

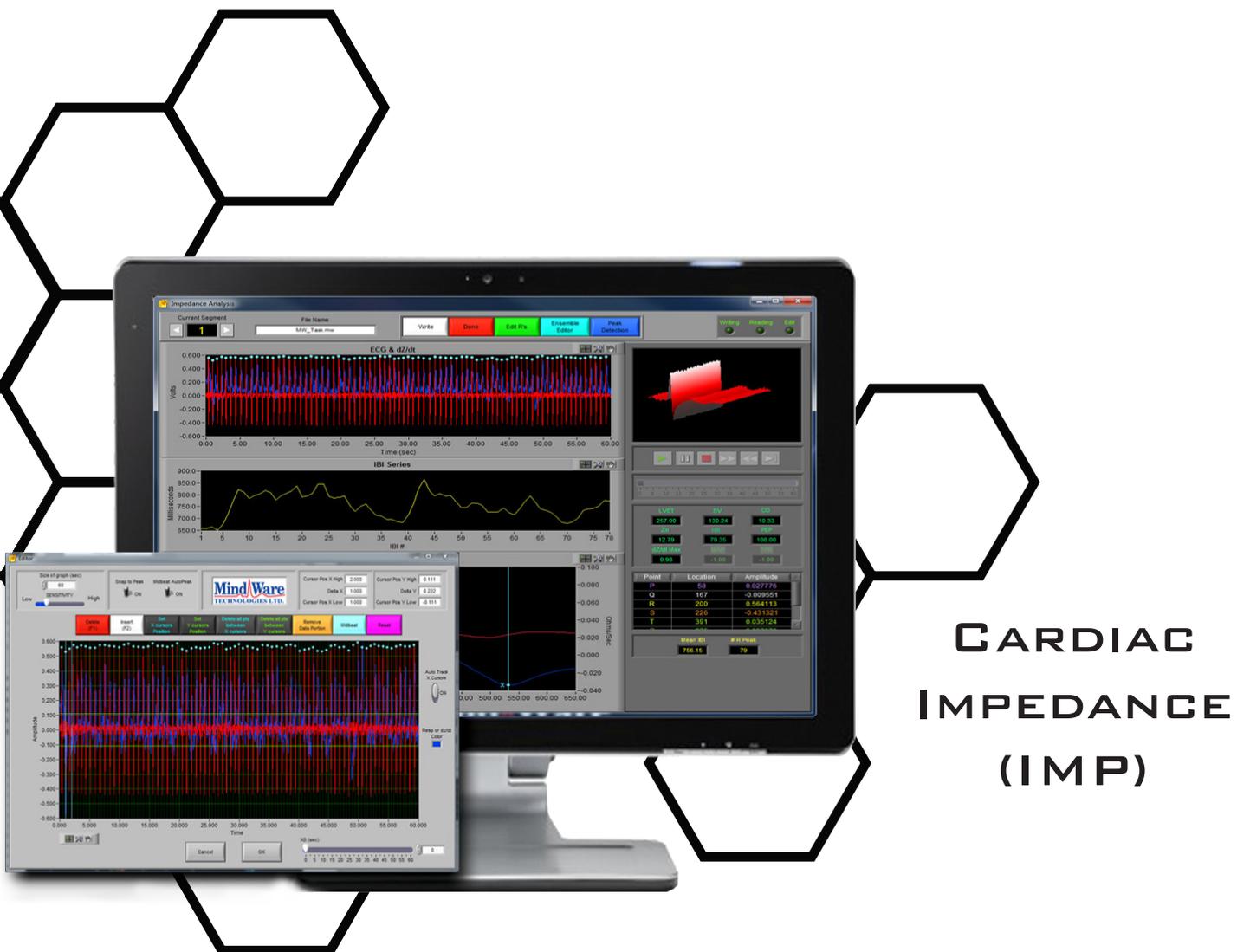
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# USER REFERENCE GUIDE

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## ANALYSIS APPLICATION

Manual



**CARDIAC  
IMPEDANCE  
(IMP)**



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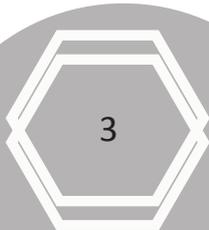
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## **Cardiac Impedance (IMP) Analysis**

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## Section 1

# Channel Mapping

Upon opening the IMP 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. For Cardiac Impedance analysis, Z0, ECG, and Event Channels (if applicable) must be identified (dZ/dt can also be mapped rather than derived from Z0).

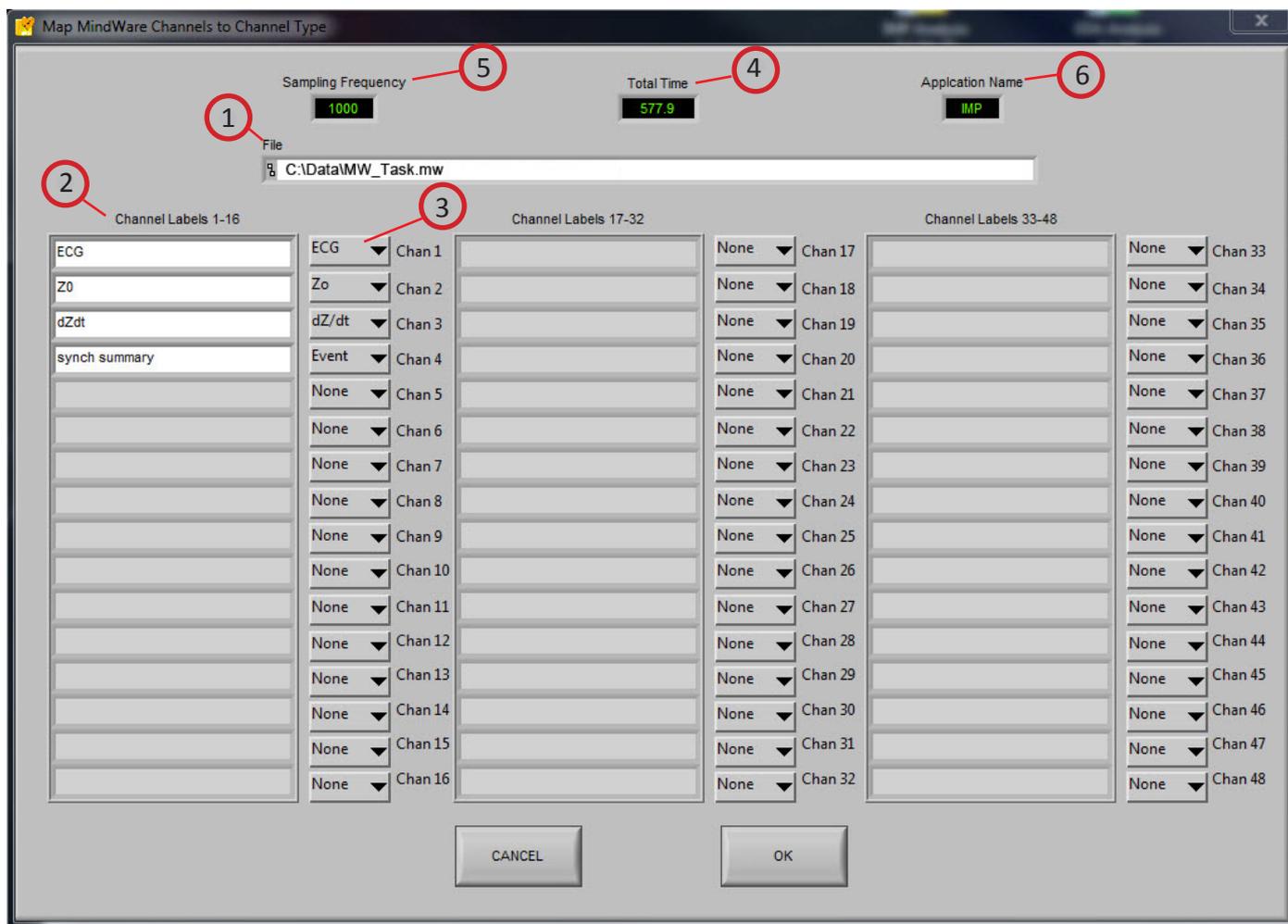


Image A



## Section 1

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.

*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 IMP analysis only the Z0 and ECG channels are required. dZ/dt can be mapped in place of deriving from Z0. 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.

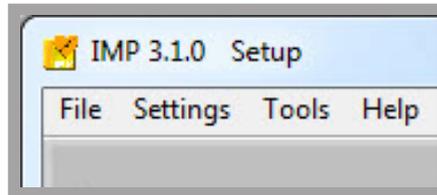
Once the desired channels have been mapped, **press OK to continue** to the Setup screen.

---

## 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:** This option allows a new file to be opened for analysis.

**Re-Map Channels:** This option opens the Map MindWare Channels to Channel Type screen for modifications to be made to the channel map.

**Scaling and Filtering Settings:** This option brings up a window detailing 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:** This option 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.

**Reinitialize 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).

### Help:

**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.

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

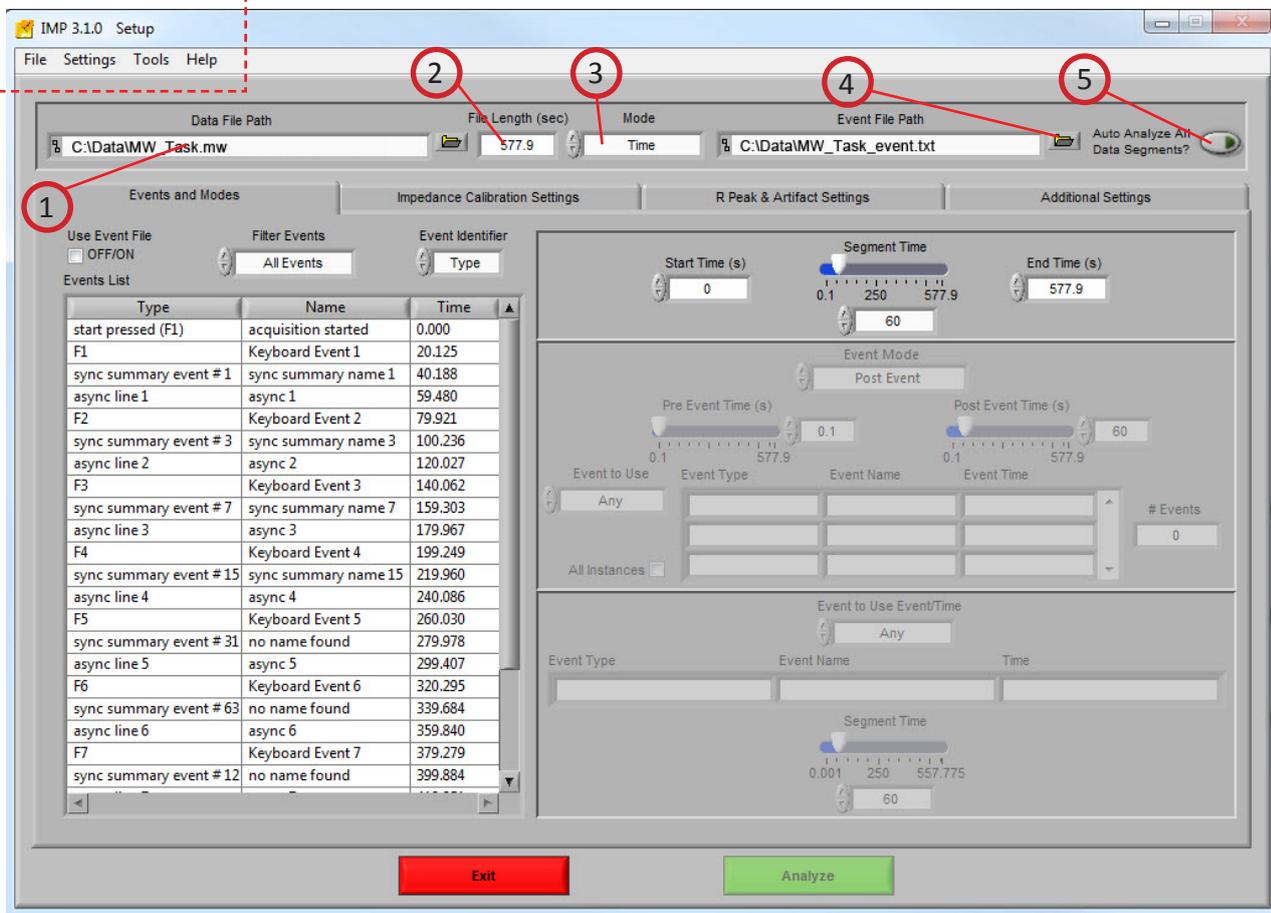


Image B

Refer to Image B,

**(1) Data File Path:** This control shows the current file selected for analysis. Also, by clicking the browse button a new file may be selected for analysis.

**(2) File Length(s):** This indicator shows the total file length in seconds.

**(3) Mode:** This control allows the user to select one of three analysis modes: Time, Event, and Event and Time. The value of this control determines which controls are enabled on the Events and Modes tab.

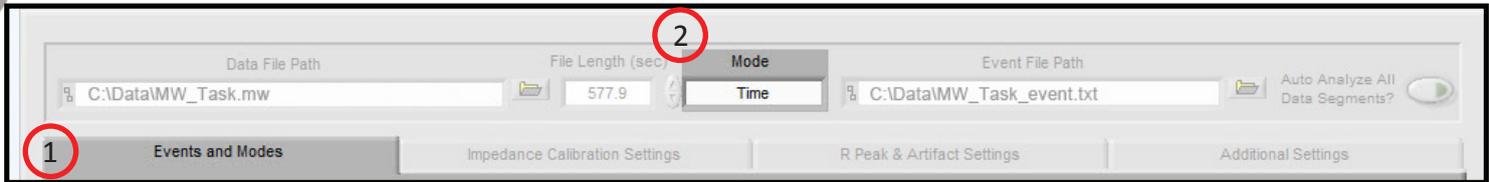
**(4) Event File Path:** If a BioLab event file is being used for analysis, the path of that event file is shown in this indicator.

**(5) Auto Analyze All Data Segments:** When this control is activated, the application will automatically analyze each segment of the dataset and output it to the specified location.

## Section 2

### Setup: Events and Modes

Image C



The first tab on the screen, titled *Events and Modes* (**1, Image C**), allows the user to select 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 BioLab Event File:** When checked, the events displayed are from the BioLab event file. Otherwise, they are detected in the channel mapped as Event.

**Filter Events:** The events shown in the list and used for analysis can be filtered by type to use summary events, keyboard events, individual events, or all events.

**Event Labels:** This control specifies how the event will be labeled when it is shown in the analysis window.

#### **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 (**8**) of the event controls displays all of the events detected in either the MWI File or the channel mapped to “Event”. This can be changed by either marking or unmarking the box named “Use BioLab Event File” above the event list. This list can be filtered by type, including Keyboard, Individual, Summary, or All Events. Also, the type of label which will be displayed on the event during analysis can be set by using the “Event Identifier” control.

## 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:** This is a combination of the previous two modes in which both the length of the data before and after a specified event can be set.

**Pre and Post:** Application will focus on data before a specified Pre event and after specified post event.

**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 of either using any event in the list or specifying a certain event to view. 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.

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:

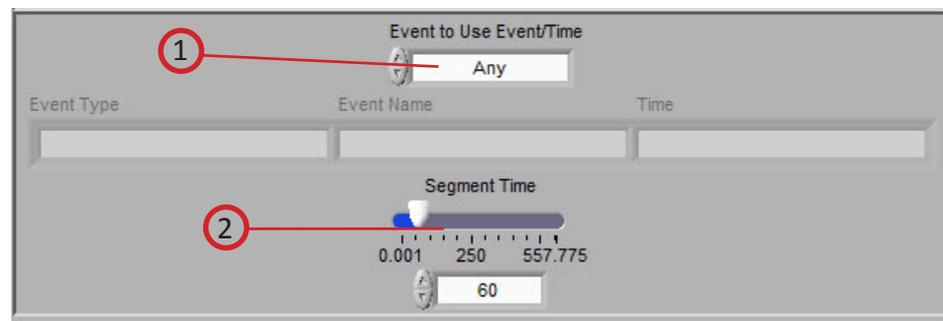


Image E

**Event to Use Event/Time (1):** This has a similar functionality as in 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

---

### Setup: IMP Calibration Settings

The second tab on the screen, titled Impedance Calibration Settings, allows the user to set the electrical properties of the impedance cardiograph as it relates to the recording as well as physical properties for the calculation of cardiac output and stroke volume. There are also settings that allow the user to define various calculation methods used in determining the placement of the Q and the B points on the ensemble waveform and for calculating stroke volume.

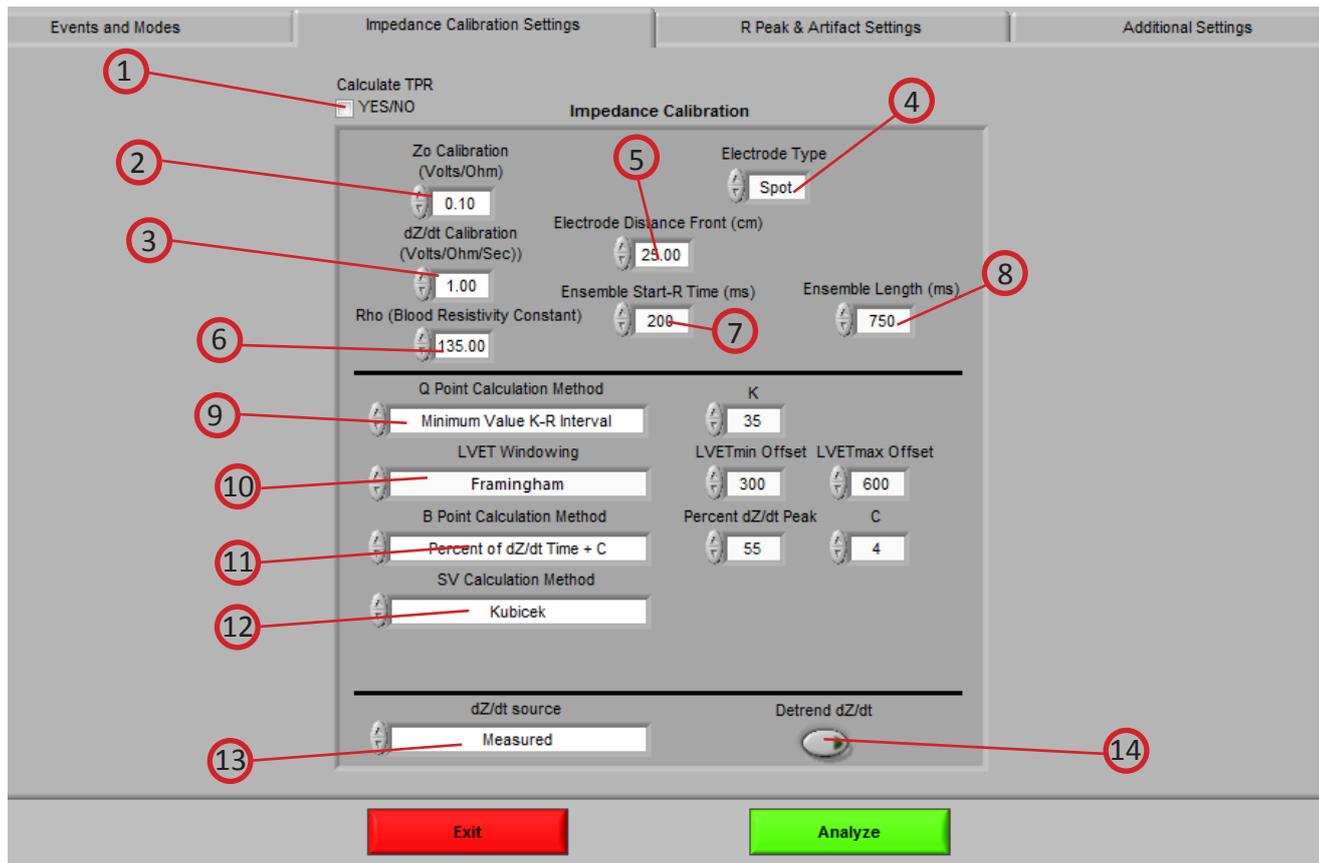


Image G

**Calculate TPR (1):** This control enables the calculation for Total Peripheral Resistance and requires the Excel worksheet generated by the MindWare BPV application.

**Z0 Calibration (Volts/Ohm) (2):** This control sets the relationship of volts per one-ohm change of impedance on the Z0 channel. This value is defined in the specification of the Impedance Cardiograph and will vary by model and manufacturer. When mapped Z0 channel has already been scaled to ohms, this control will be disabled.

**dZ/dt Calibration (Volts/Ohm per Second)(3):** This control sets the relationship of volts per ohms per second change of impedance on the dZ/dt channel. This value is defined in the specification of the Impedance Cardiograph and will vary by model and manufacturer. When mapped dZ/dt channel has been scaled to ohms/sec, this control is disabled.

**Electrode Type (4):** This control sets the type of electrode used in acquisition (either spot or band).

**Electrode Distance Front (cm) (5):** This control sets the distance in centimeters for the front (or side) set of electrodes. This is important in deriving accurate cardiac output and stroke volume parameters. If bands are used, measure the distance of the inner set of bands (bottom of electrode 2 to the top of electrode 3.) If spot electrodes

## Section 2

are being used, measure from the center of electrode 2 to the center of electrode 3.

**Rho (Blood Resistivity Constant) (6):** This control sets the blood resistivity constant. It is typically set as 135 ohms.

**Ensemble Start-R Time (ms) (7):** This control sets the window size (in ms) for the end of the ensemble period.

**Ensemble Length (ms) (8):** This control sets the window size (in ms) for the beginning of the ensemble period.

**Q Point Calculation Method (9):** This control defines the method used in determining proper Q point detection of the ECG waveform. There are three methods to select from:

**R minus Constant:** This method subtracts a constant time interval from the R wave as defined in the R Minus Constant Control (in milliseconds.) This method places the Q at the point on the ECG waveform that is 'n' milliseconds before the R.

**Max Slope Change:** This method places the Q at the point of maximum change in slope of the ECG waveform before the peak.

**Minimum Value K-R Value:** This method searches for the maximum point of slope change in the defined window of time before the R as set by the K Constant control (in milliseconds.)

**LVET Windowing (10):** This control specifies the time window used for identifying the X point on the ensemble dZ/dt waveform. The following methods are available

**Framingham:** The window for identifying X is based on data from the Framingham study and is defined by these equations:

$$\text{LVETmin} = \text{LVETmin Offset} - 0.154 * (1 - \text{RR})$$

$$\text{LVETmax} = (\text{LVETmax Offset} - (2.5 \text{ Heart Rate})) + 0.55 * \text{RZ} + 4.5$$

**RR - C:** The window for identifying X starts at Z and ends at the average RR - constant

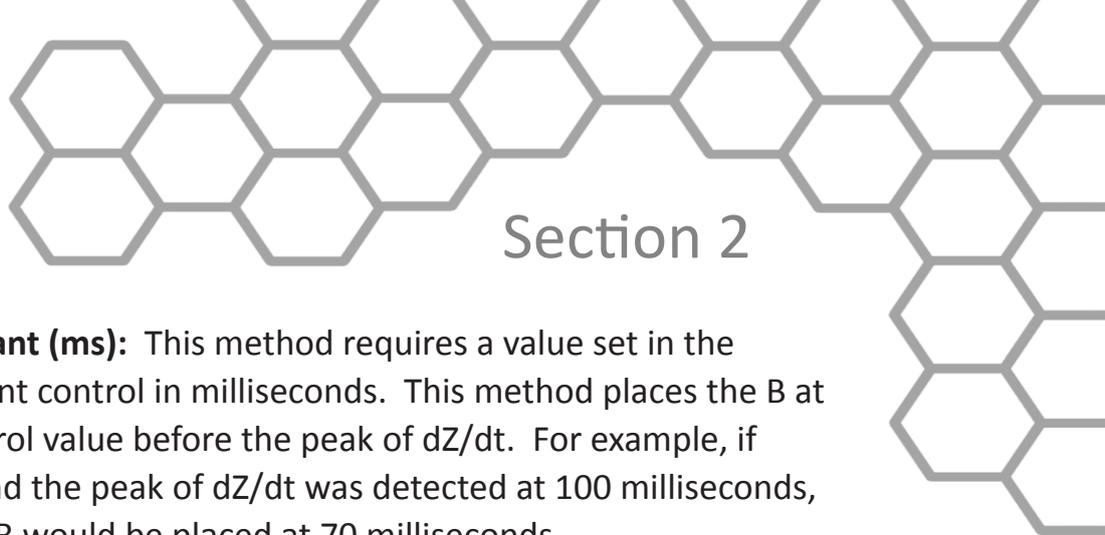
If the X point is unable to be identified within the specified window, it will be estimated using the following equation and the LVET statistic will be flagged red:

$$\text{LVETavg} = 473 - 2 * \text{Heart Rate}$$

**B Point Calculation Method (11):** This control defines the method used in determining proper B point detection of the dZ/dt waveform. There are two methods to select from:

**Max Slope:** This method places the B at the point of maximum slope of the dZ/dt waveform before the peak. The Block Size specifies how many points are used in determining slope.

**Max Slope Change:** This method places the B at the point of maximum change in slope on the dZ/dt waveform before the peak. The Block Size specifies how many points are used in determining slope.



## Section 2

**dZ/dt Peak Minus Constant (ms):** This method requires a value set in the dZ/dt Peak Minus Constant control in milliseconds. This method places the B at the point that is the control value before the peak of dZ/dt. For example, if the control is set to 30 and the peak of dZ/dt was detected at 100 milliseconds, the ensemble waveform B would be placed at 70 milliseconds.

**Percent of dZ/dt Time:** This method requires a value set in the Percent dZ/dt Peak control in percent. This method places the B at the point that is the control value of the interval of R of ECG to dZ/dt max. For example, if the control is set to 50 and the interval from R to dZ/dt max is 100 msec, B would be placed at the point that represents 150 msec. R is always placed at 100msec in the ensemble. The default value for this is 56%

**Percent of dZ/dt Time + C:** This method performs in the same way as Percent of dZ/dt Time except that it also adds a constant C to the B point value.

**SV Calculation Method (12):** This control defined the method used in determining the stroke volume in the dataset. There are three methods to select from:

**Kubicek:** This method uses the following equation:

$$SV = [\rho(L/Z_0) ^ 2] \times LVET \times dZ/dt \text{ max}$$

**Sramek-Bernstein:** This method is based on the subject's height, weight, and ideal weight and uses the following equation:

$$SV = (\text{weight} / \text{ideal weight}) \times [0.17 \times \text{height} ^ 3] / 4.2 \times (dZ/dt \text{ max} / Z_0) \times LVET$$

**Bernstein-Lemmons:** This method is based on the subject's height and weight and uses the following equation:

$$SV = (\text{Vitbv} / \text{Zeta}) \times \text{sqrt}(dZ/dt \text{ max} / Z_0) \times LVET$$

**dZ/dt Source (13):** This control defines the method used in determining the value of dZ/dt.

**Measured:** This method is used when a dZ/dt channel has been collected with the data.

**Derived From Z0:** This method is used when a dZ/dt channel has not been collected with the data.

**Detrend dZ/dt (14):** This control compensates for the DC shift in dZ/dt.

## Section 2

### Setup: IMP R Peak & 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.

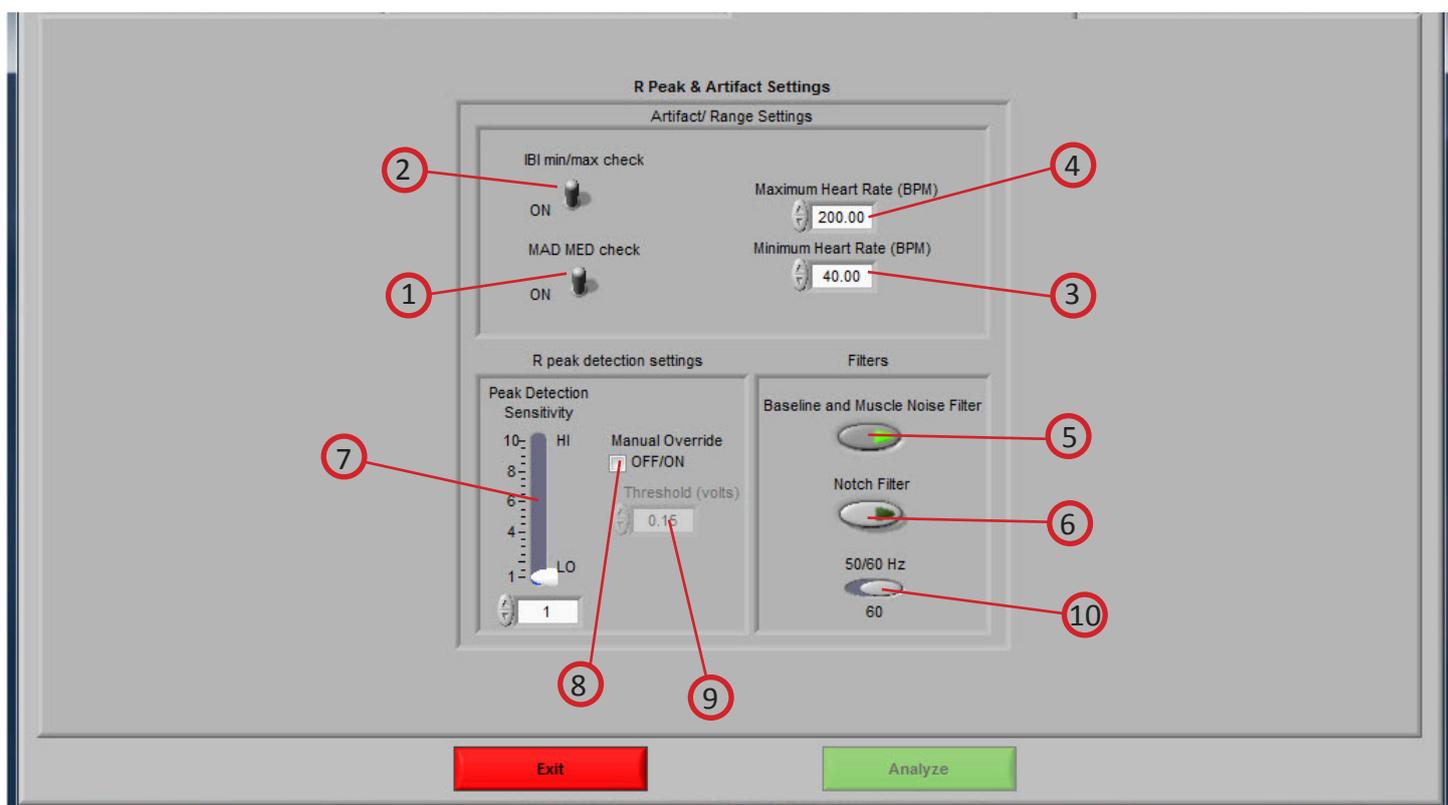


Image H



## 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.

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## 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.

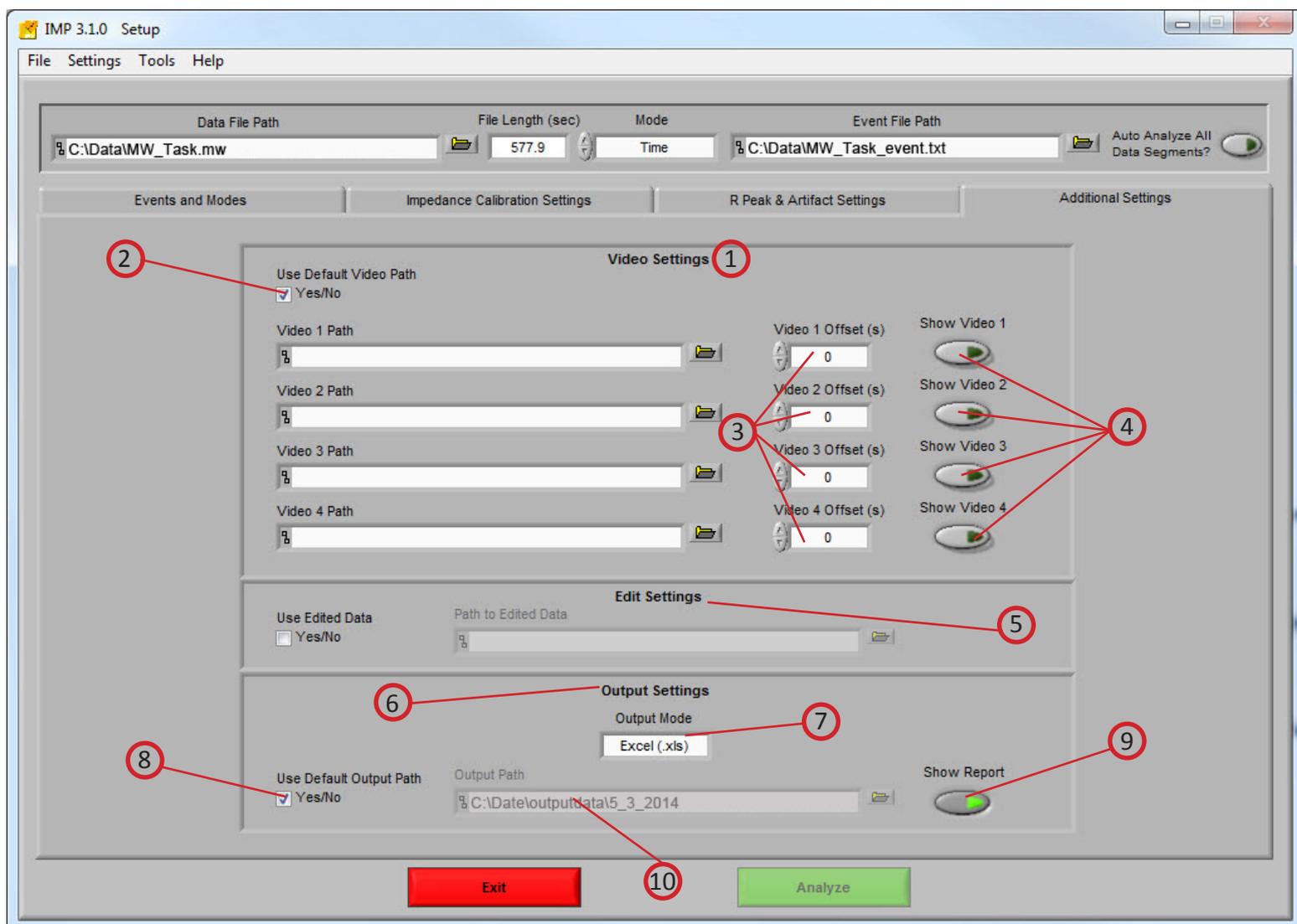
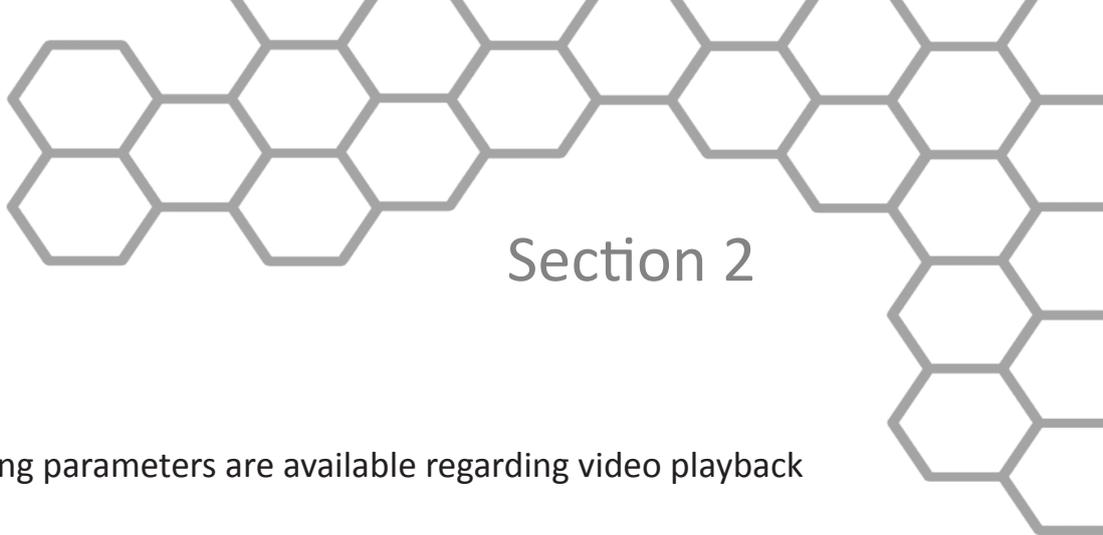


Image 1



## 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

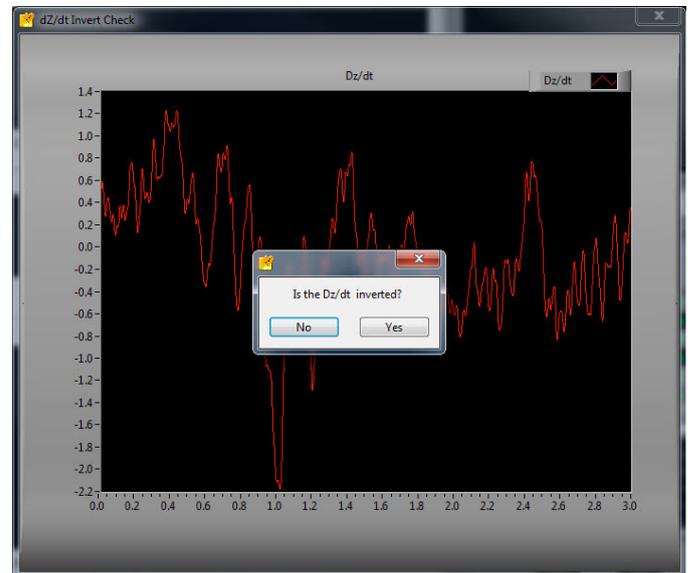
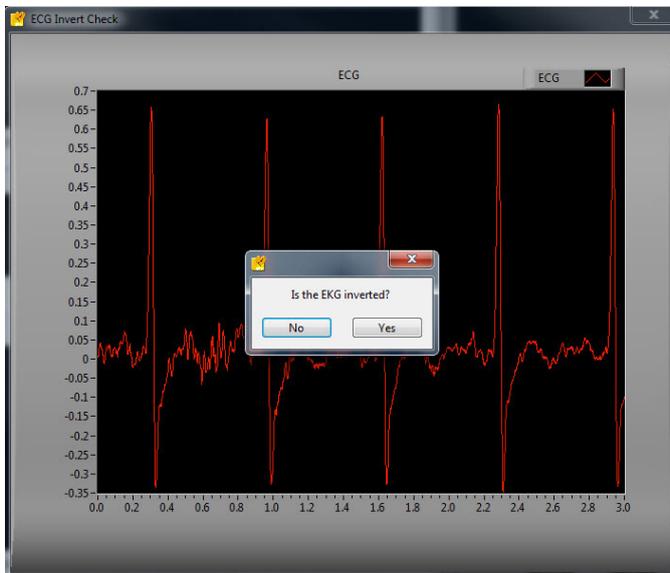
# Analysis

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



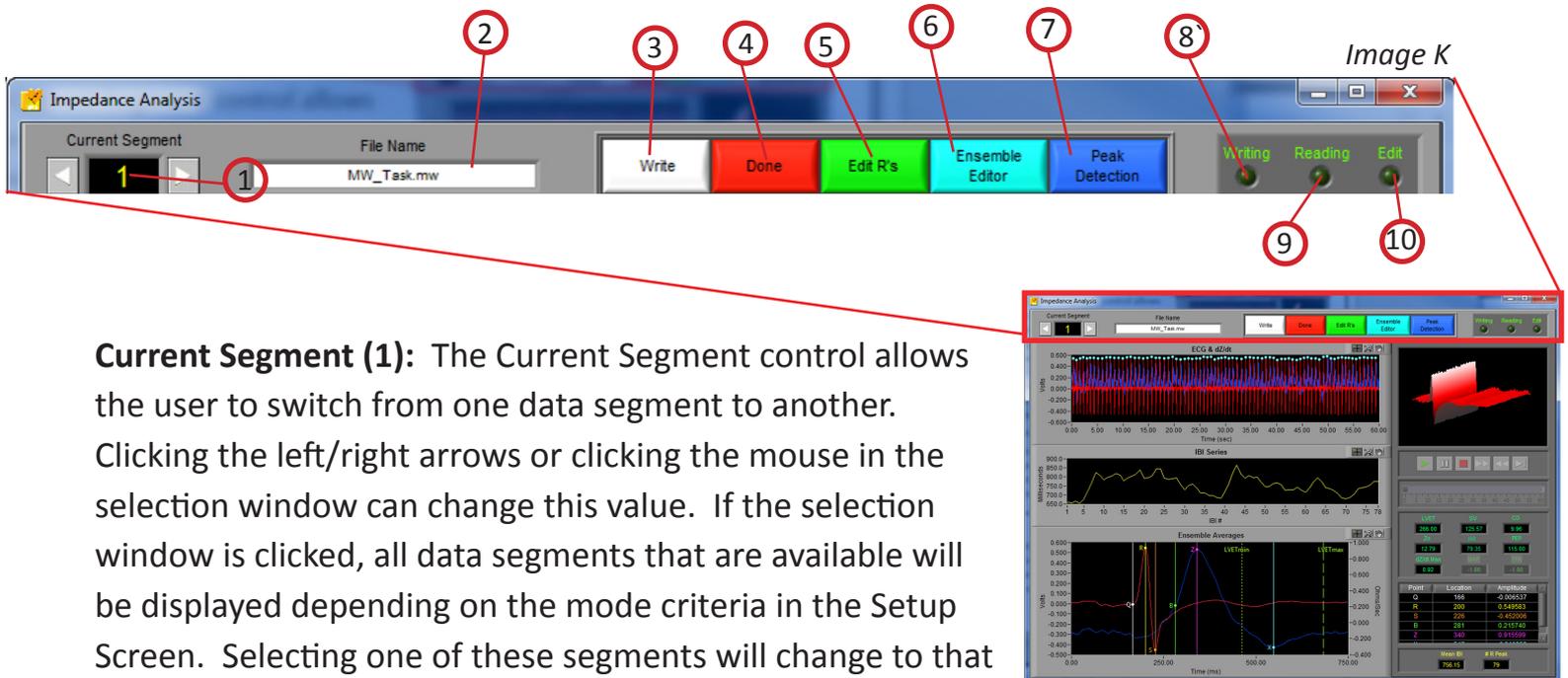
The user will then be shown a segment of data from the channel mapped as ECG (*Image J*). The user can then invert the ECG signal if required. It is important to have the phase of the R-Wave positive for the peak detection to work effectively.

Again, the user will then be shown a segment of data. This time from the channel mapped as dZ/dt (*Image J*). The user can then invert the dZ/dt signal if required.



## 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.

**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 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 and spline data portions.

## Section 3

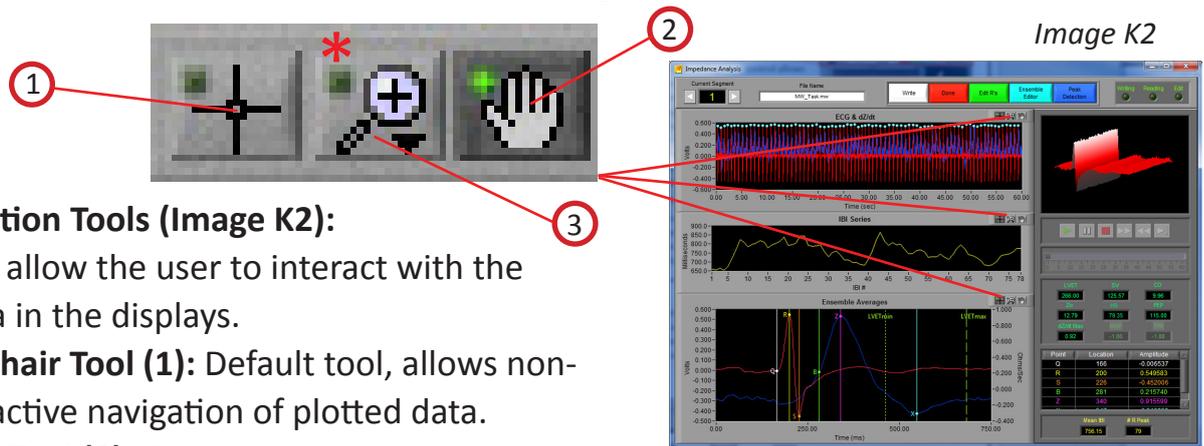
**Ensemble Editor (6):** This control switches the window to the Systolic Points Editor which allows the user to move the placement of points on the ECG ensemble waveform and dZ/dt waveform.

**Peak Detection (7):** Shows menu for adjusting the sensitivity of the peak detection algorithm.

**Writing (8):** The Writing indicator will be illuminated when the current segment results are being written to the output spreadsheet.

**Reading (9):** The Reading indicator will be illuminated when the current data file is being read.

**Edit (10):** 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 session.



### Plot Interaction Tools (Image K2):

These icons allow the user to interact with the plotted data in the 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.

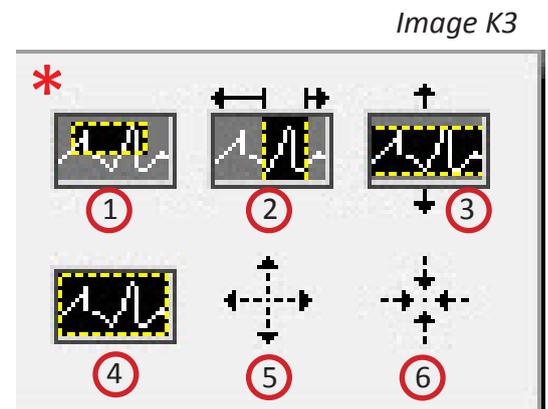
**Zoom X (2):** Zooms along the x-axis.

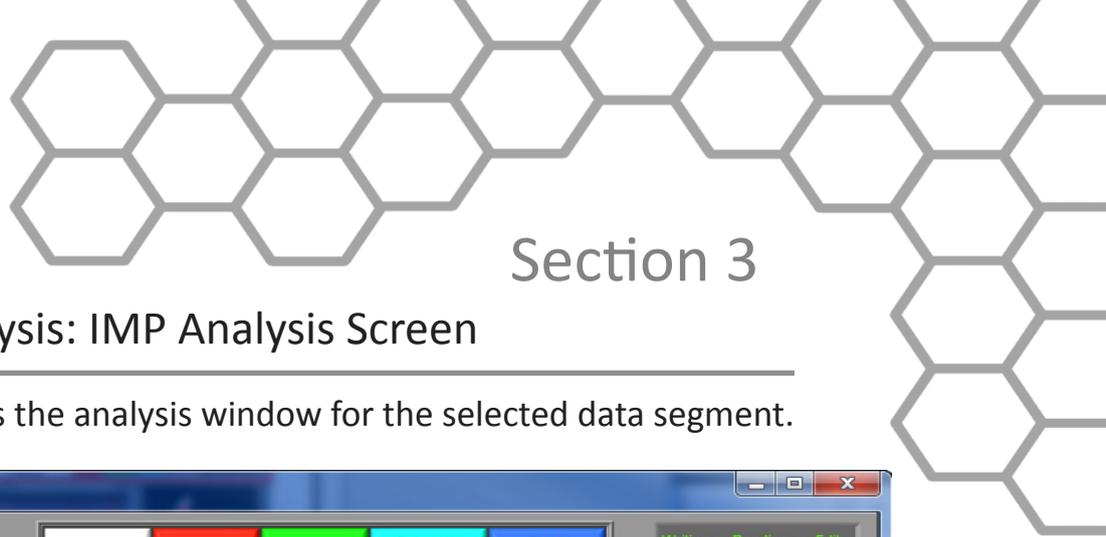
**Zoom Y (3):** Zooms along the y-axis.

**Reset: (4):** Resets view to default.

**Zoom In (5):** Zooms in by clicking

**Zoom Out (6):** Zooms out by clicking





## Section 3

### Analysis: IMP Analysis Screen

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

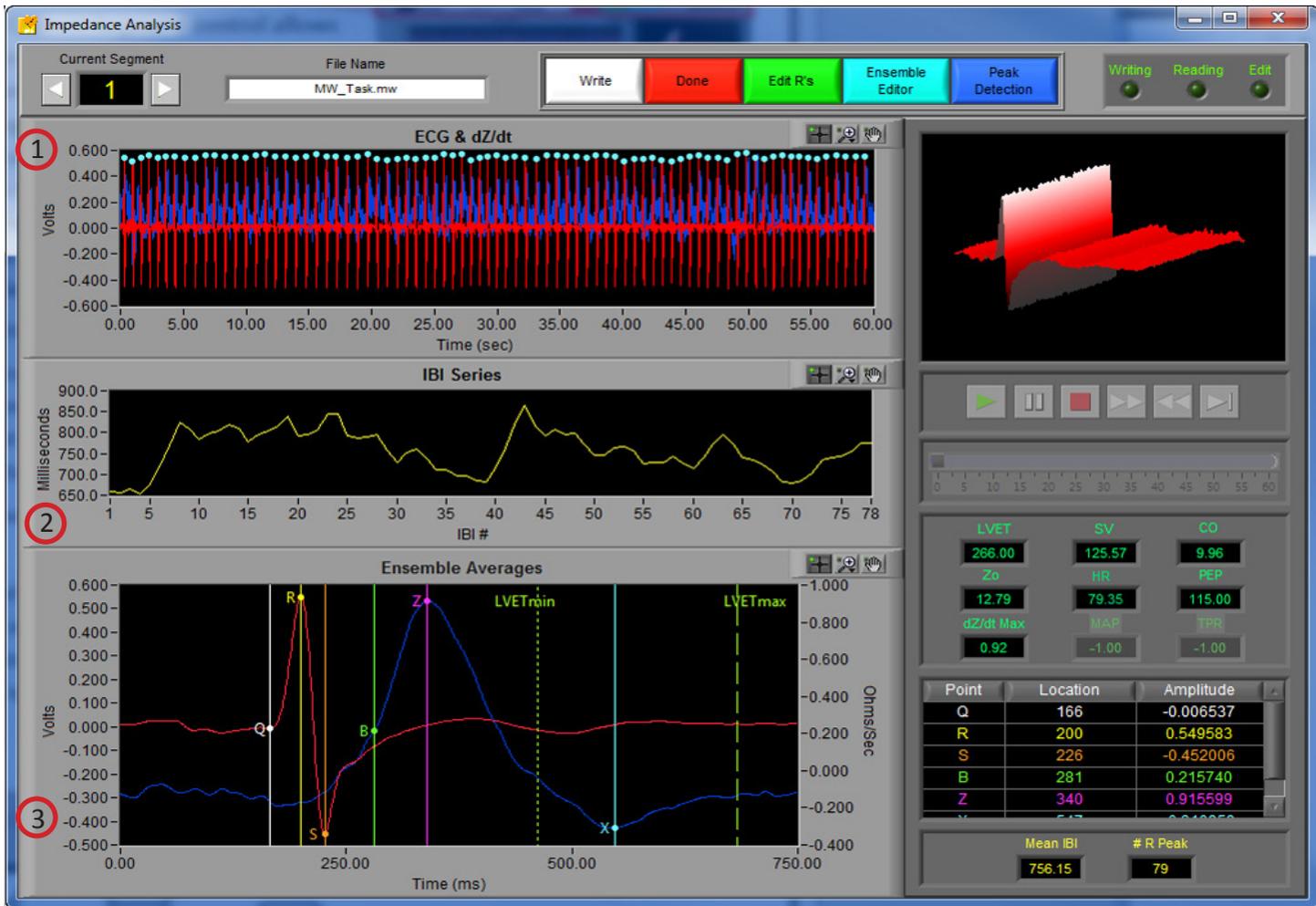


Image L

There are 3 plots visible on this screen (Refer to *Image L*):

**ECG & dZ/dt (1):** Displays the ECG and dZ/dt waveform from the current segment

**IBI (2):** The values plotted in this window are the IBI Time Series of ECG.

**Ensemble Averages (3):** The values plotted in this window are the ensemble average of both ECG and dZ/dt.

## Section 3

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### 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.



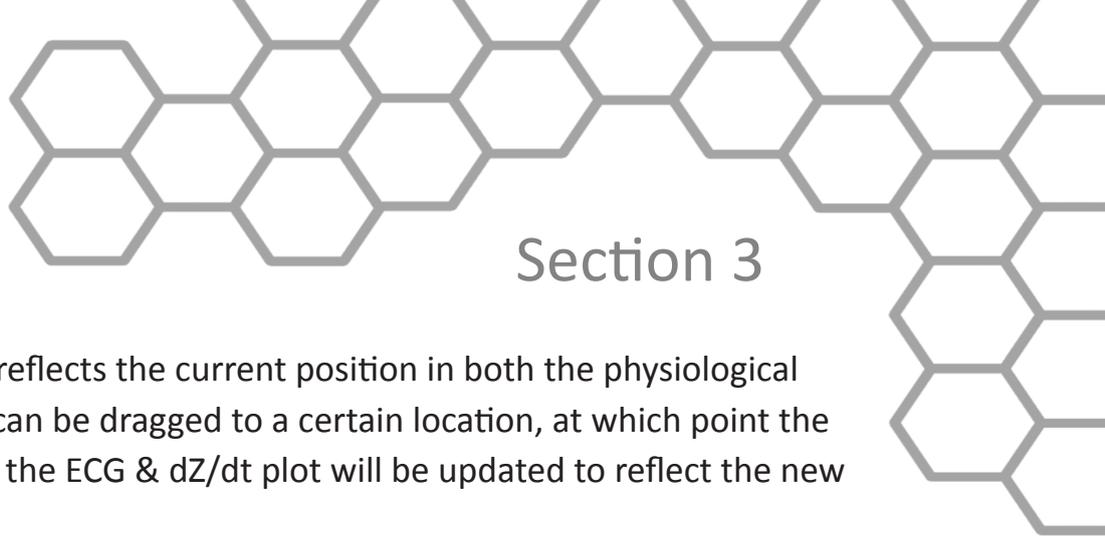
**Fast Forward:** This control speeds playback of the video up to 2x normal speed.



**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 & dZ/dt 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.

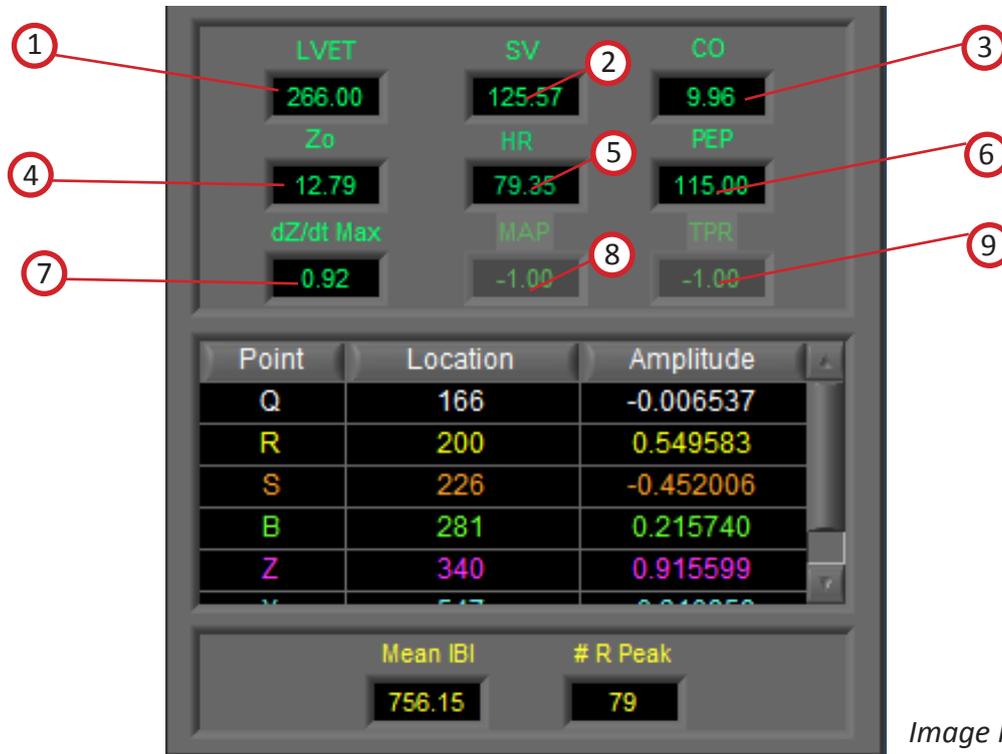


Image M

## Section 3

### Calculated Statistics (Refer to *Image N*):

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



*Image N*

**LVET(1):** The Left Ventricle Ejection Time (LVET) is defined as the distance (in ms) between the X point and B point in dZ/dt. This value will be highlighted red if the X point has been estimated rather than identified.

**SV (2):** The Stroke Volume (SV) is calculated using the method specified in the Setup screen.

**CO (3):** Cardiac Output (CO) is calculated as Heart Rate (HR) times Stroke Volume (SV).

**Z0 (4):** This is the Mean Impedance and is represented by the average Z0 in Ohms.

**HR (5):** This value represents the mean heart rate for this segment.

**PEP: (6):** The Pre-Ejection Period (PEP) is defined as the distance (in ms) between the B point in dZ/dt and the Q point in the ECG.

**dZ/dt Max (7):** This indicator represents the maximum value of dZ/dt in ohms/sec of the ensemble waveform.

**MAP (8):** Mean Arterial Pressure (MAP) is read from the BP output file. This requires BP to have been previously scored using the MindWare BP Application.

**TPR (9):** Total Peripheral Resistance (TPR) is calculated using MAP and requires BP to have been previously scored using the MindWare BP Application.



## Section 3

Point	Location	Amplitude
Q	166	-0.006537
R	200	0.549583
S	226	-0.452006
B	281	0.215740
Z	340	0.915599
V	517	0.010050

2 Mean IBI	3 # R Peak
756.15	79

Image 0

### **Refer to Image 0**

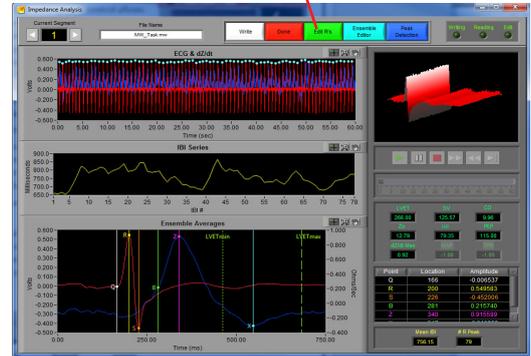
The table **(1)** lists the location (in milliseconds) and amplitude of all identified points on the ECG and  $dZ/dt$  ensemble waveforms

**Mean IBI (2):** This value represents the mean inter-beat interval in milliseconds.

**#R Peaks (3):** This value represents the number of R peaks that were detected within the window.

## Section 4

# Signal Editor

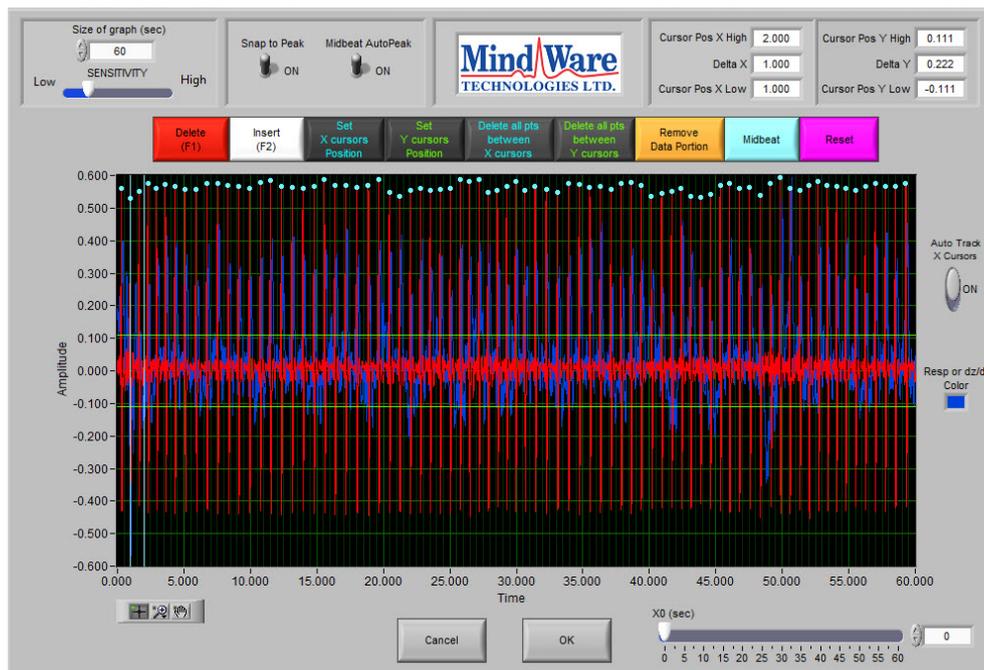


### R Peak Editor:

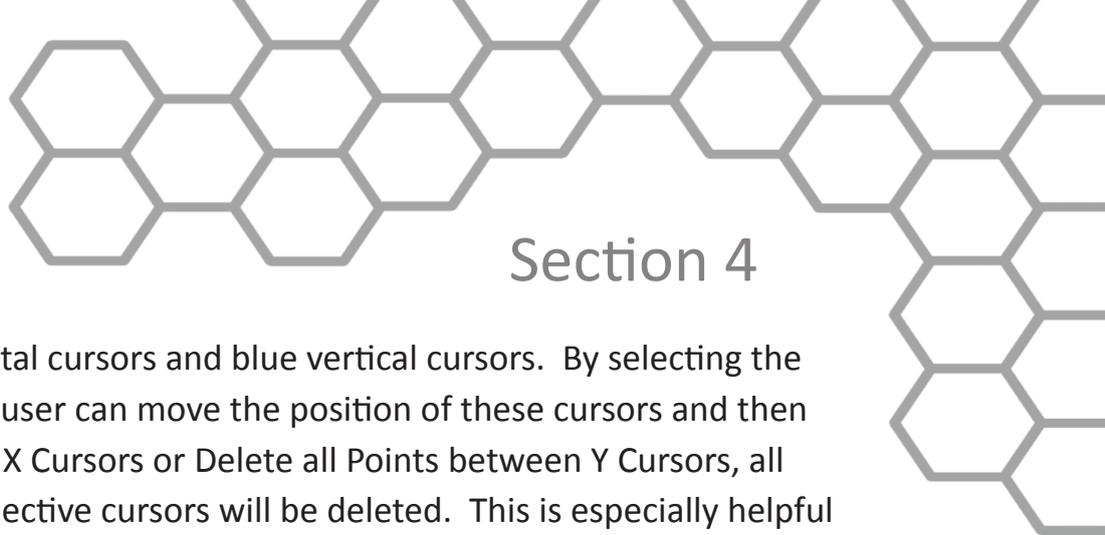
This screen can be accessed by clicking the green “Edit R’s” button at the top of the Analysis Screen.

**The R Peak 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 blue. Displayed in blue is the dZ/dt 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 and Sensitivity 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 (3):** When the Midbeat Auto Peak Control is in the “On” position the midbeat 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.

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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: Having the sensitivity to high or too low will result in too many points being deleted or not enough depending on the signal quality (noise, etc) and the rate of signal being edited.

**Insert (F2) (4):** 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 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 cursor window and described above in the Midbeat controls sections.

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

**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.

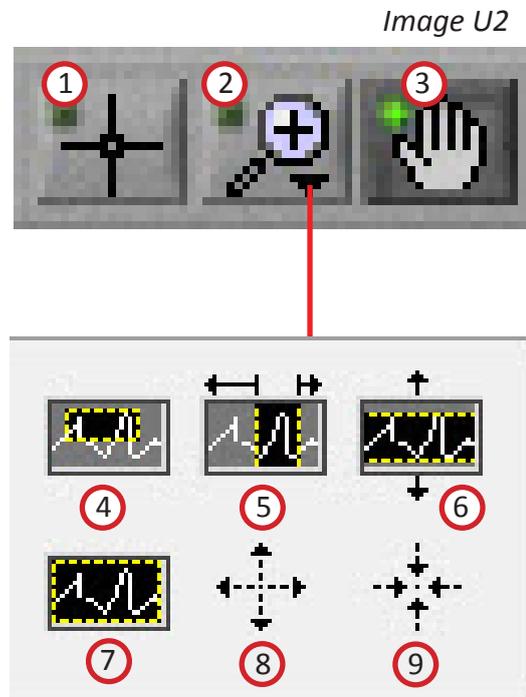
**Zoom X (5):** Zooms along the x-axis.

**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



## Section 4

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### Ensemble Editor:

This screen can be accessed by clicking the blue “Ensemble Editor” button at the top of the Analysis Screen. This will bring up the editor pop-up window.

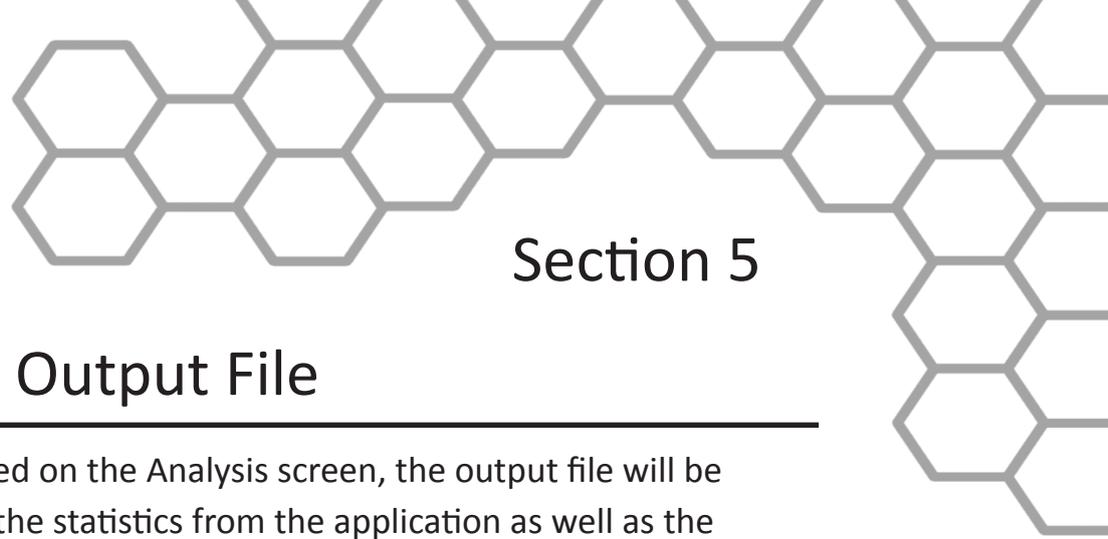
Ensemble Editor



The Systolic Points Editor allows for the calculated placement of P, Q, R, S, T, B, X and Z (1) to be relocated. In order to move the respective landmark, position the mouse over the cursor, depress the left mouse button and drag the cursor to the desired location. After exiting the editor, new values are calculated per the new placement.

**Cancel and OK (2):** The Cancel button will return to the analysis screen without saving edit data from this systolic editor session. The OK button returns to the analysis screen while saving the edits made and updating the indicators on the analysis window to reflect these edits.

**Reset Cursors (3):** This control resets the cursors to the position they were in when the systolic editor was opened.



## Section 5

# Output File

---

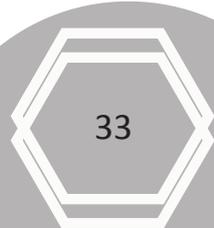
When the Write button is pressed on the Analysis screen, the output file will be written. The file contains all of the statistics from the application as well as the description of the setup. Data files are in Excel format and appear as follows.

	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 File Name	N/A		

An Excel spreadsheet file will be created containing two worksheets:

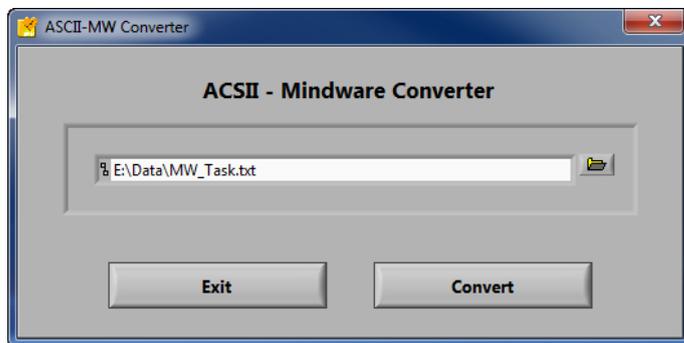
**Impedance Stats:** This worksheet (shown above) contains all setup information as well as the calculated statistics from the specified segment of data.

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

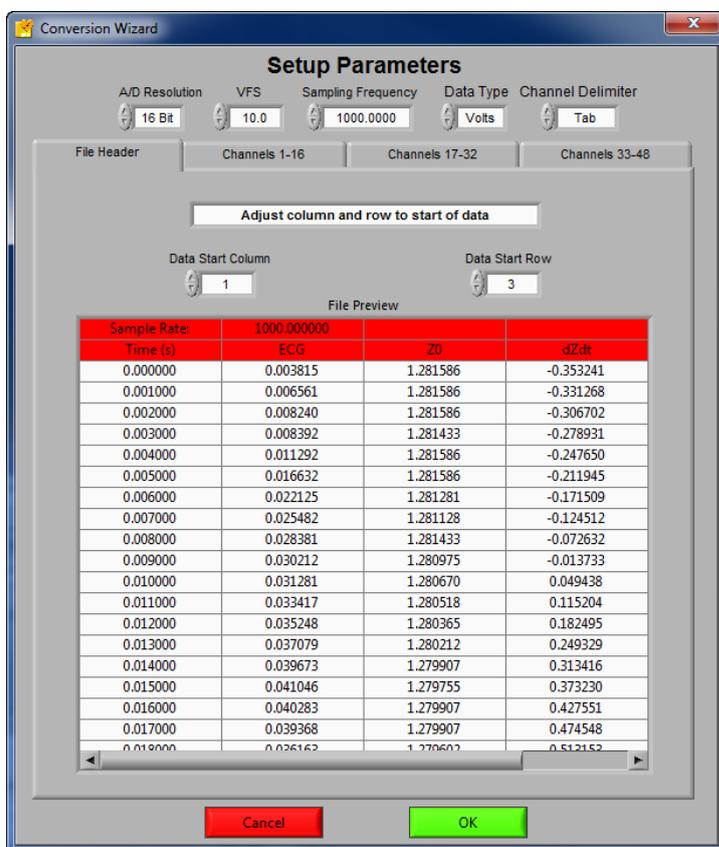


# Appendix A

## 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.

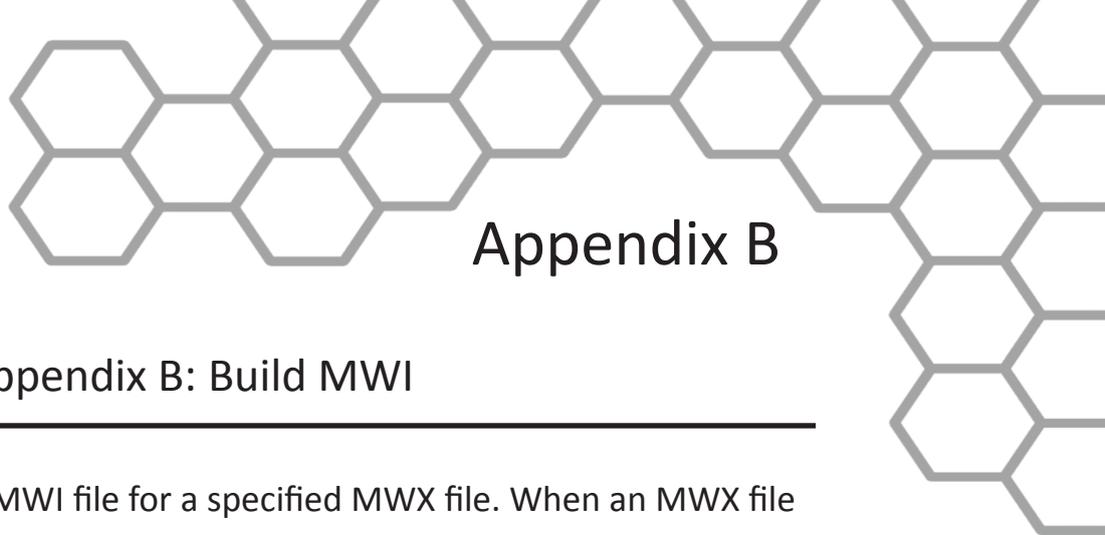
**Scaling Type:** This control specifies whether the data in the file is scaled or unscaled. If the data is scaled, the Scale Factor and Offset fields will be enabled for modification.

**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.

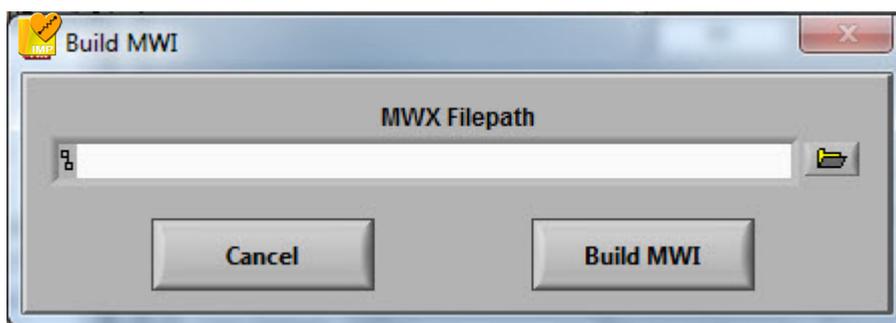


## Appendix B

### Appendix B: Build MWI

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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

### Appendix C: Software Upgrade

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Impedance 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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