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USER REFERENCE GUIDE

ANALYSIS APPLICATION

Manual



HEART RATE VARIABILITY (HRV)

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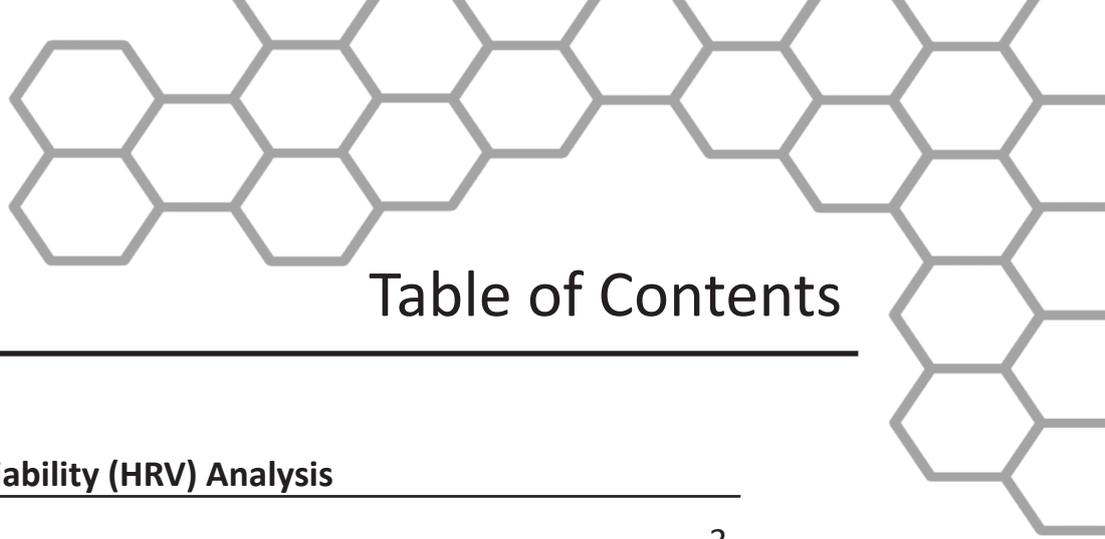
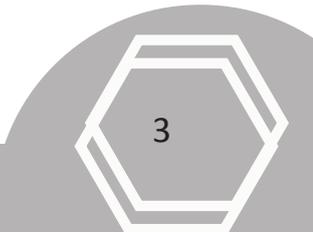


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MindWare Heart Rate Variability (HRV) Analysis

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Section 1

Channel Mapping

Upon opening the HRV analysis application a prompt will appear allowing the selection of the data file to be analyzed. Once the file is selected, press OK to proceed to the Map Channels screen (Image A).

Note: Please make sure that your computers language format is set to “English (United States)” to assure proper application functionality.

The Map Channels screen is used to identify the physiological data type for each channel in the data file. Although all data types in the file can be defined, not all channels must be assigned a specific data type. Only the ECG channel must be identified for HRV analysis. For respiratory statistics Z0, dZ/dt, or respiration must be identified. When applicable a single Event channel can be identified for event-based analysis. Any channel defined other than this will be ignored in this application.

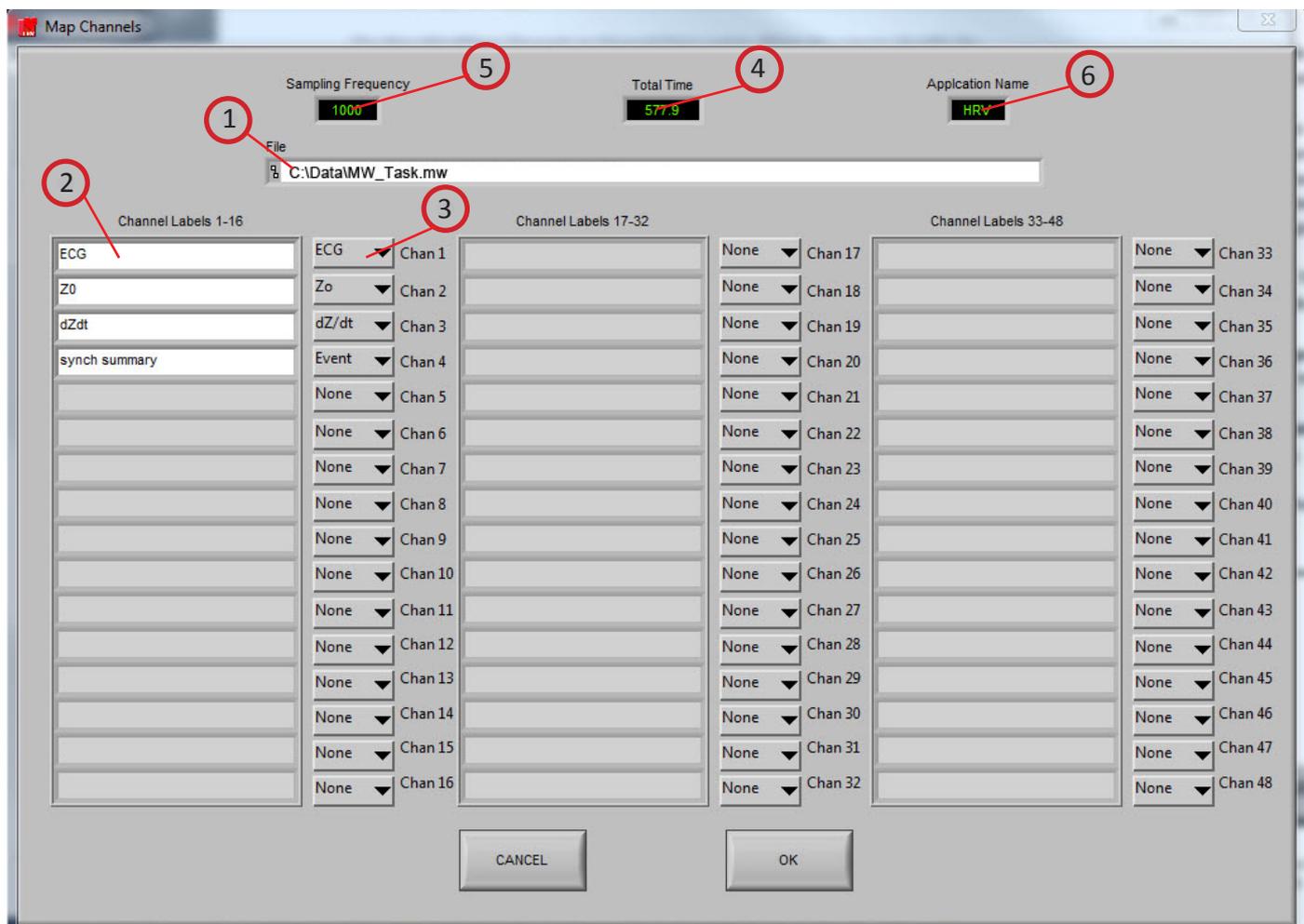


Image A



Section 1

Refer to Image A,

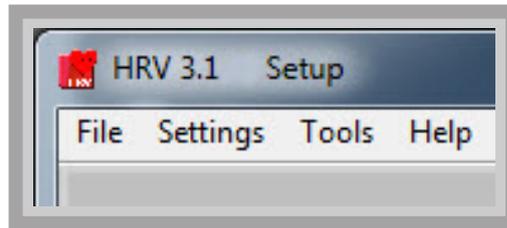
- (1) **File:** This indicator displays the path and name of the file under analysis.
- (2) **Channel Labels:** A list of the channels available for use in analysis
- (3) **Channel Types:** Specifies the physiological channel type for each channel. For HRV analysis only the ECG channel is required. For respiratory statistics either Z0, dZ/dt, or Resp channel is required. The Event channel must be defined for event-based analysis from a digital event channel.
- (4) **Total Time(s):** This indicator displays the total time as read from the input file (in seconds.)
- (5) **Sampling Frequency (Hz):** This indicator displays the Sampling Frequency as read from the input file.
- (6) **Application Name:** This indicator displays the analysis application that is currently running.

Once the desired channels have been mapped, **press OK to continue** to the Setup screen.

Section 2

Setup

The “Setup screen” contains many options pertaining to the way in which the analysis is performed. All changes to settings in the Setup screen are saved to a configuration file automatically whenever analysis is initiated or the application is exited.



File:

Open: Choose a different file for analysis

Map Channels: Change the channel map for the current file.

Scaling and Filtering Settings: Details the scaling and filtering information as it was applied to the channels during acquisition.

Export Events: Export events from an MWI file to a text file.

Exit: Exits the analysis application.

Settings:

Open Configuration: Allows a previously saved configuration file to be opened.

Save Configuration As: This option saves all current settings in the Setup screen to a configuration file which can later be recalled.

Re-initialize All to Default: This option will return all settings in the setup screen to factory default.

Tools:

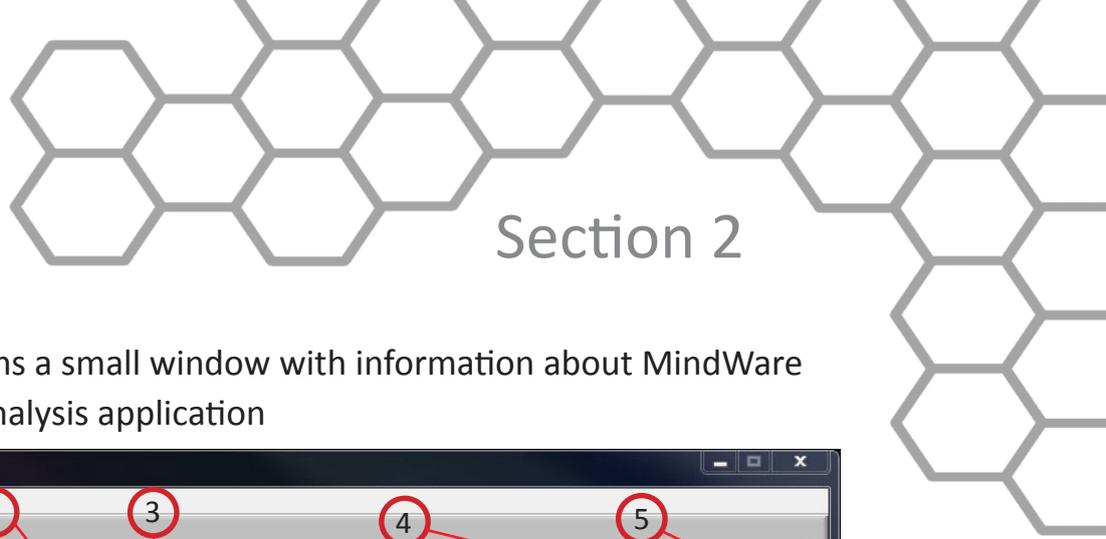
ASCII-MW Converter: The ASCII-MW Converter allows the conversion of any text file containing data in some character-delimited columns to the .mw format so that it may be used in any application (See Appendix A).

Build MWI: Builds an MWI file from an existing MWX file (needed for analysis of MWI files and viewing of data collected locally on a MindWare Mobile).

About:

Check for Updates: **This option requires an internet connection** Checks for newer versions of software and drivers. This check will happen automatically unless it has been disabled from the update window.

Show Help: This option opens a small window containing descriptions of the controls available on the screen. Hover over the desired control to view its description.



Section 2

About MindWare: Opens a small window with information about MindWare Technologies and the analysis application

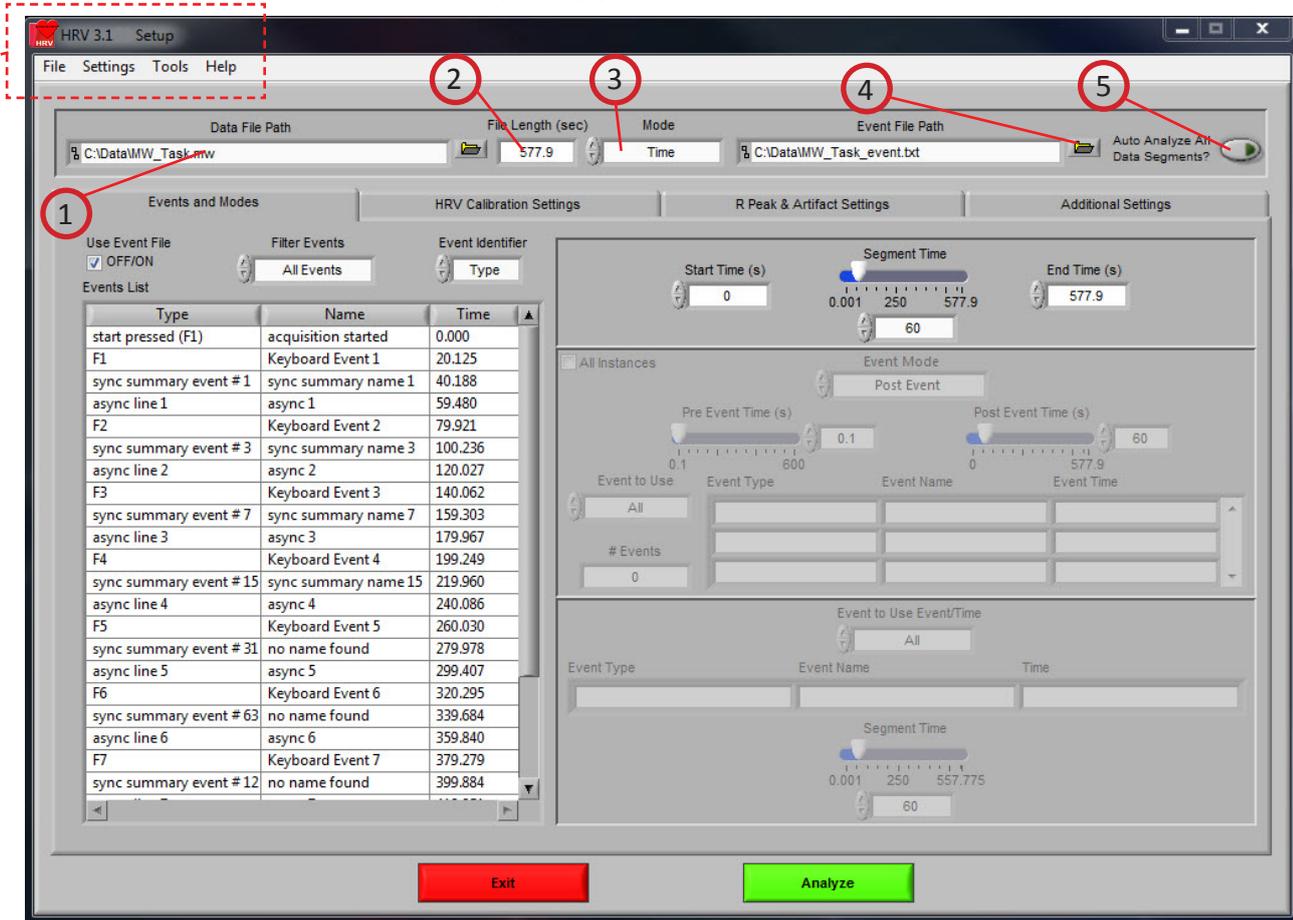
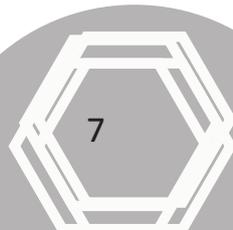


Image B

Refer to Image B,

- (1) **Data File Path:** The current file selected for analysis. By clicking the browse button a new file may be selected for analysis.
- (2) **File Length(s):** The total file length in seconds.
- (3) **Mode:** Used to select one of four analysis modes: Time, Event, Event and Time, and Real Time. The mode determines which controls are enabled on the Events and Modes tab.
- (4) **Event File Path:** The path of the event file used for analysis (when applicable).
- (5) **Auto Analyze All Data Segments:** When activated the application will automatically analyze each segment of data and write it to the specified output file.

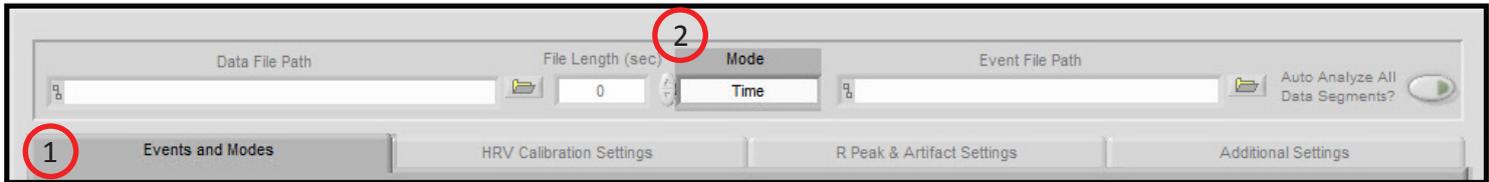


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Setup: Events and Modes

Image C



The Events and Modes tab (**1, Image C**), allows the selection of one of the many modes available to use to index through the dataset.

The left side of the screen shows all events in the file either from Event channel or the BioLab event file with the event name, type, and time. There are three controls for specifying the way in which the events are viewed:

Use Event File: When checked the events displayed are from the selected event file. Otherwise they are detected in the channel mapped as Event.

Filter Events: Used to filter the events in the list by type

Event Identifier: Specifies whether the event name or type is used as identifier. This affects both the identification of which events to use for analysis and how the events are displayed during analysis.

Select Mode (2, Image C)

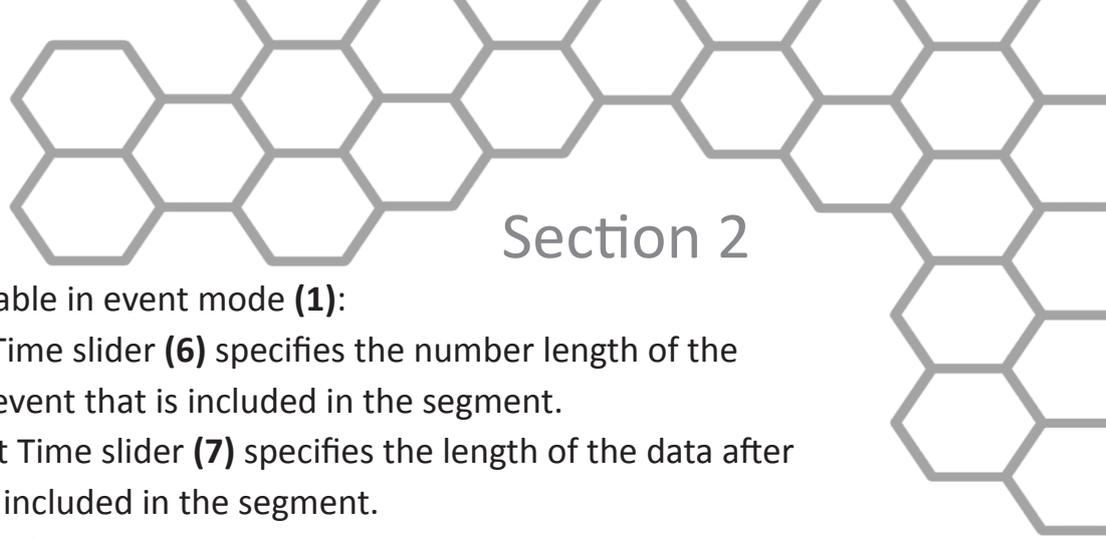
Time Mode (Image D): In time mode, the following parameters are available:

Start Time (9): Used to set the time at which the first analysis segment will start.

Segment Time (10): Specifies the length of each segment, starting at the start time and splitting the remainder of the file into equal length segments.

End Time (11): Used to set time at which the last analysis segment will end.

Event Mode (Image D): The list to the left of the event controls (**8**) displays all of the events detected in either the event file or the channel mapped to “Event”. This can be changed by either marking or unmarking the box named “Use Event File” above the event list. This list can be filtered by type.



Section 2

There are 6 viewing modes available in event mode **(1)**:

Pre Event: The Pre-Event Time slider **(6)** specifies the number length of the data before the specified event that is included in the segment.

Post Event: The Post-Event Time slider **(7)** specifies the length of the data after the specified event that is included in the segment.

Pre + Post: A combination of the Pre Event and Post Event modes in which the pre and post event segments are shown as a single segment.

Pre and Post: A combination of the Pre Event and Post Event modes in which the pre and post event segments are shown as separate segments.

Event to Event + Time: Post Event Time slider specifies a amount of time to segment analysis between the chosen events.

Event to Event: In this mode, the length of the segment is defined by the time in between the current event and the next event in the list.

For each of these event modes there is the option to use all events in the list or to specify certain events to use when segmenting the data. A specific event can be chosen from the event list by first selecting “User Defined” in the Event to Use box **(2)**, and then selecting the desired event from the list that will appear in the box labeled “Event Type” **(3)**. User Defined events also enable the ability to select all events with identical names for analysis with the “All Instances” **(5)** check box. In Event to Event mode, two specific events to go between can be selected. The number of events box **(4)** shows the total number of events of the specified type which will be shown during analysis.

The screenshot shows the 'Events and Modes' window. On the left is an 'Events List' table. On the right are various control panels. Red circles with numbers 1 through 11 point to specific UI elements: 1 points to the 'Event Mode' dropdown (set to 'Post Event'); 2 points to the '# Events' input field (set to 0); 3 points to the 'Event Type' dropdown (set to 'All'); 4 points to the 'Event Name' dropdown; 5 points to the 'All Instances' checkbox; 6 points to the 'Pre Event Time (s)' slider (set to 0.1); 7 points to the 'Post Event Time (s)' slider (set to 60); 8 points to the 'Use Event File' checkbox (checked); 9 points to the 'Start Time (s)' input field (set to 0); 10 points to the 'Segment Time' slider (set to 60); 11 points to the 'End Time (s)' input field (set to 577.9).

| Type | Name | Time |
|------------------------|----------------------|---------|
| start pressed (F1) | acquisition started | 0.000 |
| F1 | Keyboard Event 1 | 20.125 |
| sync summary event #1 | sync summary name 1 | 40.188 |
| async line 1 | async 1 | 59.480 |
| F2 | Keyboard Event 2 | 79.921 |
| sync summary event #3 | sync summary name 3 | 100.236 |
| async line 2 | async 2 | 120.027 |
| F3 | Keyboard Event 3 | 140.062 |
| sync summary event #7 | sync summary name 7 | 159.303 |
| async line 3 | async 3 | 179.967 |
| F4 | Keyboard Event 4 | 199.249 |
| sync summary event #15 | sync summary name 15 | 219.960 |
| async line 4 | async 4 | 240.086 |
| F5 | Keyboard Event 5 | 260.030 |
| sync summary event #31 | no name found | 279.978 |
| async line 5 | async 5 | 299.407 |
| F6 | Keyboard Event 6 | 320.295 |
| sync summary event #63 | no name found | 339.684 |
| async line 6 | async 6 | 359.840 |
| F7 | Keyboard Event 7 | 379.279 |
| sync summary event #12 | no name found | 399.884 |

Image D



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Event and Time (Image E): Event and Time mode combines the previous two modes to allow the selection of a specific event to use as a starting point and then to proceed through analysis in time mode from that point. The following parameters are available:

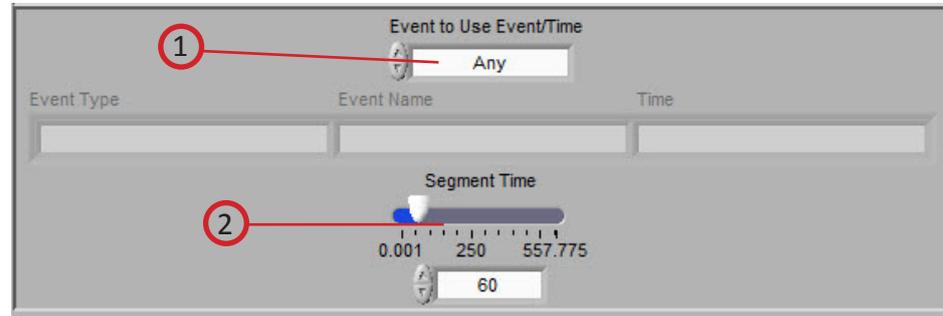


Image E

Event to Use Event/Time (1): Behaves similarly to Event mode, where “Any” will simply use whichever event is next in the list and proceed from that point and “User Defined” will proceed in time mode from the location of the specified event. The event can be specified by selecting the desired event in the event list and dragging it to the box below

Segment Time E&T (2): Specifies the length of each segment, starting at the location of the specified event and splitting the remainder of the file into equal length segments

Real Time Mode (Image F): Real Time mode analyzes second by second with the specified buffer size to compute the HRV statistics in real time for the selected file. When in Real Time analysis mode, video playback is disabled.

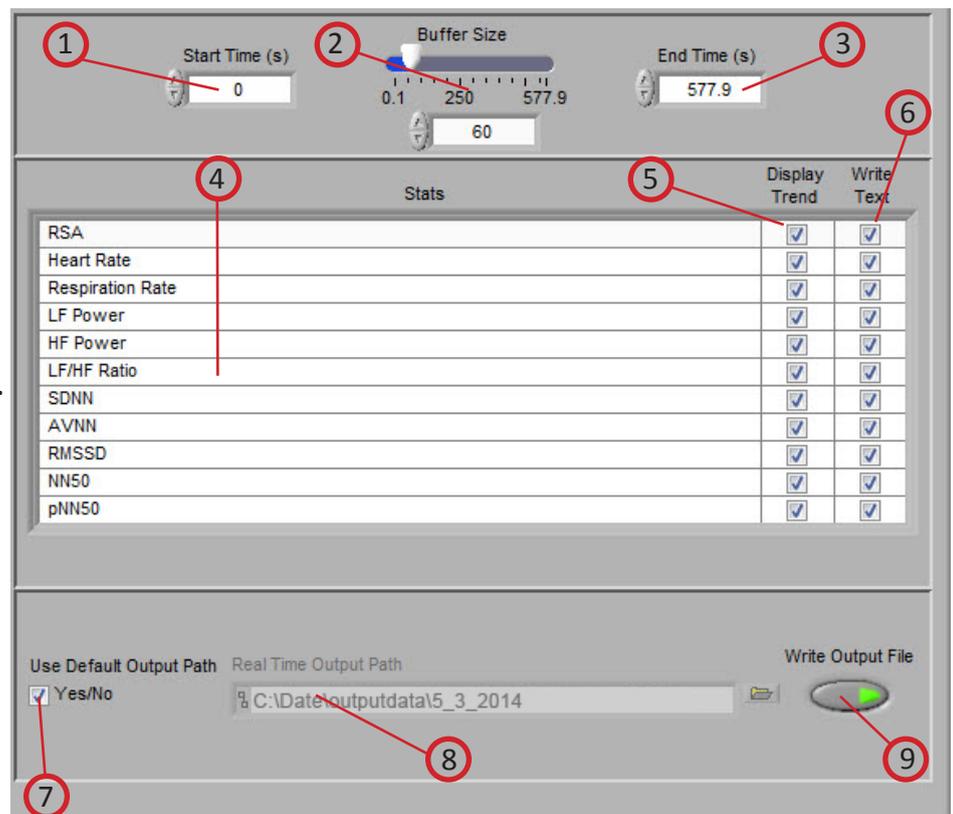
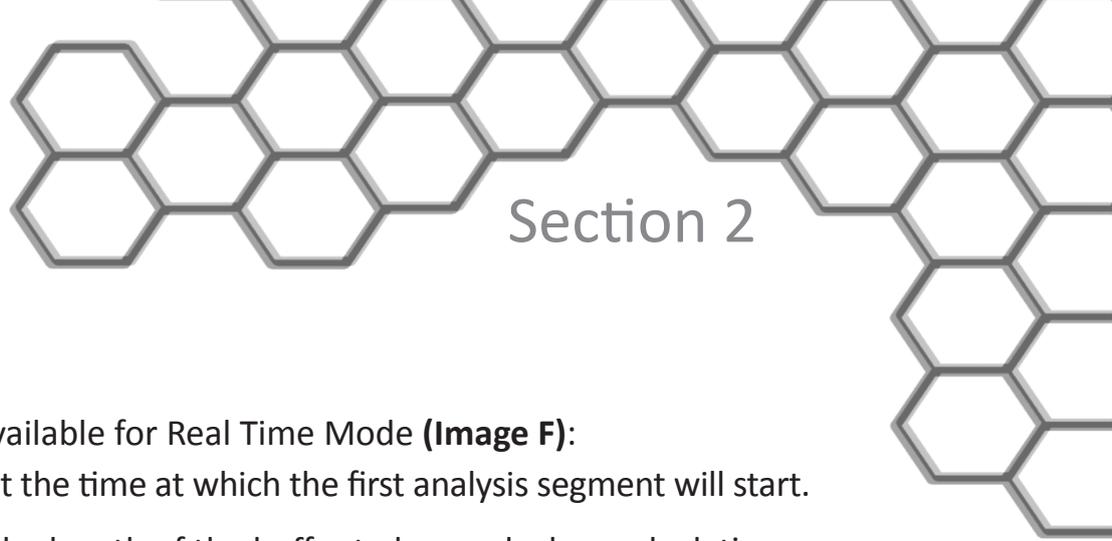


Image F



Section 2

The following parameters are available for Real Time Mode (**Image F**):

Start Time (1): Used to set the time at which the first analysis segment will start.

Buffer Size (2): Specifies the length of the buffer to be used when calculating real time stats.

End Time (3): Used to set time at which the last analysis segment will end.

Stats (4): This table lists the stats that are available for calculation in real time. Selecting Display Trend (**5**) will result in the calculations being shown on the Real Time Analysis screen as they are calculated. Selecting Write Text (**6**) will write the specified statistic in the real time output file.

Use Default Output Path (7): The default output location is a folder named “output data” in the folder which contains the file being analyzed. Within the “output data” folder, files are organized in folders by the date on which they were analyzed. If any of these folders don’t exist, they are automatically created when the first output file is written to that directory. A different location to save these files can also be specified in the file box.

Real Time Output Path (8): Specifies location where output file will be saved.

Write Output File (9): Enables/disables writing the output file

Note: It is recommended that a clean and edited series be used for real time analysis. Be sure to map the correct edit file (when applicable) on the Additional Settings tab prior to proceeding in real time mode.

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Setup: HRV Calibration Settings

The second tab on the screen, titled HRV Calibration Settings (**Image G**), allows the user to define a respiration source, set the filter bands and windowing method, and define a calculation method.

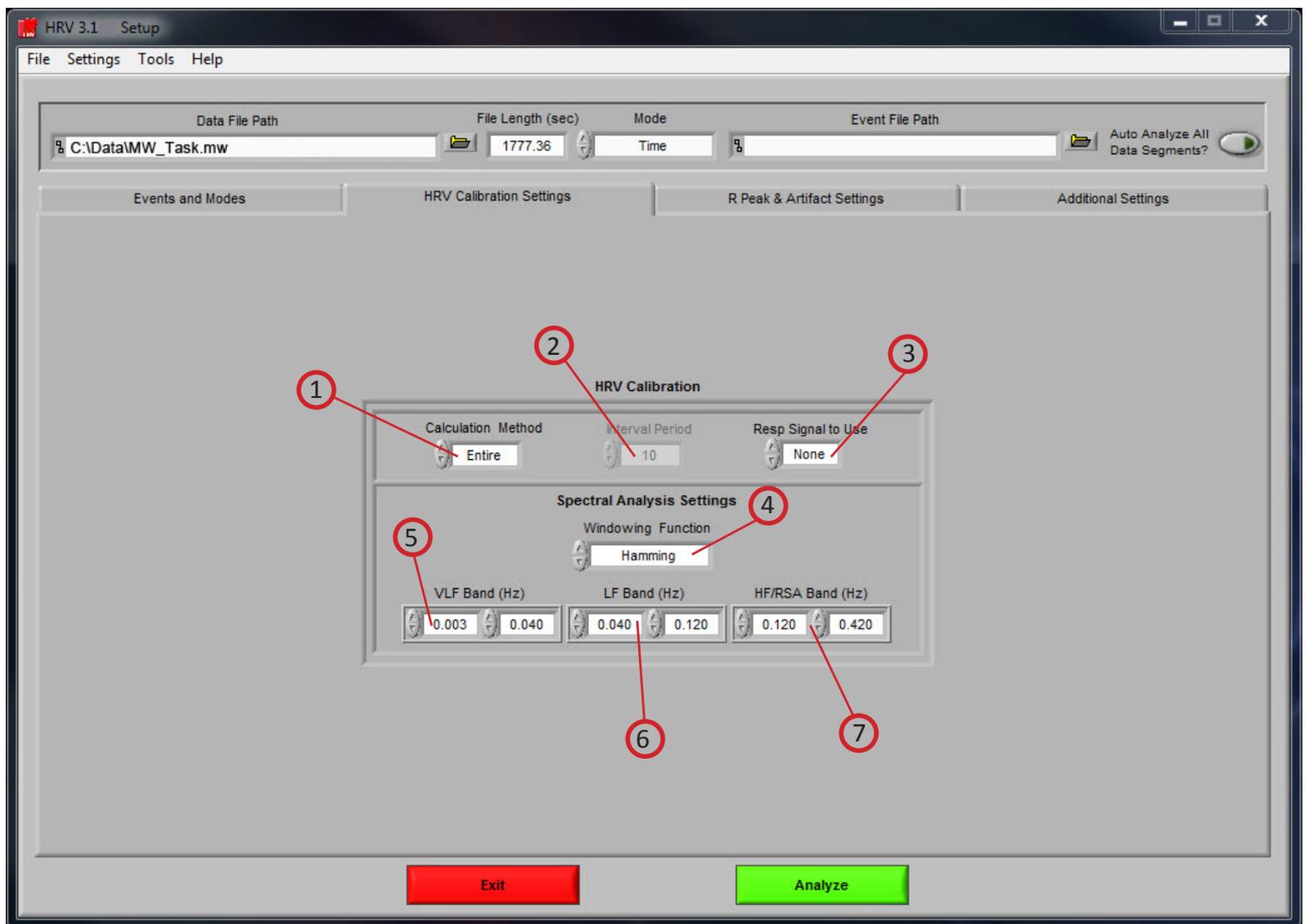
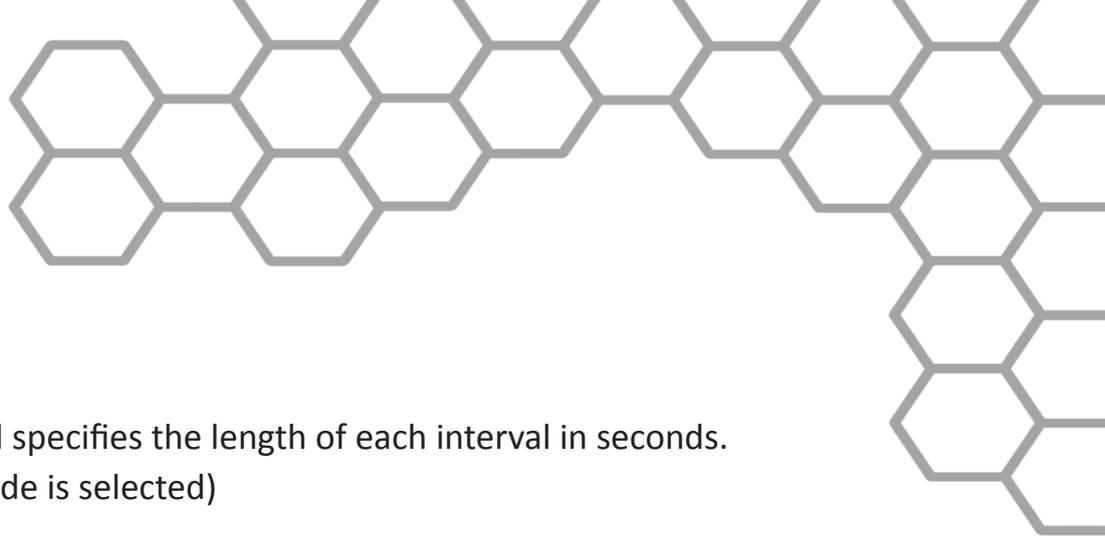


Image G

Calculation Method (1): Specifies how mean heart rate and mean IBI will be calculated. There are two methods available: Entire and Interval. In Entire mode, mean heart rate and mean IBI will be calculated using the entire segment. In Interval mode, the segment is divided into fixed time intervals specified by the Interval Period and mean heart rate and mean IBI will be calculated for each of these intervals individually.



Interval Period (2): This control specifies the length of each interval in seconds. (Only applies when interval mode is selected)

Respiration Signal to Use (3): This control selects the source to use to derive respiration measures. The options available are Resp, dZ/dt , Z0 or none.

Window Function (4): Specify the function used in building the heart period and respiratory power spectrum.

VLF Band (Hz) (5): Sets the VLF frequency cutoffs for filtering the heart period and respiration time series.

LF Band (Hz) (6): Sets the LF frequency cutoffs for filtering the heart period and respiration time series.

HF/RSA Band (Hz) (7): Sets the HF/RSA frequency cutoffs for filtering the heart period and respiration time series. The high frequency cutoff is also applied to respiration.

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Setup: R Peak and Artifact Settings

The third tab on the screen, titled R Peak and Artifact Settings, allows the user to set the sensitivity for the peak or enable manual override, enable or disable the MAD/MED or IBI min/max heart beat detection methods, set the expected heart rate range, and turn on the noise filters.

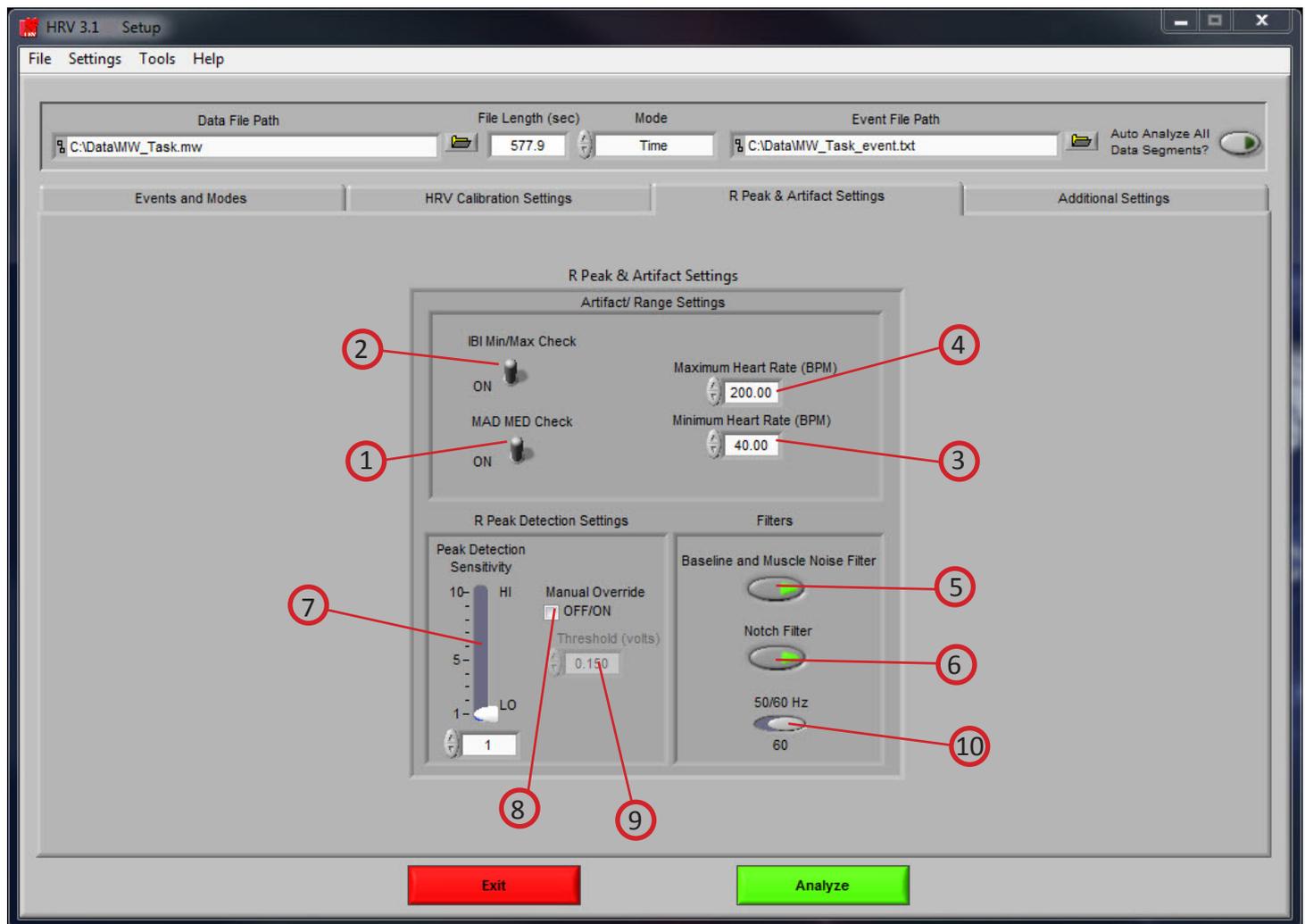
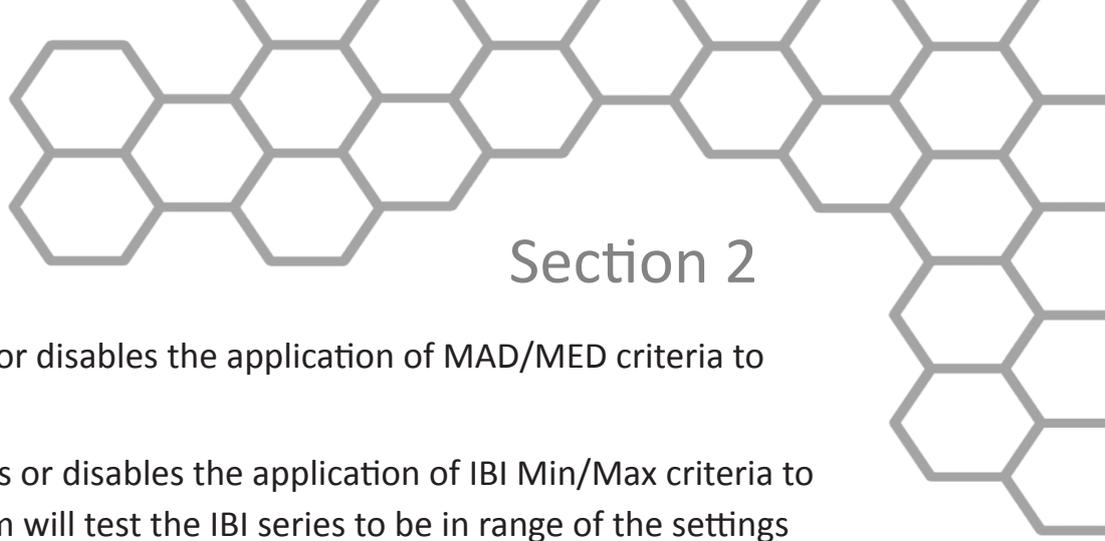


Image H



Section 2

MAD/MED Check (1): Enables or disables the application of MAD/MED criteria to the R peak detection.

IBI Min/Max Check (2): Enables or disables the application of IBI Min/Max criteria to R peak detection. The algorithm will test the IBI series to be in range of the settings selected in the Minimum Heart Rate and Maximum Heart Rate controls.

Minimum Heart Rate (BPM) (3): The minimum expected heart rate in the data series. This value will be the maximum IBI threshold.

Maximum Heart Rate (BPM) (4): The maximum expected heart rate in the data series. This value will be the minimum IBI threshold.

Baseline and Muscle Noise Filter (5): Enables or disables the muscle noise filter, which is a band pass filter (.25 to 40 Hz).

Notch Filter (6): Enables or disables the 50/60 Hz notch filter.

Peak Detection Sensitivity (7): Sets the sensitivity of the dynamic peak detection algorithm from 1 (Minimum Sensitivity) to 10 (Maximum Sensitivity).

Manual Override (8): Disables the dynamic peak detector and switches to the absolute threshold mode.

Threshold (volts) (9): Sets the minimum threshold above which to look for R peaks when Manual Override is enabled.

50/60 Hz (10): Select the frequency of the notch filter.



Section 2

Setup: Additional Settings

The last tab on the screen, titled Additional Settings, allows the user to select settings for incorporating video in analysis, the use of edited data, and the type of output file created.

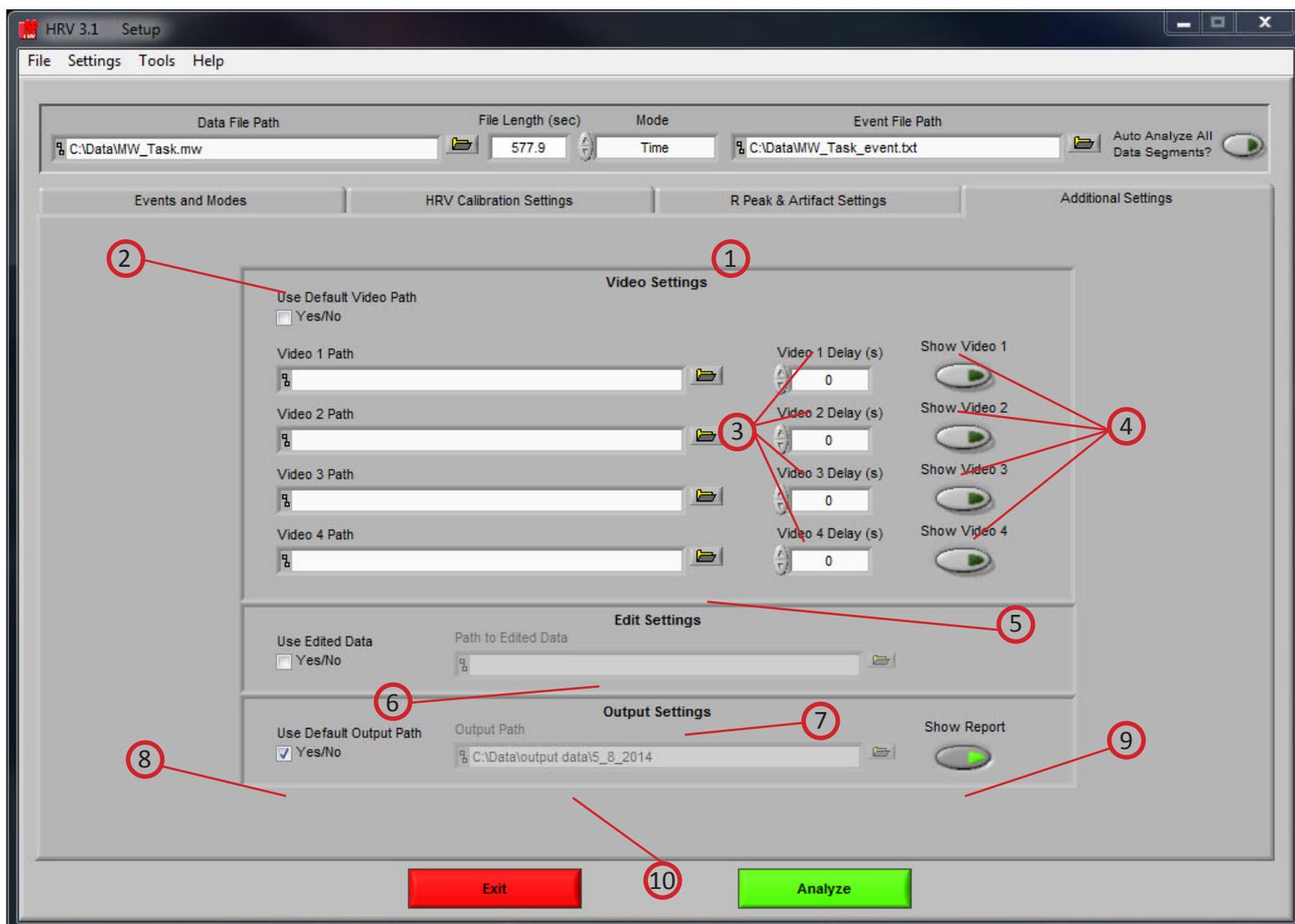
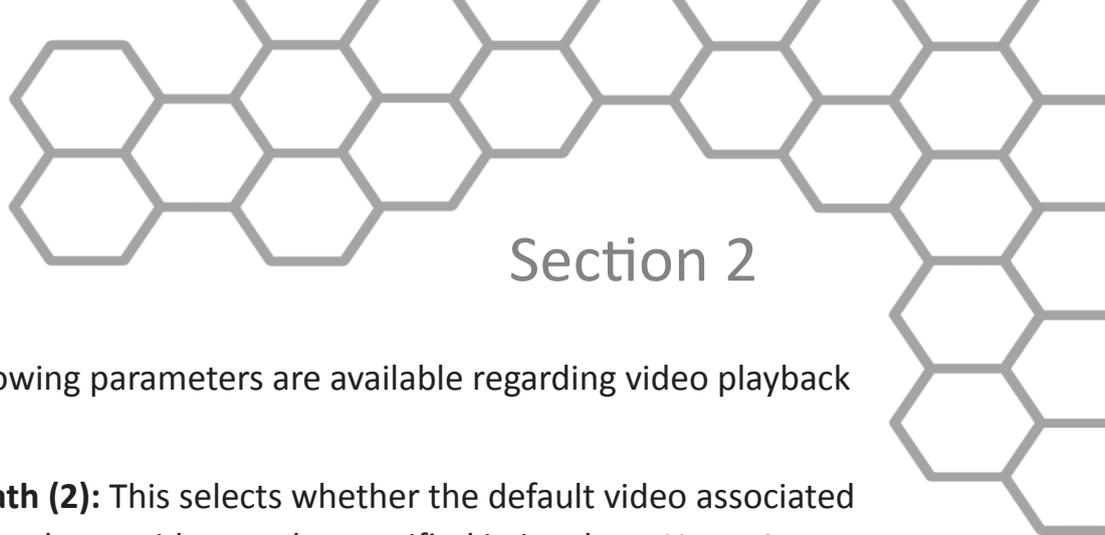


Image 1



Section 2

Refer to Image 1,

Video Settings (1): The following parameters are available regarding video playback during analysis:

Use Default Video Path (2): This selects whether the default video associated with the file will be used, or a video can be specified in its place. Up to 4 videos can be associated with analysis file.

Video Offset (3): These settings allow video playback times to be offset individually for each video file.

Show Video (4): Sets whether the video will be shown during analysis or not.

Edit Settings (5): If there is edit data associated with the current file, it can be selected here and will be used for analysis. Otherwise, only the data within the file will be used.

Output Settings (6): The following parameters are available to specify the type and location of the output files:

Output Mode (7): Output statistics are written to an Excel file.

Use Default Output Path (8): The default output location is a folder named *output data* in the folder which contains the file being analyzed. Within the *output data* folder, files are organized in folders by the date on which they were analyzed. If any of these folders don't exist, they are automatically created when the first output file is written to that directory. A different location to save these files can also be specified in the file box.

Show Report (9): When turned on, the excel spreadsheet will be opened and written to as the user writes segments to the report. When turned off, the spreadsheet will be written following analysis and saved to the specified directory but never opened.

Output Path (10): This area shows the file location for the output. Desired path can be changed by clicking the folder icon and choosing preferred location.

Section 3

Analysis

Once all Pre-Analysis settings are set the analysis can be performed by pressing the green analyze button at the bottom of the screen.



The user will then be shown a segment of data from the channel mapped as ECG (*Image J*). The user can then invert the ECG signal if required. It is important to have the phase of the R-Wave positive for the peak detection to work effectively.

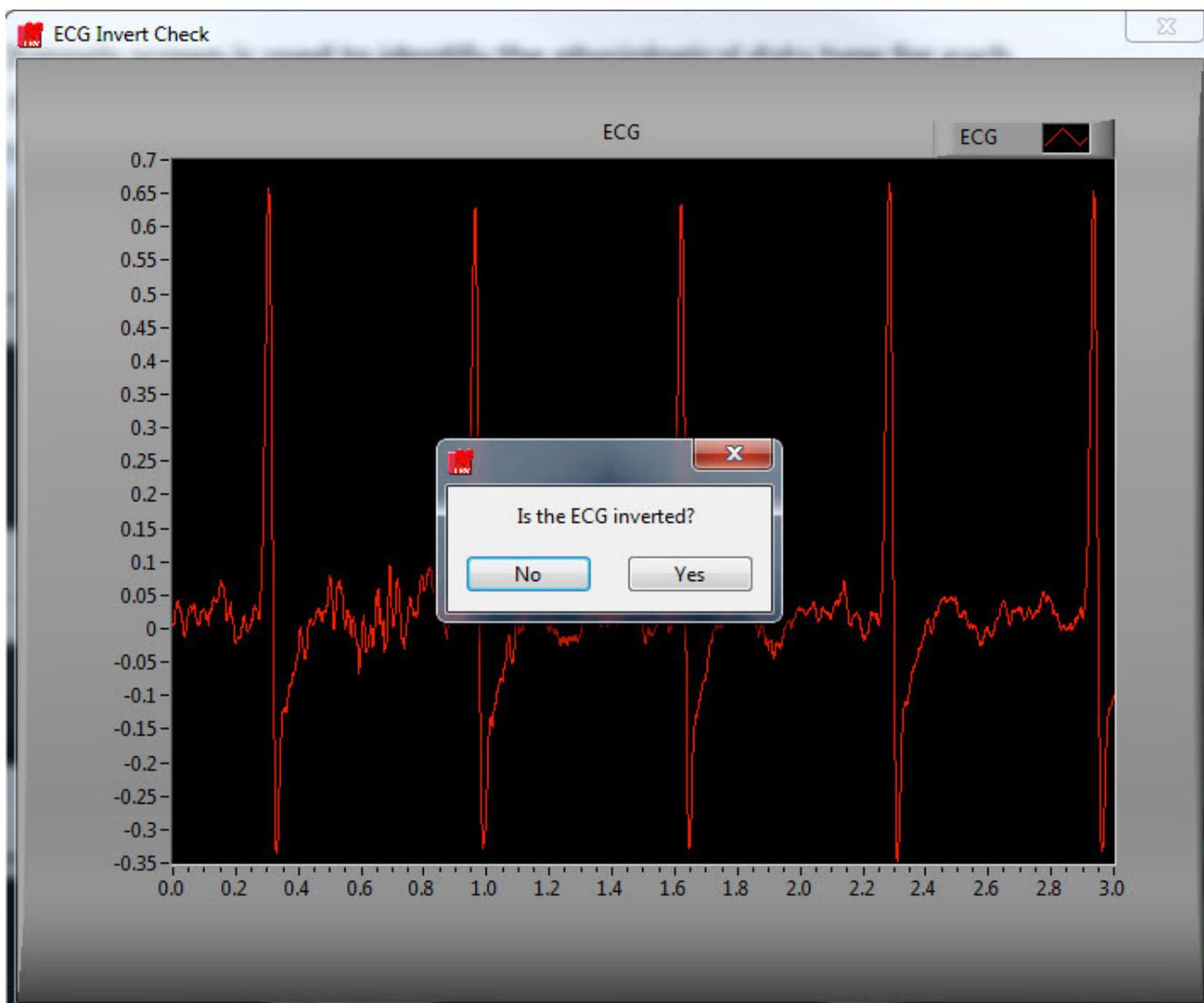
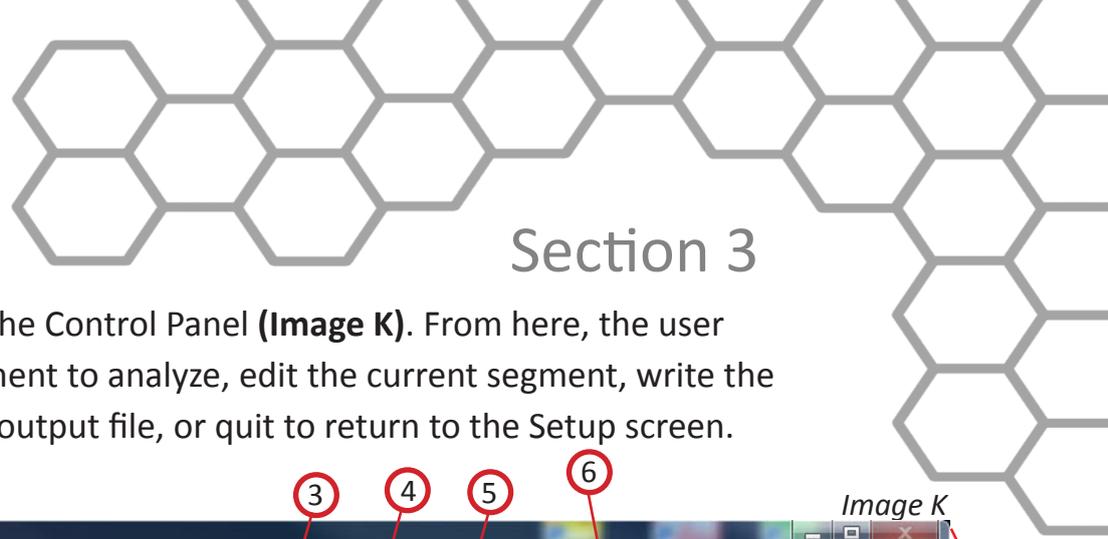
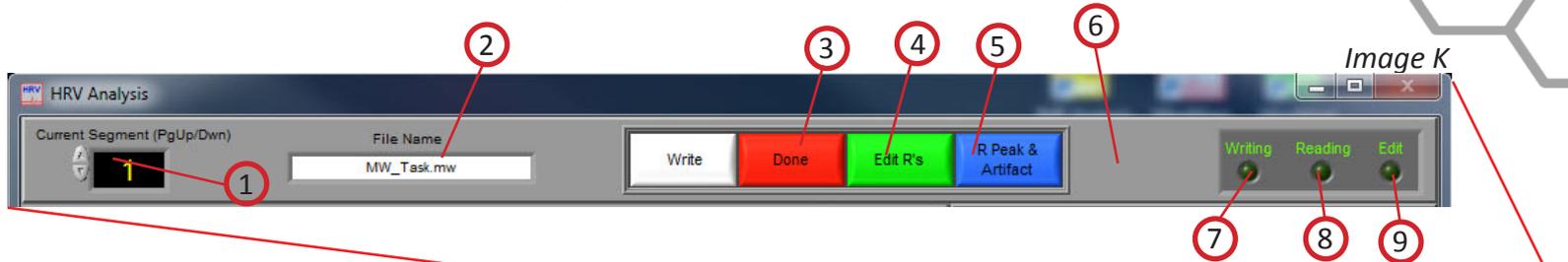


Image J

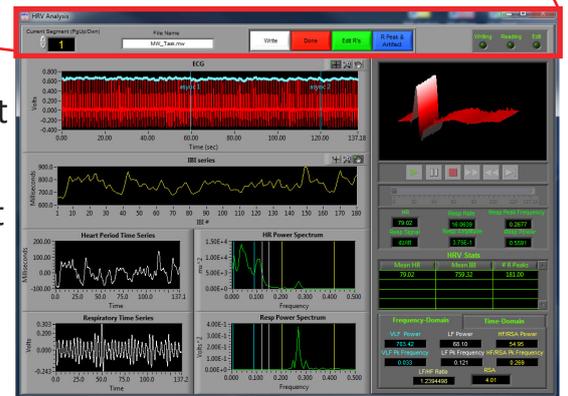


Section 3

On top of the next screen is the Control Panel (**Image K**). From here, the user can select the next data segment to analyze, edit the current segment, write the statistical information to the output file, or quit to return to the Setup screen.



Current Segment (1): The Current Segment control allows the user to switch from one data segment to another. Clicking the Left/Right arrows or clicking the mouse in the selection window can change this value. If the selection window is clicked, all data segments that are available will be displayed depending on the mode criteria in the Setup Screen. Selecting one of these segments will change to that data segment. Pressing the “Page-Up” and “Page-Down” keys allows the user to cycle through the Segments.



File Name (2): This indicator displays the name of the data file being analyzed.

Write (3): The Write control is used to write the analysis results for the current segment into the output format specified during setup. This button must be pressed after each segment or the results will not be saved. If data for this segment already exists in the file, it will be overwritten.

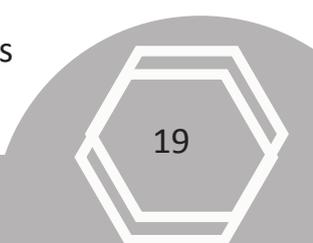
Note: The Write button is disabled when in Real Time mode.

Done (4): This control is used to terminate the current session and return the user to the Setup screen.

Edit R's (5): The Edit control switches the window to the graphical ECG editor. The user can insert, delete or move a marker allowing for the correction of any movement artifact or to manually adjust the values as derived by the peak detector. The user is also able to remove data portions.

Peak Detection (6): Shows menu for adjusting the sensitivity of the peak detection algorithm.

Writing (7): The Writing indicator will be illuminated when the current segment results are being written to the output spreadsheet.

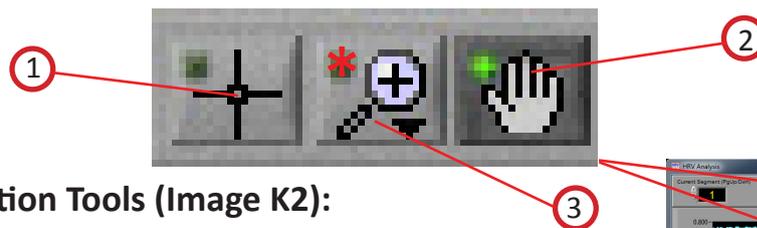


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Reading (8): The Reading indicator will be illuminated when the current data file is being read.

Edit (9): The Edit indicator will be illuminated when edited data is being used. This will be on when the user exits the editor or is using a previously edited file.



Plot Interaction Tools (Image K2):

These icons allow the user to interact with the plotted data in the ECG and IBI displays.



Crosshair Tool (1): Default tool, allows non-interactive navigation of plotted data.

Hand Tool (2): Allows user to move plotted data by clicking and dragging to desired position.

Zoom Tool (3): Can be used to visually zoom in and out of plotted data by selecting desired zoom method.

Zoom Methods (Image K3): The zoom tool has multiple methods of interaction.

Selection Zoom (1): Zooms into area by clicking and dragging selection box over desired position.

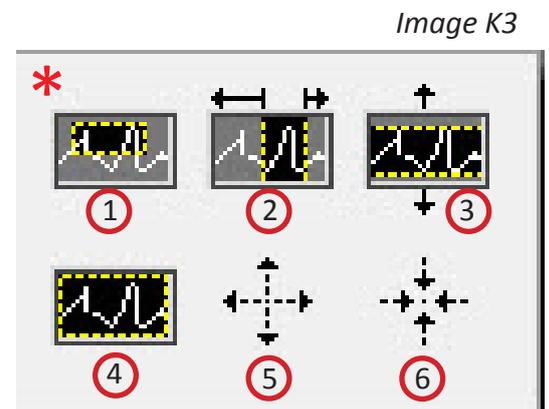
Zoom X (2): Zooms along the x-axis.

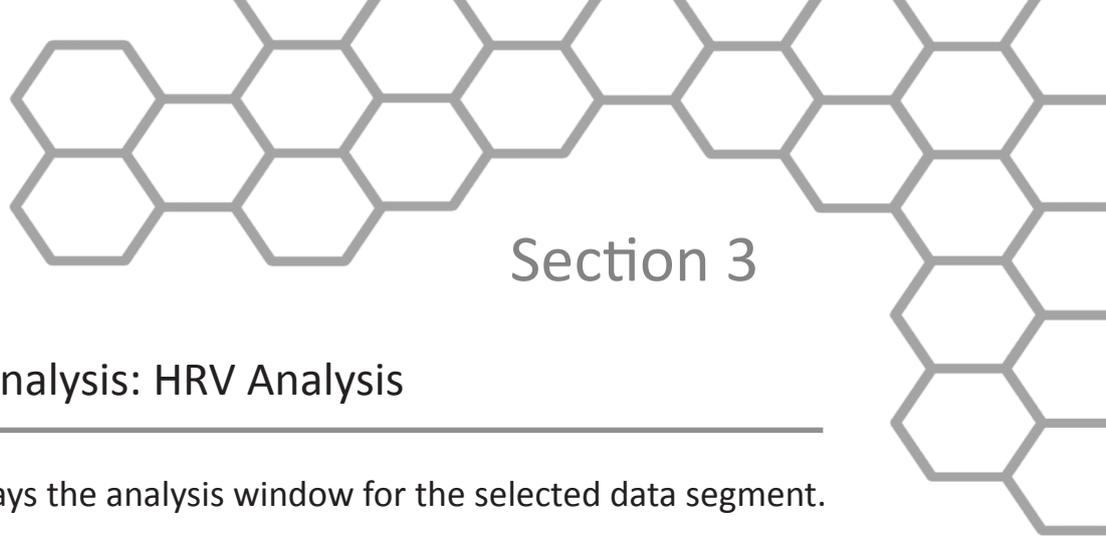
Zoom Y (3): Zooms along the y-axis.

Reset: (4): Resets view to default.

Zoom In (5): Zooms in by clicking

Zoom Out (6): Zooms out by clicking





Section 3

Analysis: HRV Analysis

The HRV Analysis screen displays the analysis window for the selected data segment.



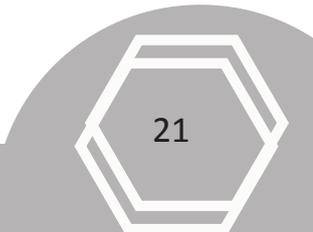
Image L

There are six plots visible on this screen (Refer to *Image L*):

ECG (1): Displays the ECG waveform from the current segment.

IBI (2): The IBI series as derived from the R Peaks detected on the ECG waveform.

Heart Period Time Series (3): The values plotted in this window are the IBI series sampled in milliseconds.



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HR Power Spectrum (4): The values plotted in this window are the output of the Heart Period Time Series.

Respiration Time Series (5): The respiration waveform for the current segment.

Resp Power Spectrum (6): The values plotted here are the spectral output of the Resp Time Series.

There are three colored bands shown on the HR Power Spectrum and Resp Power Spectrum plots. Each represents a specific frequency range in the power spectrum. (VLF Band = Blue, LF Band = White, HF/RSA Band = Yellow).

Video Controls (Refer to *Image M*):

In the upper right hand corner of the screen, the video selected during setup is displayed. Below it are the various video playback controls:



Play: This control initiates playback of the video at normal speed from the specified location.



Pause: This control pauses playback of the video at the current location.



Stop: This control stops playback of the video and returns to the start of the segment.



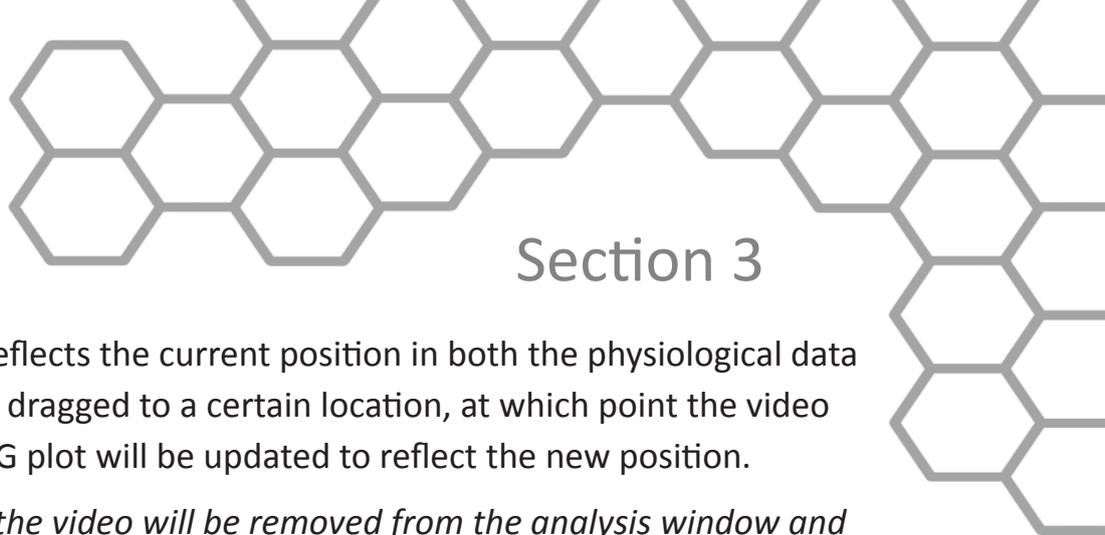
Fast Forward: This control speeds playback of the video up to 2x normal speed.



Rewind: This control rewinds the video at 2x normal speed.



Slow: This control slows playback of the video to half normal speed.



Section 3

Position Slider (1): This control reflects the current position in both the physiological data and the video playback. It can be dragged to a certain location, at which point the video and the position cursor in the ECG plot will be updated to reflect the new position.

Note: By pressing CTRL+U the video will be removed from the analysis window and re-opened in its own resizable, floating window (3). To return the video to the analysis window, press CTRL+D.



ECG Ensemble Elements (2): In the event that either the video is undocked or there was no video selected to be shown during setup, the video display is replaced by the ECG Ensemble Elements Plot.

The 3D plot displays the ensemble average of all of the ECG waveforms found in this data segment. The plot can be rotated to show different views by selecting or holding the plot with the left mouse button and moving to a different viewpoint.



Image M

Section 3

Calculated Statistics (Refer to *Image N*):

Below the video controls, in the lower right hand corner of the HRV Analysis screen, are the calculated stats on the current data segment:

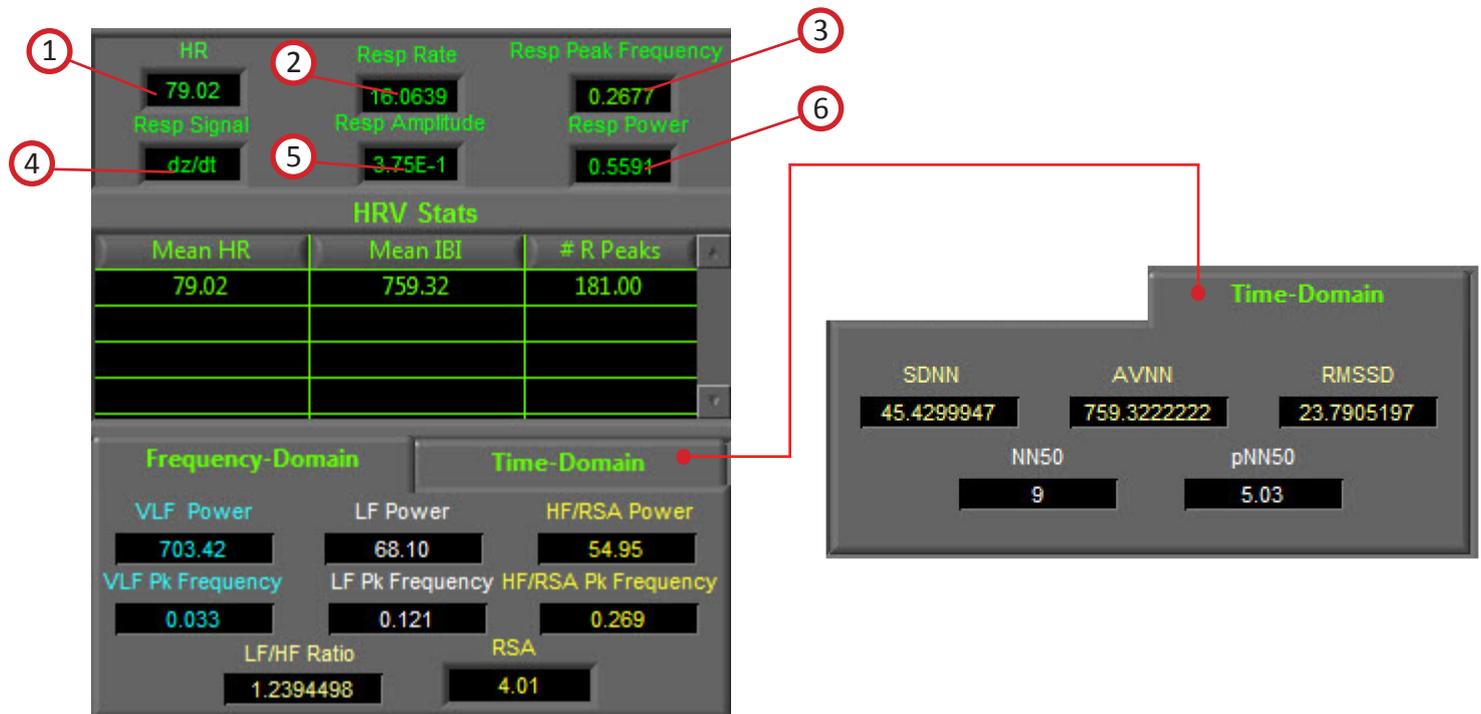


Image N

HR (1): This value represents the mean heart rate for this segment.

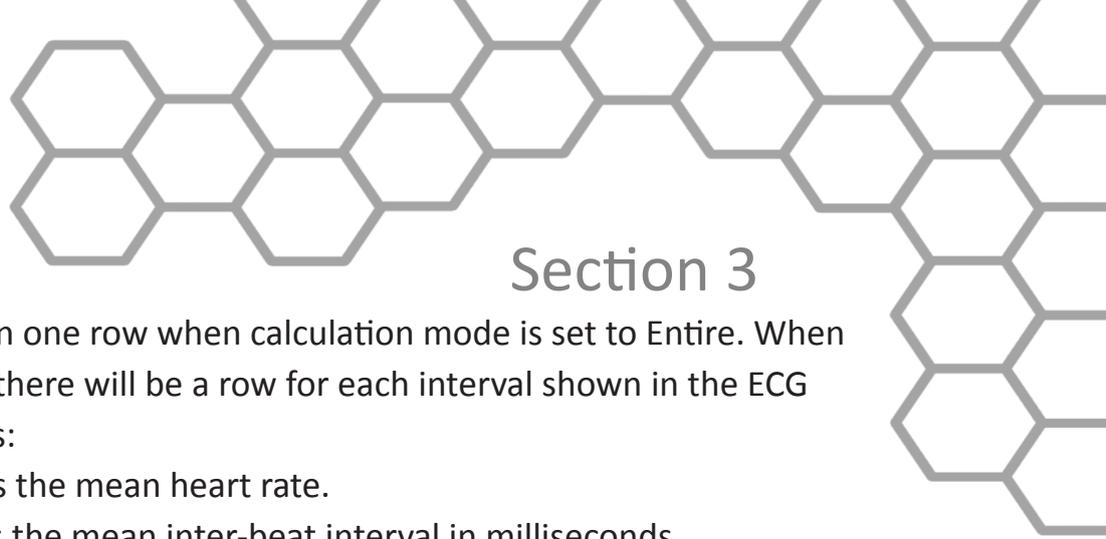
Resp Rate (2): This value represents the respiration rate measured in breaths per minute as derived from the Resp Power Spectrum.

Resp Peak Frequency (3): This value represents the peak frequency in the respiration power spectrum.

Resp Signal (4): This value shows the source used to derive respiration.

Resp Amplitude (5): This value represents the mean respiration amplitude for this segment.

Resp Power (6): This value represents the spectral power in the respiration power spectrum.



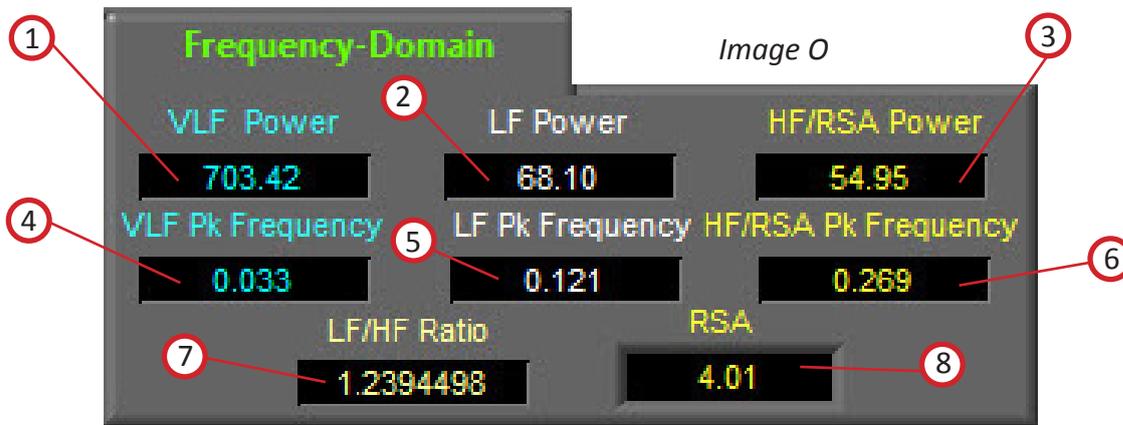
Section 3

HRV Stats (7): This table will contain one row when calculation mode is set to Entire. When calculation mode is set to Interval, there will be a row for each interval shown in the ECG plot. This table contains three fields:

Mean HR (8): This value represents the mean heart rate.

Mean IBI (9): This value represents the mean inter-beat interval in milliseconds.

#R Peaks (10): This value represents the number of R peaks that were detected within the window.



Frequency-Domain (Image 0): This submenu contains frequency domain values pertaining to the calculation of RSA. The following calculated values are shown:

VLF Power (1): This value represents the amplitude in the heart rate power spectrum at the frequency identified as VLF Peak Frequency.

LF Power (2): This value represents the amplitude in the heart rate power spectrum at the frequency identified as LF Peak Frequency.

HF/RSA Power (3): This value represents the amplitude in the heart rate power spectrum at the frequency identified as HF/RSA Peak Frequency.

VLF Peak Frequency (4): This value represents the peak frequency in the heart rate power spectrum as measured in the VLF Frequency Band.

LF Peak Frequency (5): This value represents the peak frequency in the heart rate power spectrum as measured in the LF Frequency Band.

HF/RSA Peak Frequency (6): This value represents the peak frequency in the heart rate power spectrum as measured in the HF/RSA Frequency Band.

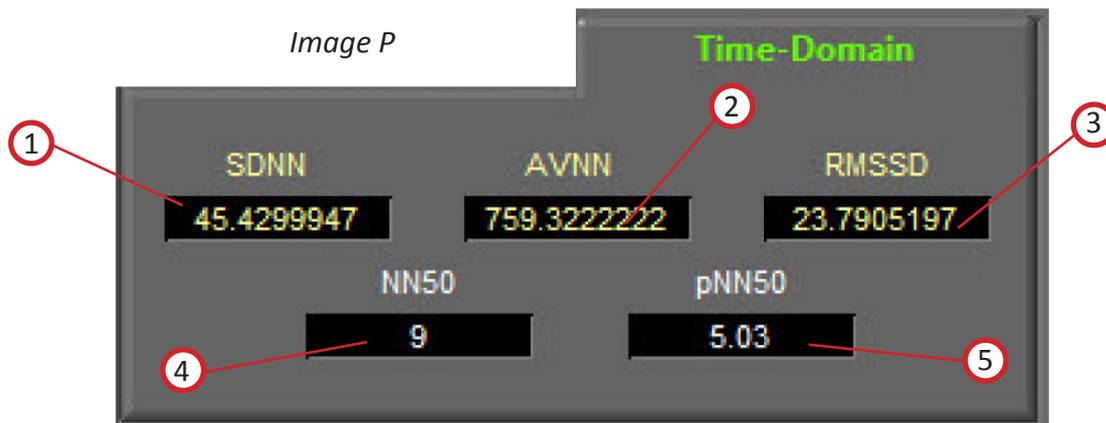
LF/HF Ratio (7): This value represents the ratio of Low Frequency Power divided by the High Frequency Power.

RSA (8): This value represents the RSA value for the current segment.

Section 3

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Time-Domain (*Image P*): This submenu contains time domain calculations derived from NN intervals in the IBI series. The following calculated values are shown:



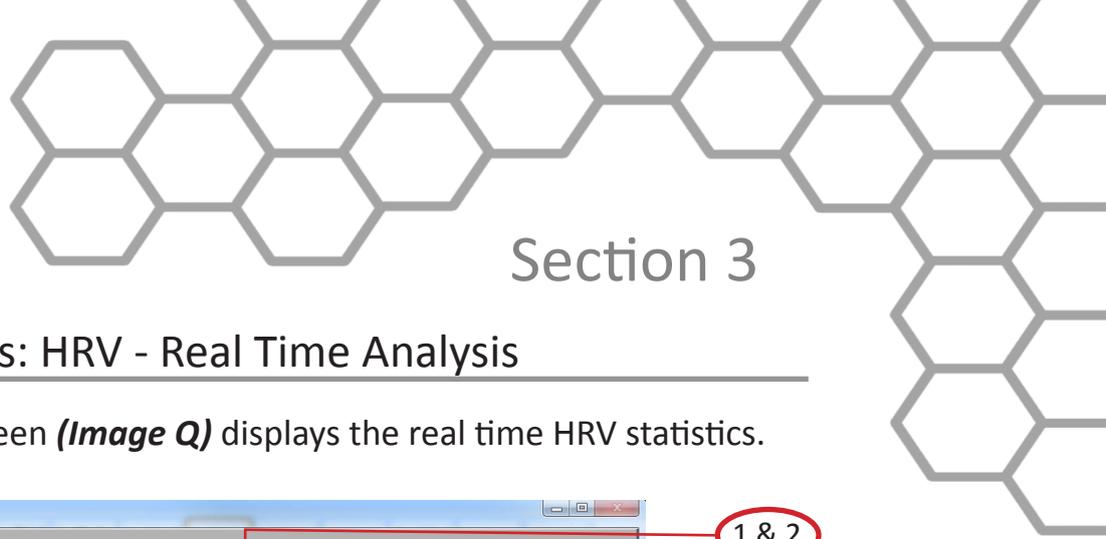
SDNN (1): This value represents the standard deviation of NN intervals.

AVNN (2): This value represents the average of all NN intervals.

RMSSD (3): This value represents the root mean square of successive NN intervals.

NN50 (4): This value represents the number of NN intervals which differ by more than 50 ms from the previous interval.

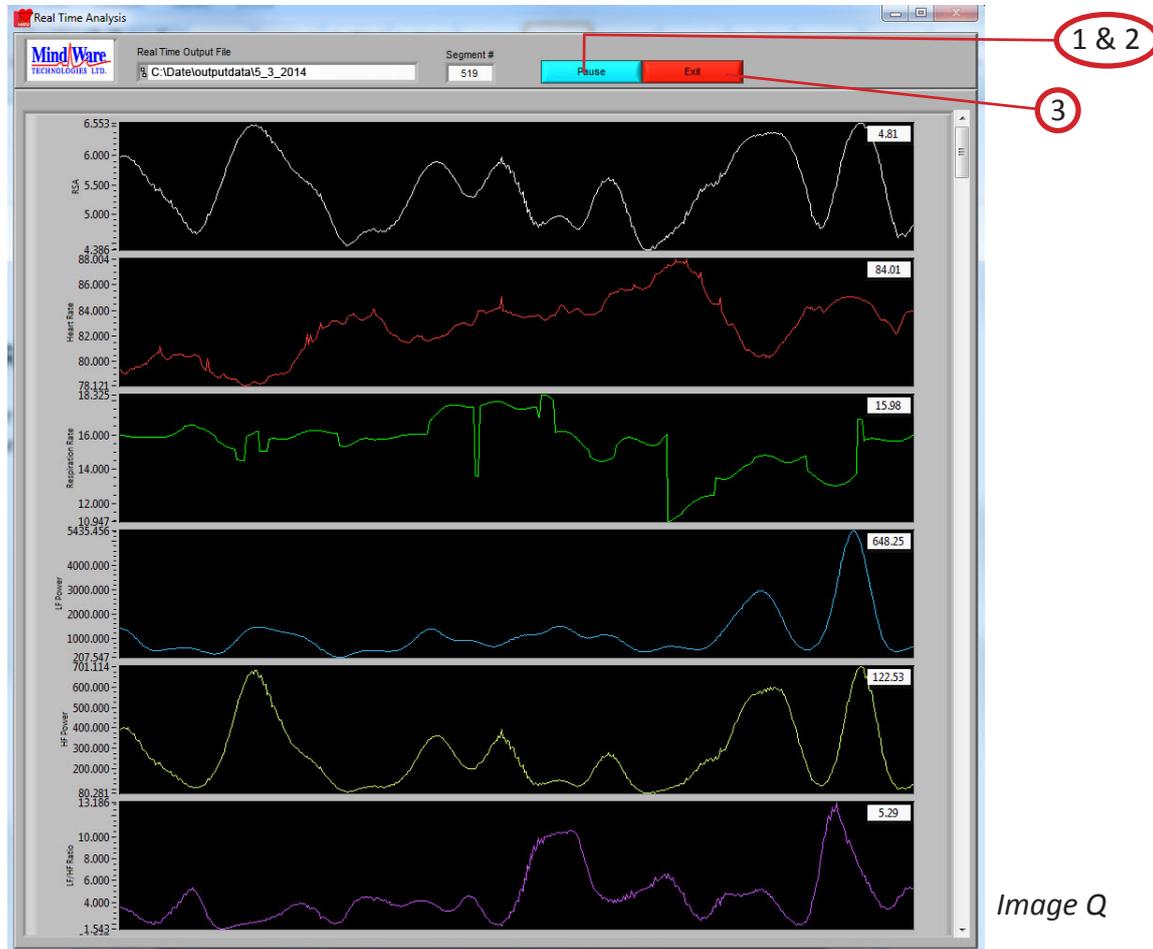
pNN50 (5): This value represents the fraction of NN intervals which differ by more than 50 ms from the previous interval.



Section 3

Analysis: HRV - Real Time Analysis

The HRV Real Time Analysis screen (*Image Q*) displays the real time HRV statistics.

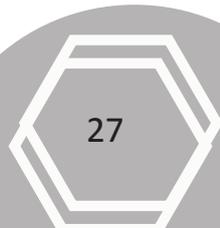


This screen will either appear on its own, or along with the standard Analysis screen depending on the setting on the Setup screen. On this screen, a plot is shown for each of the selected HRV statistics. As these statistics are calculated second by second, their values appear in their respective charts. This screen can be expanded to display more plots at a time, or these additional plots are available by scrolling down. The following options are available (*Image Q*):

Pause (1): Will temporarily stop the calculation of the real time stats.

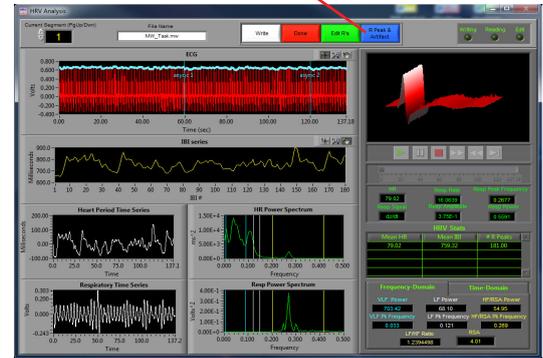
Resume (2): Will continue the calculation of the statistics (Only available when analysis is paused).

Exit (3): This control will end the calculation of real time stats and close this window.



Section 4

Signal Editor



ECG Editor:

This screen can be accessed by clicking the green “Edit R’s” button at the top of the Analysis Screen.

The ECG Editor (*Image R*), is an easy to use, yet powerful tool allowing for the modification of the placement of ECG R-peaks detected programmatically from the peak detection algorithm. It is a graphical based editor and will carry any modification that is made back to the analysis screen. The editor has built in artifact detection algorithms and will dynamically update the graph as points are edited.

There are two waveforms visible from within the editor. Displayed in red is the ECG time series with the peaks marked in light blue. Displayed in blue is the respiration time series.

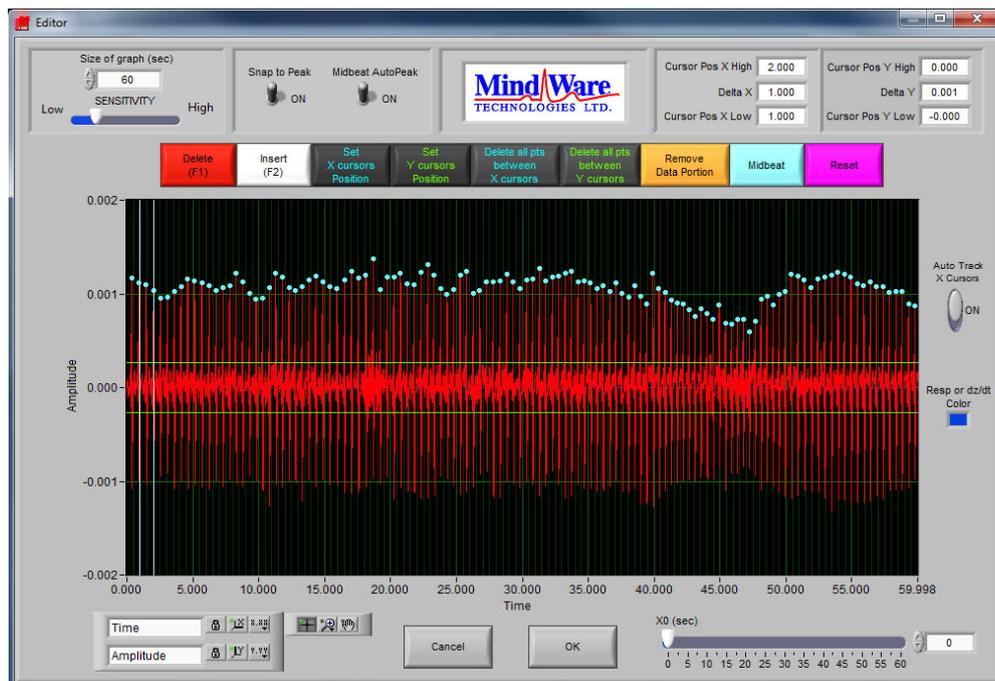
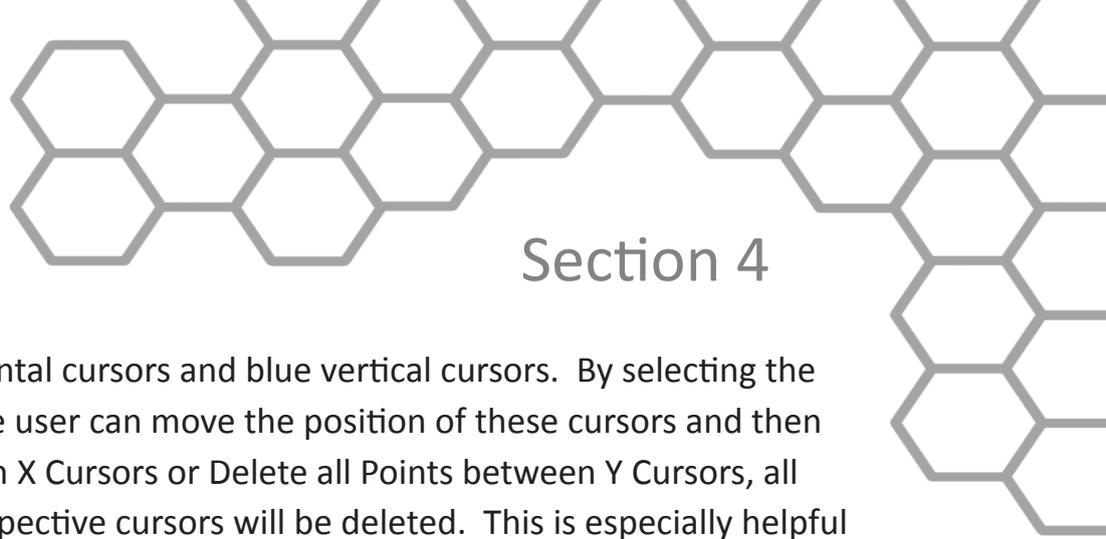


Image R



Section 4

There is also a set of green horizontal cursors and blue vertical cursors. By selecting the crosshair tool under the graph the user can move the position of these cursors and then click the Delete all Points between X Cursors or Delete all Points between Y Cursors, all peaks detected between their respective cursors will be deleted. This is especially helpful for removing large T components of ECG. This will only remove the markers on the ECG waveform.

Image R2



ECG waveform graph (Image R2): The ECG waveform is displayed in red. The blue markers denote the R peaks as detected from the peak detection algorithm. The yellow circular markers with cross hair markers denote potential artifact detected by the error detection algorithms. The Y values are scaled in volts and the X values are in time (seconds). The graph tools window in the bottom left has three tools for aid in editing. The tool with the cross hairs should be used for inserting and/or deleting points and takes the form of a circle that can be scaled in size to manage more or less points. The size of the circle is directly linked to the sensitivity bar and can be controlled with that or the tracking wheel on mouse. The second tool, the magnifying glass, can be used to zoom in on the graph. The third tool, the hand, is used to scroll through the entire data set. The control in the bottom left corner can be used to zoom out the graph after zooming in by clicking on the X or Y button to zoom the graph back to its original position. This graph also contains cursors used to delete multiple points simultaneously. These cursors can be dragged freely to a desired location.

More detailed descriptions found further in the following pages of Section 4.

Section 4

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Settings (Image 5):



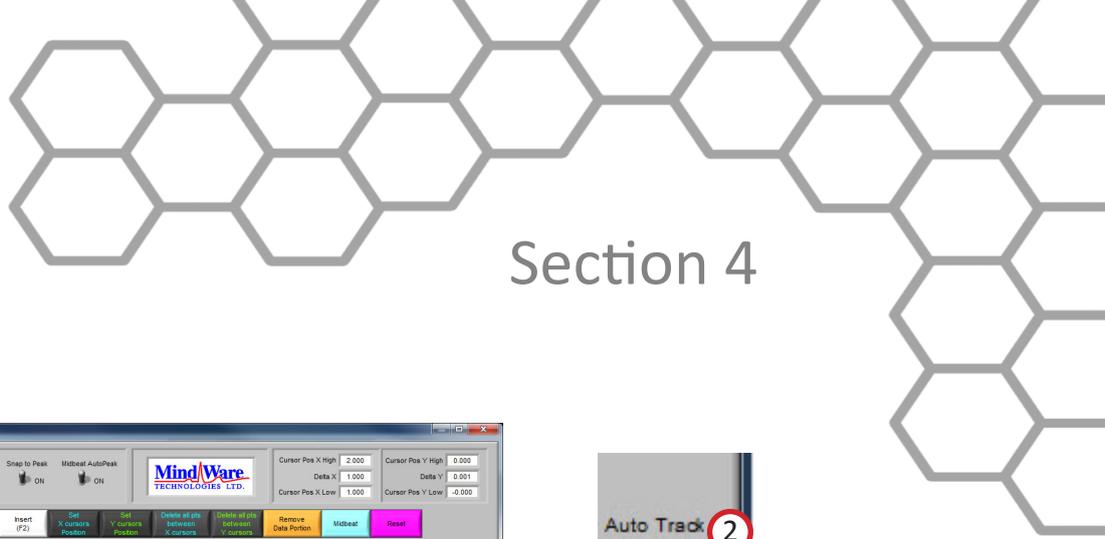
Image 5

Size of Graph (seconds) (1): The Size of Graph control determines how much of the waveform to display at once. This value can be changed to fit less data onto the screen at once much like a zoom window.

Snap to Peak Control (2): The snap to peak switch when in the “On” position will enable the snap to peak algorithm for point insertion. When the snap to peak switch is in the “OFF” position, it disables the snap to peak algorithm and allows for manual insertion of a point at the point clicked upon within the graph indicator. To successfully insert a point using the snap to peak setting, the user must also click the mouse within a band defined by the sensitivity control. The lower the sensitivity control, the more precisely the user must click on the exact spot of desired insertion. The higher the sensitivity control, the less precise the user needs to be, but this can cause point insertion at a place other than the desired point and removal of too many points when deleting.

Midbeat Auto Peak Control (3): When the Midbeat Auto Peak Control is in the “On” position the mid beat algorithm is enabled. When the switch is in the “Off” position the midbeat control will mark a position exactly half way between the two selected points.

Cursor Lines Information (4): This section gives the location of the x and y line cursors and the distance between them in numeric values.



Section 4

Image T



Settings Continued (Image T):

X0 (seconds) (1): The X0 control determines where to start the graph in time. The user can slide this control to move their way through the segment in the edit screen.

Auto-Track Cursors (2): When activated, the cursors will retain their position on the screen as the data is scrolled through. When off, the cursors keep their position in the data and can leave the screen if scrolled past.

Resp or dZ/dt Color (3): This color box shows the current color of the respiration or dZ/dt plot. Clicking this control allows the user to change the color of this plot.

Section 4

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Tools (Image U):

Image T



Set X Cursor Position (1): The Set X Cursor Position brings up a window through which the user can set the high and low position of the X cursors by changing their numerical value. The Cursor Pos X Low and Cursor Pos X High show these settings.

Set Y Cursor Position (2): The Set Y Cursor Position brings up a window through which the user can set the high and low position of the Y cursors by changing their numerical value. The Cursor Pos Y Low and Cursor Pos Y High show these settings.

Delete (F1) (3): This control latches when pressed until pressed again. If the points are within the range defined by the sensitivity control and the mouse click they will be deleted.

Note: Sensitivity is represented by cursor circle that can be scaled in size to manage more or less points. The scaling is directly linked to the sensitivity bar and can be controlled with that or the tracking wheel on mouse.

Insert (F2) (4): This control latches when pressed until pressed again. If the points are within the range defined by the sensitivity control (visible as scalable cursor circle) and the mouse click they will be inserted at the point of the mouse click or at the peak defined by the snap to peak window control above as long as snap to peak is on.

Delete All Points Between X Cursors (5): All points within the boundary defined by the vertical blue cursors will be removed.

Delete All Points Between Y Cursors (6): All points within the boundary defined by the horizontal green cursors will be removed.

Remove Data Portion (7): This control will remove all data within the boundary defined by the cursors.

Midbeat (8): This control will mark a Midbeat point between two points selected with the X cursors.

Reset (9): This control resets the R peaks to the original state when the editor was first entered.



Section 4

Tools Continued (Image U2):

Crosshair Tool (1): Allows for point and cursor interaction within the plotted data. Default tool for Insert and Delete commands

Hand Tool (2): Allows user to move plotted data by clicking and dragging to desired position.

Zoom Tool (3): Can be used to visually zoom in and out of potted data by selecting desired zoom method.

Zoom Methods: The zoom tool has multiple methods of interaction.

Selection Zoom (4): Zooms into area by clicking and dragging selection box over desired position.

Zoom X (5): Zooms along the x-axis.

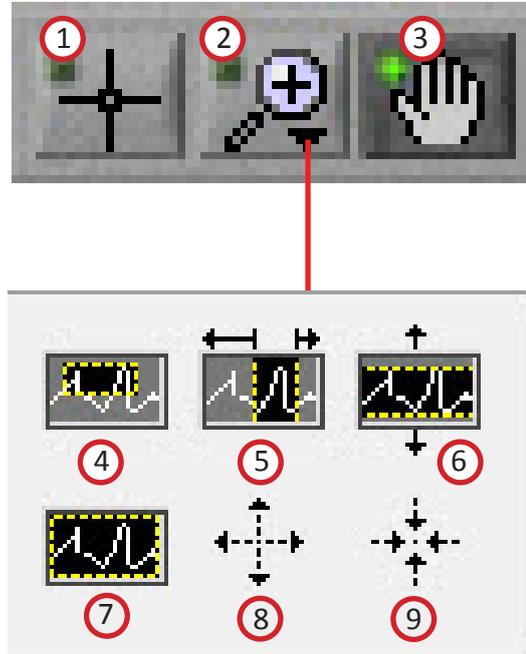
Zoom Y (6): Zooms along the y-axis.

Reset (7): Resets view to default.

Zoom In (8): Zooms in by clicking

Zoom Out (9): Zooms out by clicking

Image U2

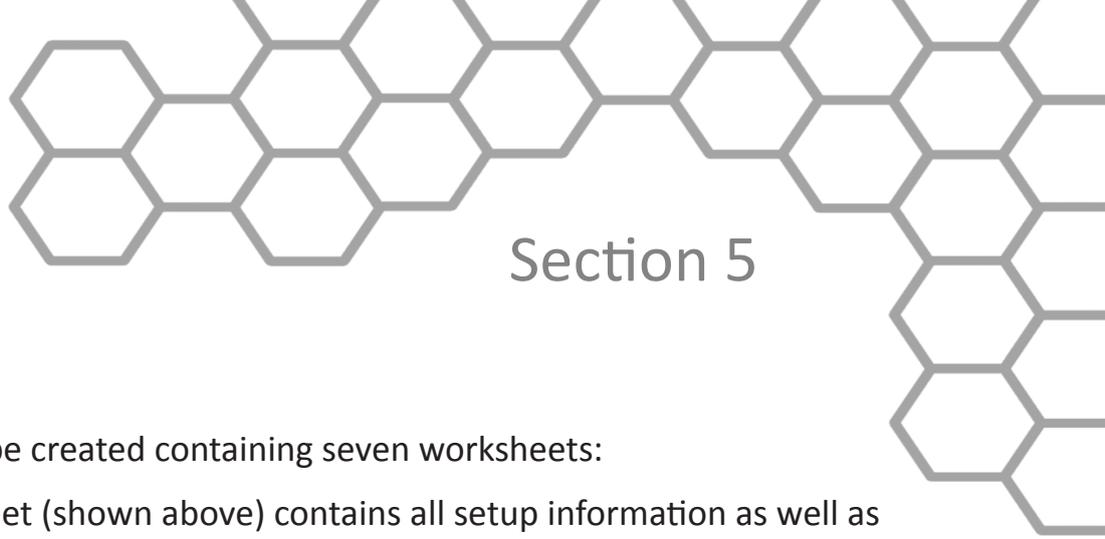


Section 5

Output File

When the Write button is pressed on the Analysis screen, the output file will be written. The file contains all of the statistics from the application as well as the description of the setup. Data files are in Excel format and appear as follows.

| | A | B | C | D |
|----|------------------|--------------------|---|---|
| 1 | Version | 3.1.0 | | |
| 2 | Date | 5/8/2014 | | |
| 3 | Time | 1:18 PM | | |
| 4 | File Name | C:\Data\MW_Task.mw | | |
| 5 | Event File Name | N/A | | |
| 6 | Analysis Mode | Time | | |
| 7 | Event Filter | N/A | | |
| 8 | Event Identifier | N/A | | |
| 9 | Start Time | 0 | | |
| 10 | Segment Time | 60 | | |
| 11 | End Time | 577.9 | | |
| 12 | Event Mode | N/A | | |
| 13 | Pre-Event Time | N/A | | |
| 14 | Post-Event Time | N/A | | |
| 15 | Event to Use | N/A | | |
| 16 | All Instances | N/A | | |
| 17 | 1st Event | N/A | | |
| 18 | 2nd Event | N/A | | |
| 19 | # of Events | N/A | | |
| 20 | Event/Time Event | N/A | | |
| 21 | 1st Event | N/A | | |
| 22 | Segment Time | N/A | | |
| 23 | | | | |
| 24 | Edit File Used? | No | | |
| 25 | Edit File Name | N/A | | |
| 26 | | | | |
| 27 | Sampling Freque | 1000 | | |



Section 5

An Excel spreadsheet file will be created containing seven worksheets:

HRV Stats: This worksheet (shown above) contains all setup information as well as the calculated statistics from the specified segment of data.

IBI Series: This worksheet contains the IBI series derived from the specified segment of data.

Power Band Stats: This worksheet contains the stats about each power band for the specified segment of data.

Heart Period Time Series: This worksheet contains the heart period time series from the specified segment of data.

Heart Period Power Spectrum: This worksheet contains the heart period power series from the specified segment of data.

Respiration Time Series: This worksheet contains the respiration time series from the specified segment of data.

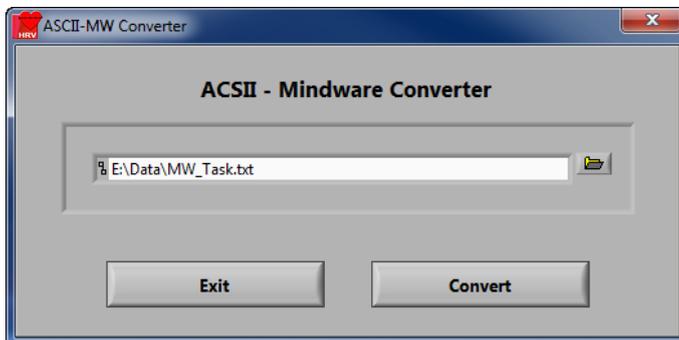
Respiration Power Spectrum: This worksheet contains the respiration power series from the specified segment of data.

When in **Interval Mode**, an additional worksheet will be created titled Interval Stats, which contains the mean heart rate, mean IBI, and # of R Peaks from each of the intervals in the current data segment.

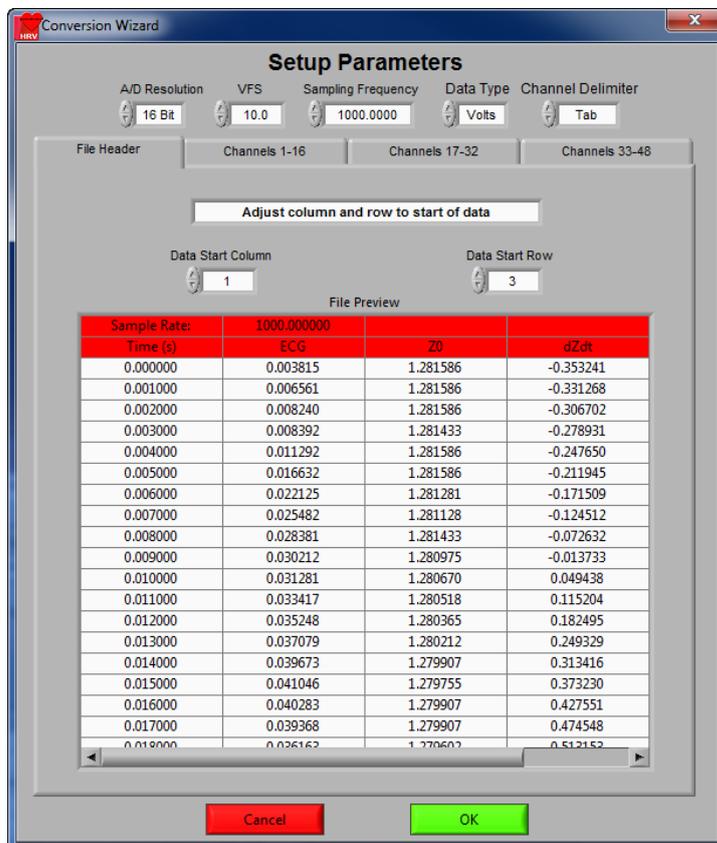
When in **Real Time Analysis Mode**, a different output file is written containing the real time HRV statistics second by second in a tab-delimited table along with a header containing important setup information. This file is named: **Filename_HRV RT_time.txt** and is stored in the specified Real Time Output Path.

Appendix A

Appendix A: ASCII-MW Converter



The ASCII-MW Converter allows the conversion of any text file containing data in some character-delimited columns to the .mw format so that it may be used in any analysis application. To begin conversion, select a text file containing data by using the browse button on the file path control and pressing Convert. To exit the converter and return to the setup screen, press Exit.





Appendix A

The next screen in the conversion process is the Text File Conversion Wizard. From this screen, details about the data in the text file must be entered in order to properly scale and display the data in the analysis applications. It is extremely important that these values are identical to the way the data was acquired to ensure the correct conversion.

A/D Resolution: This control is the resolution of the A/d converters in the hardware used to acquire the data in the file.

VFs: This control is the volts full scale of the hardware used to acquire the data in the file.

Sampling Frequency (Hz): This control is the sampling frequency at which the data in the file was collected.

Data Type: This control specifies whether the data in the file is in volts or A/d counts.

Channel Delimiter: This control specifies the character which is used to separate data channels in the file.

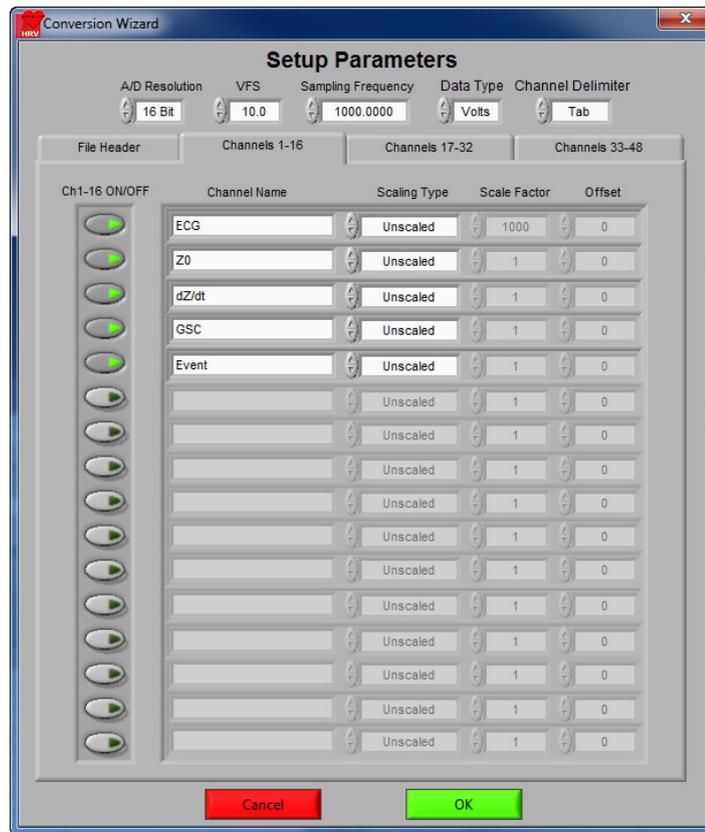
Below these settings is the submenu control. The following submenus are available:

File Header: This submenu contains a preview of the beginning of the selected text file. Using the controls **Data Start Column** and **Data Start Row**, select where the data actually begins in the file past any file header information. Rows and columns which will not be included in conversion appear in red.

Channels 1-16: This submenu contains the channels found in the text file and allows for them to be selected/deselected for conversion.

Appendix A

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The following controls are available:

Channel Names: This control allows the user to specify a name for the data channel to be saved in the .mw file header.

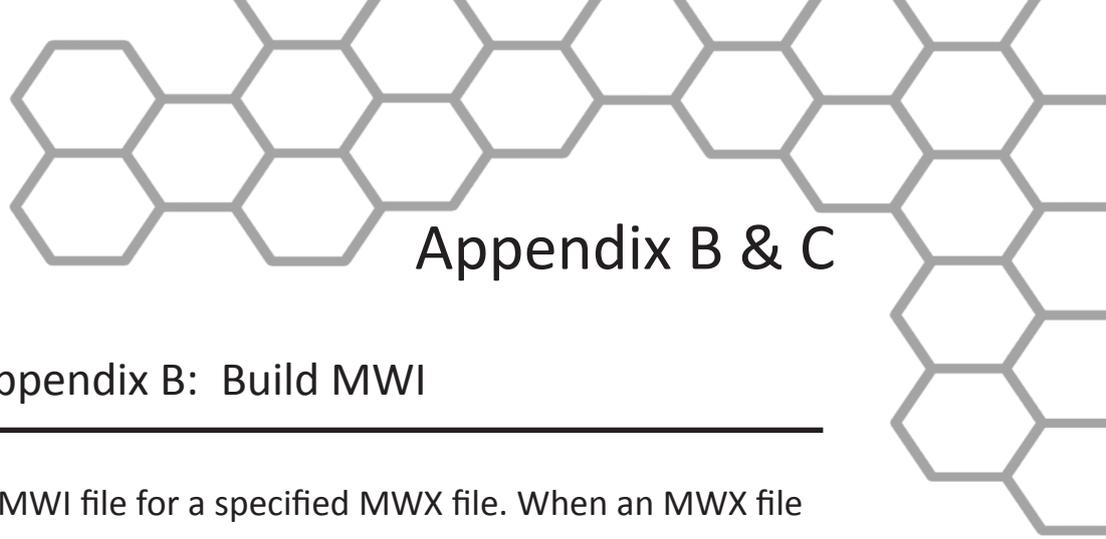
Scaling Type: This control specifies whether the data in the file is scaled or unscaled. If the data is scaled, the Scale Factor and Offset fields will be enabled for modification.

Scale Factor: If the data in the specified channel is scaled, this control represents the factor by which it is scaled.

Offset: This control represents the offset of the scaled data channel.

Submenus **Channels 17-32** and **Channels 33-48** behave in the same way.

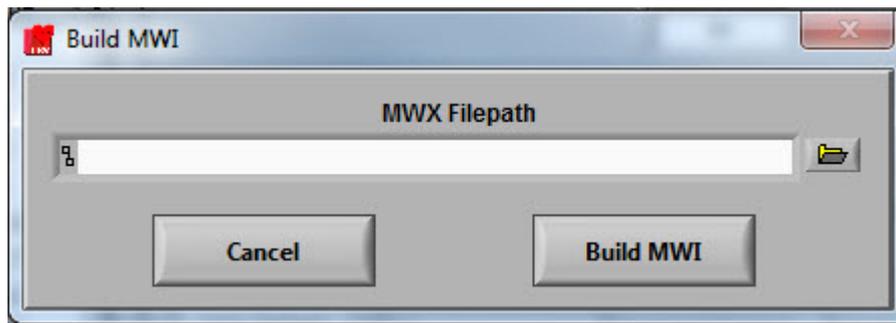
Pressing OK will convert the file to the .mw format (may take several minutes depending on size of data file) and return to the Setup screen. Pressing cancel will return to the file selection window.



Appendix B & C

Appendix B: Build MWI

The Build MWI tool created an MWI file for a specified MWX file. When an MWX file is created without an MWI file (such as in local mode of Mobile Recording), an MWI file will need to be created before that file can be analyzed.



Appendix C: Software Upgrade

MindWare HRV Software will automatically check for new versions of the application on startup. To manually check for updates you can go to Help>>Check for Updates.

It is recommended to keep this feature enabled to ensure the latest version of the application is always being used. However, automatic checking for updates can be disabled on the update notification window.



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