping, it is recommended that the threshold is set to 0.

7.5 Nap Details

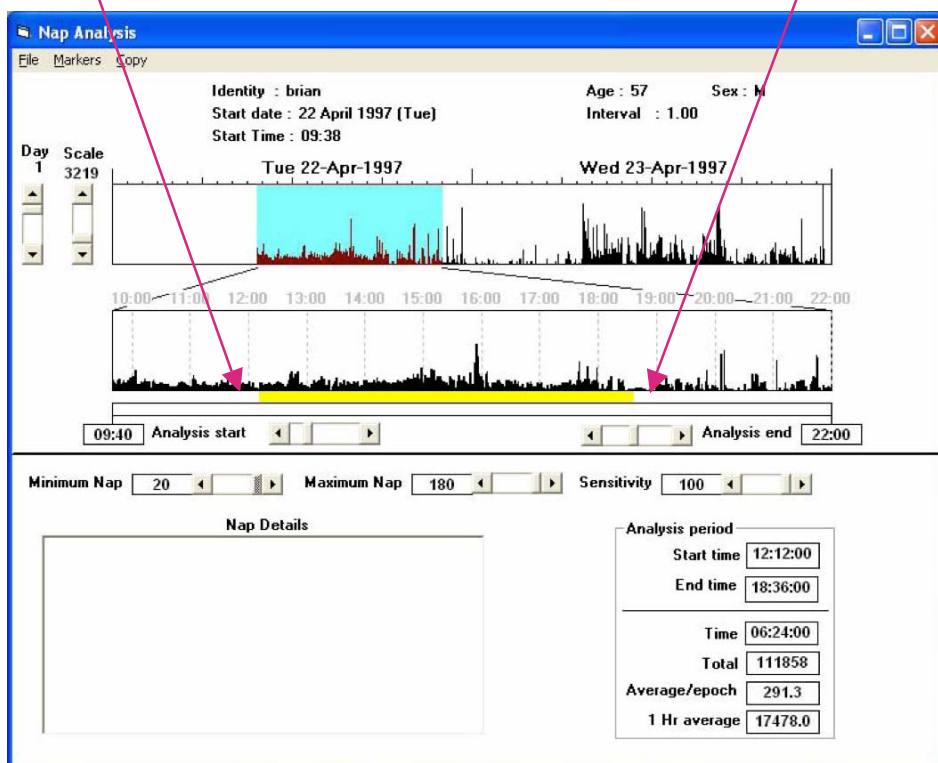
The 'Nap Details' screen shows the following information:

- Nap number
- Start time
- Nap length
- Total nap length
- Average nap length

Please note that if no period of time fulfils the criteria set then this screen will be blank.

7.6 Analysis period

It is possible to analyse a subsection of the nap analysis screen. Select the entire period of time to be analysed in the normal way. Select the sub period to be analysed by: left clicking at the start of the analysis period and right clicking at the end of the analysis period as shown below:



This then provides the following information shown in the 'Analysis period' window to the bottom right of the screen:

- Start time
- End time
- Total time
- Total activity
- Average activity/epoch
- 1 hour average activity

8. Light Analysis Menu

There are 2 Actiwatch models which allow ambient light levels to be recorded along with activity; the Actiwatch Light (AWL) and the ActiLight. For full details of the Actiwatch product range, please see **Section 1.3** of the ***Actiwatch Guide to Getting Started***. Full details on the ActiLight are given in **Section 9**.

Clicking on 'Light analysis' (please note that the light analysis option is only available when a light file is loaded) brings up the following screen:



8.1 Analysing a light file

In order to analyse a light file, it is necessary to select a period of time for analysis. This is done by either left clicking at the required time on the top third of the screen to mark the start of the analysis period and right clicking to mark the end, or by using the analysis start and end scroll bars shown below the expanded display screen.

When the required time period has been selected, the analysis will be automatically performed and the results shown in the bottom third of the screen. The following information will be displayed:

- Average light intensity in Lux
- Maximum light intensity in Lux
- Amount of time spent above reference

8.2 File

8.2.1 Colours

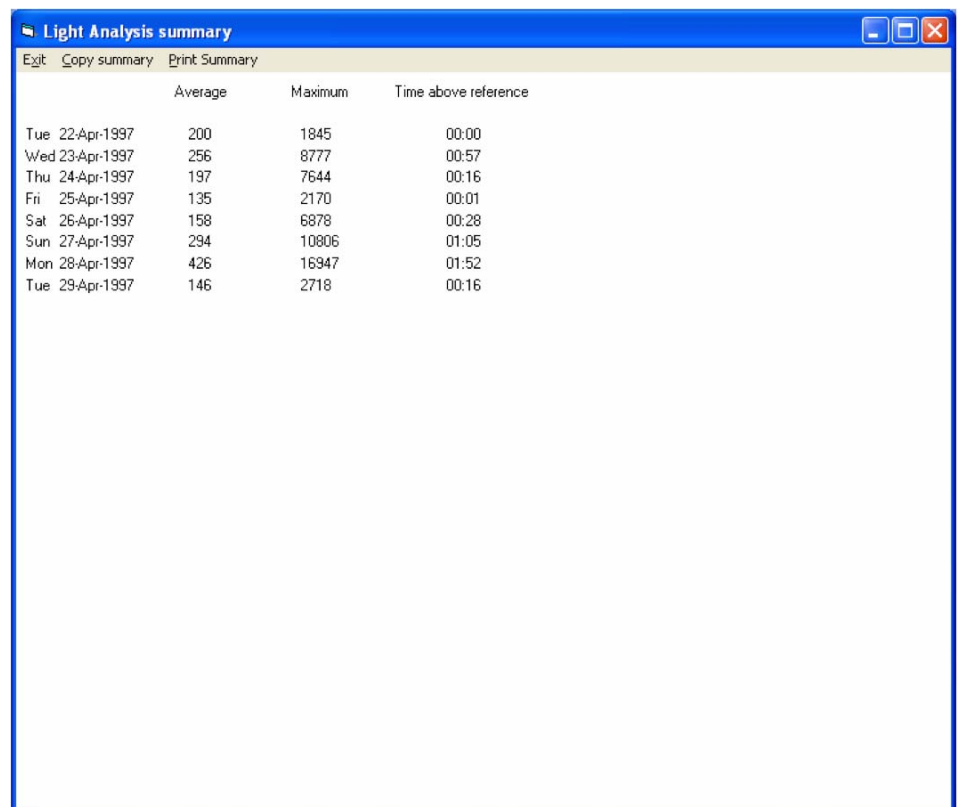
Selecting 'File' and then 'Colours' allows the user to change the colour that the light is displayed in. Full details on colours are given in **Section 4.1.3**.

8.2.2 Print

Selecting 'File' then 'Print' prints the screen shown above if a printer is connected to the host PC.

8.3 Summary

Selecting 'Summary' brings up the following screen:



The screenshot shows a window titled 'Light Analysis summary' with a menu bar containing 'Exit', 'Copy summary', and 'Print Summary'. The window displays a table with the following data:

	Average	Maximum	Time above reference
Tue 22-Apr-1997	200	1845	00:00
Wed 23-Apr-1997	256	8777	00:57
Thu 24-Apr-1997	197	7644	00:16
Fri 25-Apr-1997	135	2170	00:01
Sat 26-Apr-1997	158	6878	00:28
Sun 27-Apr-1997	294	10806	01:05
Mon 28-Apr-1997	426	16947	01:52
Tue 29-Apr-1997	146	2718	00:16

This shows the average light, maximum light and the time above reference for the duration of the recording.

8.3.1 Copy summary

Selecting 'Copy summary' from the light analysis screen shown above copies the data shown above to the clipboard. It can then be pasted into a third party program such as Excel for further analysis.

8.3.2 Print summary

Selecting 'Print summary' prints the screen shown above if a printer is connected to the host PC.

8.4 Copy Expanded Stats

Selecting 'Copy' and 'Expanded stats' copies the information from the expanded display window to the clipboard for use in a third party program such as Excel. An example of copied data is shown below:

Expanded Statistics for 22 April 1997 to 23 April 1997				
Start	02:10			
End	18:15			
Average	377			
Max	8777			
Time above Ref	00:57			

8.5 Cal

Clicking on 'Cal' allows the user to recalibrate the light data. Selecting 'Cal' brings up the following message:



All AWL and ActiLight units are calibrated before they leave CamNtech, however if there is reason to believe that the AWL or ActiLight unit is not recording appropriate light levels the calibration can be reset using the following procedure:

- Place the Actiwatch (or sensor) under a constant light source of known intensity (in Lux) for 1 hour or longer.
- Download the data.
- Set the threshold bar to the known level of the light source.
- Select 'Cal' from the Light Analysis menu.
- Adjust the 'Calibration' scroll bar so that the reference line just touches the top of the display.
- Place the Actiwatch on the Reader as instructed and store the new calibration factor.

All light level data recorded by the AWL and AWL Plus units are subsequently displayed and plotted in Lux.

NB This operation should only be undertaken if the user is confident with the procedure involved. Please contact CamNtech in case of any queries.



8.6 On screen controls

- Scale**
 The scale control can be used to alter the level of light displayed. The software autoscales the light data. Reducing the scale increases the resolution of the light data.
- Day**
 The day control is used to scroll through the days of the recording.
- Reference level**
 The reference level can be set to allow the user to measure the amount of time spent above the reference level. The amount of time that the light level is above the reference level is shown on the bottom left hand side of the screen.
- Analysis start**
 The scroll bar can be used to set the analysis start which defines the start of the expanded display window. Alternatively, left clicking on the main display shown in blue and yellow above will also set the analysis start.
- Analysis end**
 The scroll bar can be used to set the analysis end which defines the end of the expanded display window. Alternatively, right clicking on the main display shown in blue and yellow above will also set the analysis end.

9. The ActiLight

The ActiLight is designed to be used in conjunction with the Actiwatch AW7, AW4 and Mini. Full instructions on the use of the Actiwatch can be found in previous sections.

9.1.1 ActiLight overview

The ActiLight is an ultra light-weight device which detects and logs light intensity. The data is stored in the watch and can be downloaded to a PC for analysis. As such, it is a convenient tool for the ambulatory recording of light levels for clinical use and for research purposes.

The ActiLight can be used in conjunction with the Actiwatch which records physical activity. The light and data files can be combined using specialised software so that the light data is superimposed on activity plots which quantify the intensity and duration of physical activity.

9.1.2 ActiLight Technical Specification

Diameter:	24 mm
Depth:	7 mm
Weight:	7.5 grams
Range:	0.5-40,000 Lux
Memory:	128 KB
Recording Time:	45 days
Sampling Rate:	3 seconds
Battery life:	500 days
Battery type:	CR 1220
Waterproof:	Yes - 2Bar
Infra-Red Filter:	Yes
CE Marked in UK:	Yes
Warranty:	2 years
PC Analysis:	Win® 2000/XP
Resolution:	



Light Range (Lux)	Resolution (Lux)
0-200	0.1
200-2000	2
2000-8000	4
8000-20,000	50
20,000-40,000	200

9.1.3 Wearing the ActiLight

The ActiLight can be worn anywhere on the body or clothing. There are 2 mounting options available. It can be supplied with a fixing hook as shown in the picture above which allows the unit to be either pinned to clothing or affixed to a chain which can be worn on the neck. It can also be supplied with a wrist mount option for wearing with a strap similar to the Actiwatch Mini. If ambient light levels in, for example, a bedroom are required then the ActiLight can be placed face up on a flat surface for maximum light capture.

9.1.4 Setting up the ActiLight

The ActiLight is set up from the Actiwatch Activity and Sleep Analysis Software. Please note that software version 5.52 or later is required for correct operation of the ActiLight.

Select 'Write' from the 'Reader' menu to display the set-up parameters.

The user then needs to input the following subject data:

- User identity (subject identifier)
- Start date (can be up to 7 days in advance)
- Start time
- Epoch length (variable between 15 Secs and 15 Mins)
- Gender
- Age

Once all of the above parameters have been entered, selecting 'Send' will send the parameters to the ActiLight. When the ActiLight has successfully been set up, the following message will be shown:



The ActiLight can then be worn as detailed above. Please note that the recording time is dependent on the epoch selected. The available recording times are as follows:

Epoch Length	Total Recording Time
15sec	11.3 days
30sec	22.5 days
1 Min	45 days
2 Mins	90 days
5 Mins	225 days
10 Mins	450 days
15 Mins	675 days

Please note that when selecting a 15 Min epoch, the total recording time is limited by the battery life rather than by the memory available. Total battery life is 500 days of normal use. Instructions for changing the battery are given below.

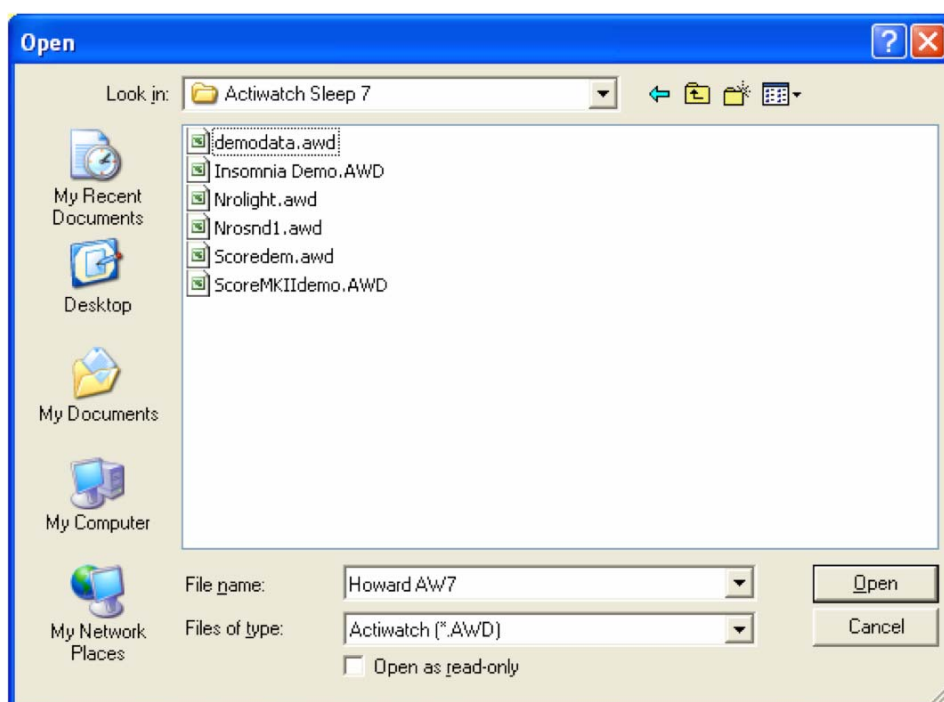
9.1.5 Downloading data from the ActiLight

Having placed the ActiLight on the reader and ensured that the reader LED is lit in red, selecting 'Reader' and then 'Read' will download the data stored in the ActiLight. Once downloaded, the data can be stored under the desired file path.

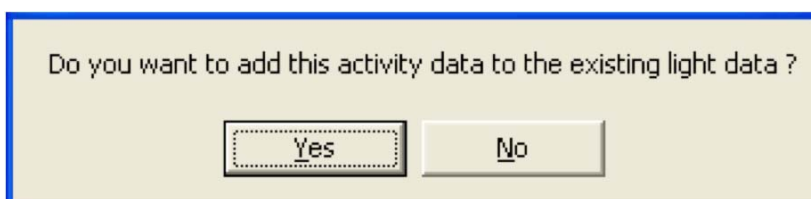
9.1.6 Loading data from the ActiLight

Important – If data from the ActiLight is to be combined with data from the Actiwatch, the ActiLight data must be loaded first.

To load and combine an activity and light file, select 'File' and then 'Load'. This brings up the following screen:



Select the required light file and select 'Open'. Repeat the procedure to add the desired activity file. This will bring up the following message:



Selecting 'Yes' will combine the activity and light files. They can then be viewed in the Activity and Sleep Analysis Software. For full details on analysing a combined activity and light file, please see **Section 9**.

9.1.7 Changing the ActiLight battery

The battery in the ActiLight is changed by removing the three screws in the back plate. The battery is a lithium-ion CR1220 which will give 500 days use in normal operation. Replacement batteries are available from CamNtech. Please contact CamNtech for up to date availability and pricing information. The replacement battery is fitted with the writing upwards.

It is necessary to update the battery fitted date in the software when the battery has been replaced. This is done by clicking on the battery fitted date screen during setup.

The following message will be displayed:



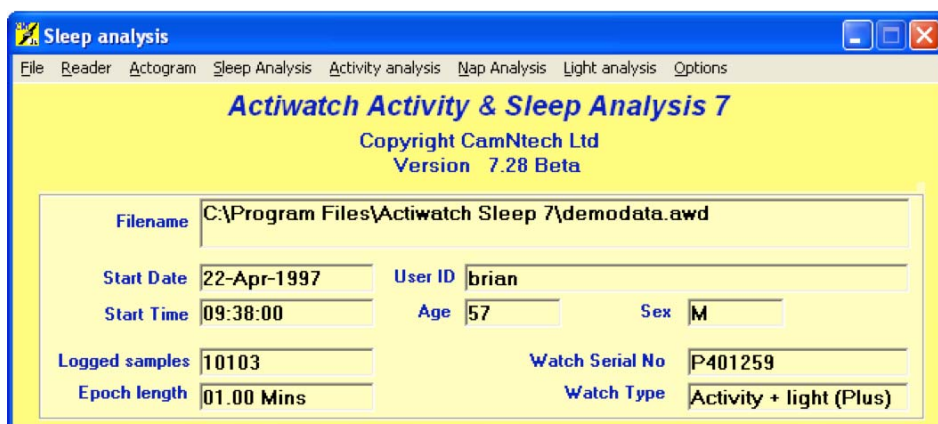
Selecting 'Yes' will load the current date and the battery life remaining will be reset to 500 days. Please note that it is necessary to send this information to the ActiLight after resetting the battery fitted date in order to update the information stored in the unit. This should ONLY be done if the data in the ActiLight has been downloaded and is no longer required as this procedure will erase any data stored in the ActiLight.

NB. This battery changing procedure is the same for the Actiwatch Mini. Details of the battery changing procedures for other Actiwatches are given in the Technical Appendix.

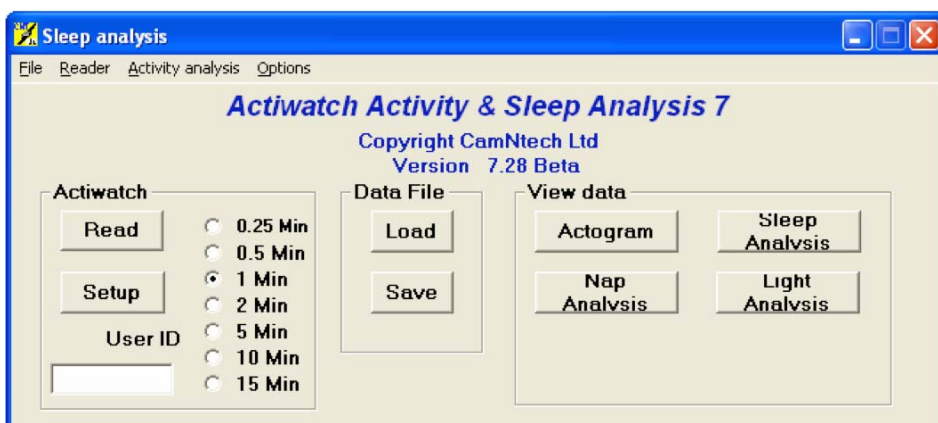
10. Options Menu

10.1 Full Menus

The default setting is for the software to display full menus as shown in the screen below:



Selecting 'Options' and then un-ticking 'Full menus' will give the following alternative menu options:



Please note, it is recommended that full menus are used wherever possible.

11. Technical Appendix

11.1 Sensor calibration and reproducibility

All Actiwatches are calibrated on a specially designed calibration jig before they leave CamNtech. The Actiwatch incorporates a calibration factor to produce the same output for the same amount of motion (in terms of g). In practice, inherent variation in application of Actiwatch units means that no two Actiwatches will produce exactly the same output. To minimise this difference it is important to develop a standardised Actiwatch mounting and positioning protocol.

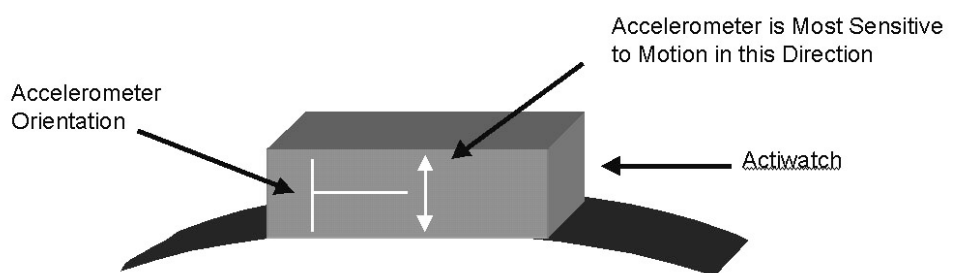
11.2 How does the Actiwatch work?

Activity is measured by the means of a piezo-electric accelerometer that is set up to record the integration of intensity, amount and duration of movement in all directions. The corresponding voltage produced is converted and stored as an activity count in the memory unit of the Actiwatch. The maximum sampling frequency is 32Hz. It is important to realise that due to this improved way of recording activity data there is no need for sensitivity settings as the Actiwatch unit will record all movement over 0.05g. Filters are set to 3 to 11 Hz.

The following sections contain a worked example of how the Actiwatch works and definitions of terms used in actigraphy.

11.2.1 Activity Counts

Activity is measured in counts. This is a generic term used to denote the amplitude of the signal produced by the accelerometer in the Actiwatch. The number of counts is proportional to the **intensity** of the movement.



The electronics in the watch checks or samples the amplitude thirty two times per second and it captures the **highest amplitude** in that second. This represents the **peak intensity** of the movement in that second.

Prior to sampling the movement waveform is continuous. A sinusoidal waveform is shown below for ease of visualisation. In practice the waveform could be any shape and does not necessarily have to be periodic.

Acceleration

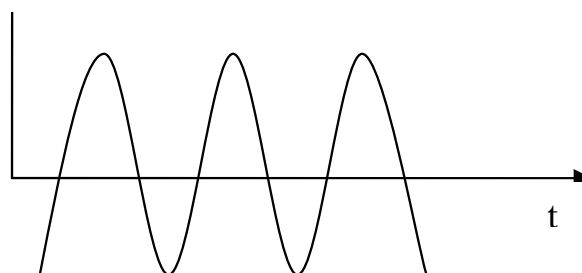


Fig 1

The sampling process converts the continuous signal into discrete steps each representing a sample as shown below:

Acceleration

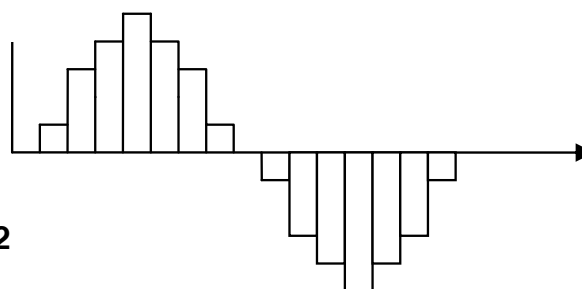


Fig 2

In the Actiwatch, the amplitude of each step can have a value between -128 and +128. These values are referred to as “counts”. The greater the number of counts the higher the acceleration in the period represented by a particular step. Since the maximum achievable acceleration for human movement is 5g, 25 counts/sec represents approximately an acceleration of 1 g.

NB. The above definition of counts may not apply to other actimeters.

Example

	Period	Count
1.	1/32 sec	50
2.	1/32 sec	22
3.	1/32 sec	75
4.	1/32 sec	60
5.	1/32 sec	34
6.	1/32 sec	10
7.	1/32 sec	15
8.	1/32 sec	41
9.	1/32 sec	25
10.	1/32 sec	9
11.	1/32 sec	17
12.	1/32 sec	25
13.	1/32 sec	7
14.	1/32 sec	1
15.	1/32 sec	40
16.	1/32 sec	33
17.	1/32 sec	28
18.	1/32 sec	5
19.	1/32 sec	12
20.	1/32 sec	13
21.	1/32 sec	2
22.	1/32 sec	29
23.	1/32 sec	36
24.	1/32 sec	50
25.	1/32 sec	15
26.	1/32 sec	6
27.	1/32 sec	11
28.	1/32 sec	18
29.	1/32 sec	19
30.	1/32 sec	42
31.	1/32 sec	8
32.	1/32 sec	66

The captured count is 75.

11.2.2 Epoch

An epoch is a period defined by the user for the purpose of logging (and therefore viewing) the captured activity data. The data logged is the sum of the captured counts from the individual 1-second intervals making up the epoch.

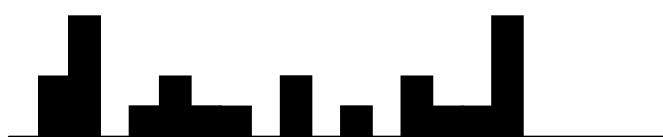
Example for a 2-sec epoch

Period	Highest count
1 sec	5
1 sec	10
Total Count	15

11.2.3 Activity Score

This is the same as the total count for an epoch. In the example above the Activity Score is 15 for one epoch. If there is no activity for two seconds the score for the epoch will be zero.

The scores are plotted on an Actogram epoch by epoch. The Actogram below has 16 epochs; however only 12 epochs have activity in them.



11.2.4 Total Activity Score

This represents the total count for all the epochs between sleep start and sleep end.

11.2.5 Mean Activity Score

This is the average count per epoch. If the Total Activity Score in the example above is 35 then the Mean Activity Score will be $35/16$.

11.2.6 Mean Activity Score in Active Periods

This is the average count per **active epoch**. In the example above it is $35/12$.

11.3 Sleep scoring algorithm

Determination of sleep and wakefulness by the Actiwatch Sleep Analysis software relies on an algorithm using the activity data recorded by the Actiwatch in a series of linked calculations. The Actiwatch algorithm looks at each data point from each epoch and those surrounding it and makes a total score based on these activity counts.

The adjacent activity scores influence the total score in the following way:

Within 1 minute of the scored epoch, activity levels are reduced by a factor of 5 in comparison to the epoch being scored and this value is added to the scored value.

Within 2 minutes of the scored activity epoch, activity values are reduced by a factor 25 and in comparison to the epoch being scored and this value is added to the scored value.

Using the default Medium Sensitivity, for 1-minute epoch data (and pro rata for other epochs used) a total score of 40 will be enough to designate the epoch as being 'Awake'.

For automatic determination of Sleep Start the algorithm looks for a period of at least 10 minutes of consecutively recorded immobile data, with no more than 1 epoch of movement within that time, following the Bed Time. The start of this defined period is classified as Sleep Start and the difference between this and Bed Time is used to determine Sleep Latency.

For Sleep End the algorithm looks backwards from the last sample in the analysis window for a specific consecutive period of activity below the threshold and classifies the last epoch in this period as Sleep End. Within this period, we allow for up to 2 epochs above the threshold.

The threshold and consecutive period of activity below the threshold necessary to equate to sleep end is determined by the epoch length set, as such:

Epoch	15 seconds	30 seconds	1 minute	2 minutes
Threshold (counts)	≤ 1.5	≤ 3	≤ 6	≤ 12
Period of activity below threshold required (epochs)	21 (5.25 mins)	11 (5.5 mins)	6 (6 mins)	4 (8 mins)

The sleep-wake algorithm has been validated using medium sensitivity. Results obtained with other sensitivity settings should be interpreted with care.

11.4 Time keeping

The Actiwatch range are set from the PC clock and elapsed time is marked in each unit by means of a crystal which oscillates 32 times a second. Selecting a sampling epoch sends an instruction to wait a certain number of oscillations before storing the number of activity counts. This system is also used when specifying any delays in start time.

11.5 Sensitivity settings

The sleep scoring algorithm has 4 different sensitivity settings:

- Low Threshold level 80
- Medium Threshold level 40
- High Threshold level 20
- Auto Threshold level variable

Altering the sensitivity setting selected alters the number of counts in an epoch required to score that epoch as wake. The default setting is medium and when this setting is selected, an activity score in an epoch of 40 or more is sufficient for that epoch to be scored as awake.

When auto sensitivity is selected, the software makes a direct relationship between the subject's activity level and the threshold above which an epoch is scored as wake. The sensitivity setting should not be changed unless there is a good reason to do so. If the sensitivity setting is changed during sleep analysis, the previously calculated data is cleared and a warning will be flagged.

11.6 Shock resistance

Severe shocks generate very high g forces which can damage sensors and can affect the calibration if the sensor is mechanically displaced. The new surface mounted technology used in the AW7 and the Actiwatch Mini minimises considerably both the risk of damage and the effect on the calibration.

Tests which CamNtech has conducted have shown that after dropping an AW7 onto concrete from a height of 2 metres the calibration was unchanged and the sensor was undamaged.

Care should be taken with the Actiwatch AW4 and Actiwatch Light as these models although robust are not as resistant to shock as the AW7 and Mini.

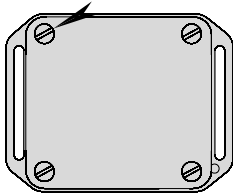
11.7 Temperature range

All Actiwatches in the range are suitable for operation in the temperature range -10 to plus 40 degrees centigrade.

11.8 Changing the battery (Actiwatch AW4, and AWL)

Under normal circumstances and usage the battery life of the batteries supplied in the Actiwatch AW4 and AWL units (CR2025 - a 3 Volt, 150 mAmp/hour Lithium Manganese cell) is 6 months. Replacing the batteries should be done as a matter of course at 6 monthly intervals or before a study that encompasses this time. The battery is located beneath the stainless steel plate that is screwed to the Actiwatch.

With any Actiwatch units supplied after July 1997 (series 6 units), simply unscrew the 2 screws without shoulders leaving the top right and bottom left ones in relation to the orientation mark in place but loosened such that the base will pivot. By pivoting the base and turning the Actiwatch the battery will drop out and it can be easily replaced by one of the correct type and the screws tightened up. The Test Actiwatch routine should be run after changing the battery to check the Actiwatch is functioning correctly. This can actually be done before the final tightening of the screws. For older units the following procedure should be adopted:



1. Remove three of the screws from the back of the Actiwatch completely leaving the one at the opposite corner to the small orientation marker in place.
2. Undo this screw three turns.
3. Turn the Actiwatch over so that the black face is upwards and rotate out the base complete with the battery.
4. Replace the battery with a new one.
5. Rotate the base back into the correct position.
6. Tighten the single screw.
7. Place the Actiwatch on the reader and use the Test Actiwatch routine from the Reader menu.
8. If the Actiwatch is OK then replace the other 3 screws and the Actiwatch is ready for use.
9. If the Actiwatch does not operate then try steps 2 to 7 again with the same battery.
10. If this does not work then leave the battery in the Actiwatch for 10 minutes then re-test the Actiwatch.

After the battery change has been carried out check that the memory length of the Actiwatch is correct; if it is not replace the battery and test again.

If after changing the battery the user finds that the Actiwatch appears to have stopped functioning then it is likely that on insertion an electrical contact between the Actiwatch base and body has been rapidly made and then lost again. This will have caused the microprocessor in the Actiwatch to crash causing the apparent malfunction. Please remove the battery and replace it again and the Actiwatch will start working normally. Please contact CamNtech technical support if the problem persists.

NB. The procedure for changing the battery in the ActiLight and Actiwatch Mini is different from this procedure and is detailed in section 9.1.7. The battery in the AW7 is a sealed unit which gives up to 8 years of continuous use. After this period the unit can be returned to CamNtech for battery exchange. Please contact CamNtech for up to date pricing on this option.

11.9 Trouble Shooting

CamNtech is confident that the user should have a trouble-free time when using the Actiwatch system. However, some easily solvable problems may occur examples of which are given below.

1. Reader red light does not come on when the Actiwatch is placed on it and/or the PC will not communicate with the Actiwatch:

- Check the Communication links – is the correct COM port selected?
- Is the Actiwatch on the Reader in the correct orientation? Make sure the hole on the base of the Actiwatch and the dot on the Reader are in the same position whilst Reading. If an Actiwatch Mini or an ActiLight is being used, the arrow should point upwards indicating correct orientation.
- Try sliding the Actiwatch up the Reader away from the grey rectangle.
- Are there any communication conflicts on the host PC?
- Does the battery in the Actiwatch need changing?
- Is the Actiwatch placed Plastic Lid side down – i.e. is the ID number visible?

2. The PC will not let the user access the Software:

- Is the COM port being used by another application?
- Has the host PC sufficient free memory available to run the software?

If there are any other problems with the Actiwatch system or for any technical queries please contact technical support:

Telephone +44-(0)1480-831223

admin@camntech.co.uk

For any other information on the products described in this Manual or other queries please contact CamNtech using the details provided at the front of this manual.