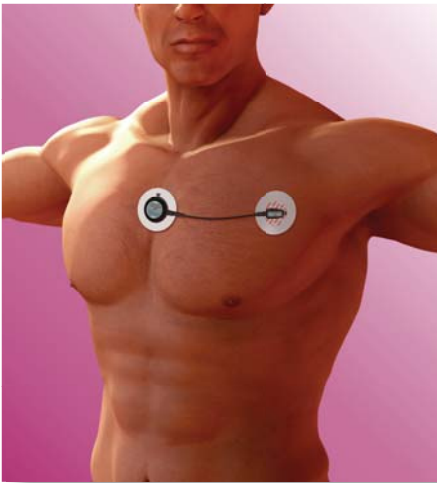




**The Actiwave Cardio** is a miniature ECG, movement, and position data recorder. Actiwave Cardio records high-resolution ECG waveforms as well as the frequency and intensity of activity in 3-axes and the subject's position. The researcher can choose an ECG sampling rate of 32Hz to 1024Hz, activity sampling rate of 32Hz to 128Hz, and data point resolution of 8, 9, or 10 bits. Using an ECG sampling rate of 128Hz, activity sampling rate of 32Hz, and 8 bit resolution, the Cardio can record up to 31 hours of data.

Used in combination with the Cardio Viewer software, data collected by the Cardio can be easily analysed for Heart Rate Variability, Sleep Quality, and Daily Energy Expenditure.

### *How does it work?*



The Actiwave Cardio attaches to the chest using standard ECG electrodes with 4mm male snap connectors. An internal accelerometer measures 3-axis acceleration as well as position. Physiological signals are amplified, sampled and stored in non-volatile flash memory.

At the end of the recording session, the Cardio is removed from the electrodes and placed on a dock connected to a PC. The Actiwave software transfers data from the recorder to the PC via the dock and USB cable.

Actiwave data is stored on the PC in European Data Format (EDF+) files. The user may view and analyse the files using several popular third-party software packages, including some public-domain software. The optional Cardio Viewer Software may be used to scan the saved .edf files for Cardio recordings and lists the files available for analysis. Clicking once on a file name brings up a preview of the selected file. Clicking twice on a filename starts the analysis, and after a few seconds, the analysis results are displayed.

## PQRST Interval and Heart Rate Variability Analysis

An example of the heart-rate variability analysis performed by Cardio Viewer is shown below. The ECG display in the upper left shows the overlay of the PQRST waveforms for the selected interval. In the lower right corner the average timing for each interval is listed, as well as the average R-wave peak. The center right box contains the heart rate variability statistics. Both time-domain and frequency statistics are calculated and listed. An annotation of the individual's position is also provided.

Time periods selected in the Data Viewer window appear in the analysis selection window.

ECG display shows an overlay of all R-waves in the selected time period.

Click Find/Goto point and then click on part of PQRST waveform to see the corresponding data point in the Data Viewer window.

Select the amplitude scale, or display only the average R-wave

Export data to a clipboard for easy import to a spreadsheet

Choose to have PQRST timing automatically recalculated, or manually recalculated.

Heart Rate Variability including both time and frequency domain statistics

Average PQRST segment timing and average R-wave peak amplitude.

**ECG display**

**Select a time period to view and analyse**

Whole of the data: (2:31:00 PM to 1:22:30 PM)  
 Selected data only: (6:34:34 PM to 7:11:18 PM)  
 Displayed window: (00:00 AM (Starting at 6:22:56 PM))

**HRV statistics**

Analysis length	12:36:44 AM	Analysis End	7:11:18 PM
Analysis start	6:34:34 PM		
No of R waves	3510	Minimum IBI	0.520
Average IBI	0.628	Maximum IBI	0.910
Standard dev.	0.031		
RMSSD	0.010		
HF	31.3	LF/HF ratio	5.6
LF	173.7		
VLF	124.2		
Position	Slouching		
Rotation			

**ECG timing statistics**

Averaged R wave peak	1383 $\mu$ V
PR interval	140 ms
QT interval	332 ms
PR segment	80 ms
ST segment	104 ms
QRS	124 ms

**R wave utilities**

Remove noise  
 Find/Goto point  
 Reset

**Display options**

Display every R wave  
 ECG timing cursors

Auto  
 4 mV  
 2 mV  
 1 mV  
 0.5 mV

**Export**

Export IBIs  
 Export ECG

**PQRST timing**

Recalculate  
 Auto calculate

## Sleep Analysis

**The Actiwave Cardio** is a convenient alternative for analysing length of sleep intervals. Because the Cardio measures not just intensity and frequency of activity, but also the position of the individual, it is possible to know whether the person was resting in an upright position, or whether they were actually lying down trying to sleep. The Cardio Viewer program uses both activity intensity and position to determine the length of each sleep interval, and the overall sleep period.

In addition to the sleep analysis, the Cardio Viewer software also calculates the average sleeping heart rate, minimum Inter-beat interval (R-wave to R-wave interval) and the maximum Inter-beat interval.

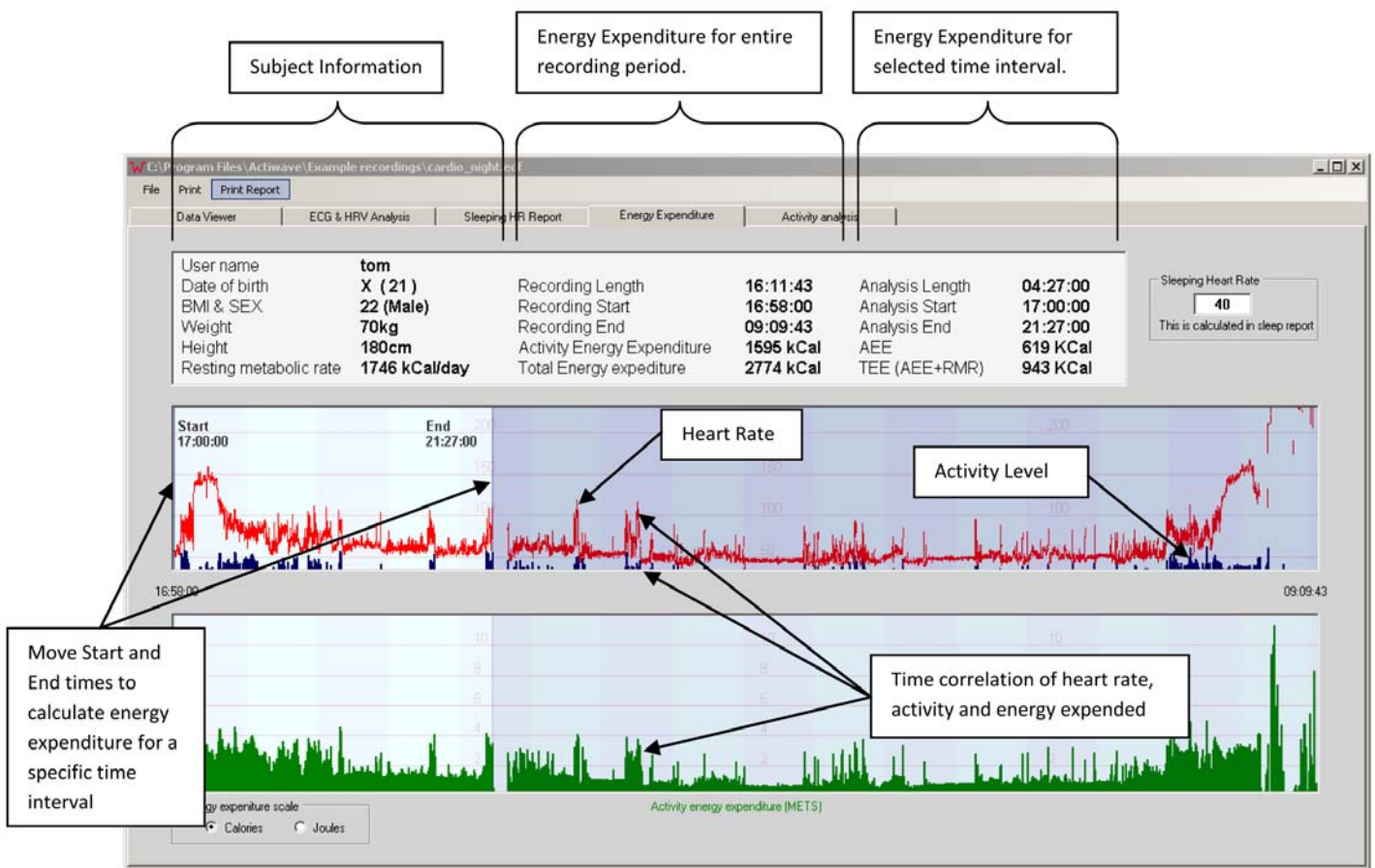
The screenshot below shows the sleep analysis window in the Cardio Viewer software.



## Energy Expenditure

The **Cardio Viewer software** also analyses Energy Expenditure. The Resting Metabolic rate is calculated using the Schofield equations<sup>1</sup>, the subject's height and their weight. The Activity Energy Expenditure is calculated using branched model equations derived by Brage *et al.*<sup>2</sup> The two are added to give the Total Energy Expenditure.

The Energy Expenditure tab in the Cardio Viewer displays the heart rate in beats per minute, activity intensity per epoch, and activity energy expenditure in METS. The Energy Expenditure for the total recording time is calculated and displayed as well as the Energy Expenditure for a selected period of time.



### ***Actiwave Cardio Advantages***

- Extremely small, light-weight recording device. The main body of the Cardio recorder has a 32mm diameter, a 10mm thickness, and weighs only 10.3g.
- Simultaneous measurement of ECG, activity intensity and frequency, and body position.
- User-selectable ECG sampling rates from 32Hz to 1024Hz, activity sampling rates from 32Hz to 128Hz, and resolution of 8, 9, or 10 bits.
- Records up to 31 hours of data with 128Hz sampling rate and 8 bits resolution.
- Data recorded in standard EDF+ files for easy import into a wide variety of analysis programs.

### ***Cardio Viewer Advantages***

- Directly loads Actiwave Cardio files.
- Automatic analysis of Heart Rate Variability.
- Uses body position and activity to distinguish sleep intervals from rest intervals.
- Calculates Daily Energy Expenditure and Activity Energy Expenditure for a selected interval.

### ***Additional Information***

See our website at [www.camntech.com](http://www.camntech.com) for more information regarding these products.



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