

MindWare Cardiac Impedance Analysis (IMP) Analysis

User Reference Guide

Version 3.0.12

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Section 1: Channel Mapping

Upon opening the Cardiac Impedance analysis application, the user will be prompted to select a file for analysis. Once this file is selected, press OK to proceed to the channel mapping screen.

Map MindWare Channels to Channel Type

Sampling Frequency: 1000.00 Total Time: 577.90 Application Name: IMP

Use BioLab Event file: OFF/ON

File: C:\Data\MW_Task.mw

Channel Labels 1-16	Channel Labels 17-32	Channel Labels 33-48
ECG	None	None
Z0	None	None
dZ/dt	None	None
synch summary	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None
None	None	None

CANCEL OK

The Map MindWare Channels to Channel Type screen allows the user to identify the physiological data type for each channel in the data file using a pull down list. The list is derived from the header of the input file.

Although each data type in the file can be defined, not all channels must be assigned a specific data type. For Cardiac Impedance analysis, dZ/dt, Z0, ECG, and Event Channels (if applicable) need to be selected. Any channel defined other than these types will be ignored in Cardiac Impedance analysis.

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File: This indicator displays the path and name of the file under analysis.

Channel Labels: This indicator displays the names of the channels as read from the file header of the input file.

Channel Types: These controls allow the user to assign a channel name from File Header Channel Names to a specific data type. For basic Cardiac Impedance analysis, only the Z0 and ECG channels are required. The Event channel must be defined for any of the event-based analysis modes.

Total Time(s): This indicator displays the total time as read from the input file (in seconds.)

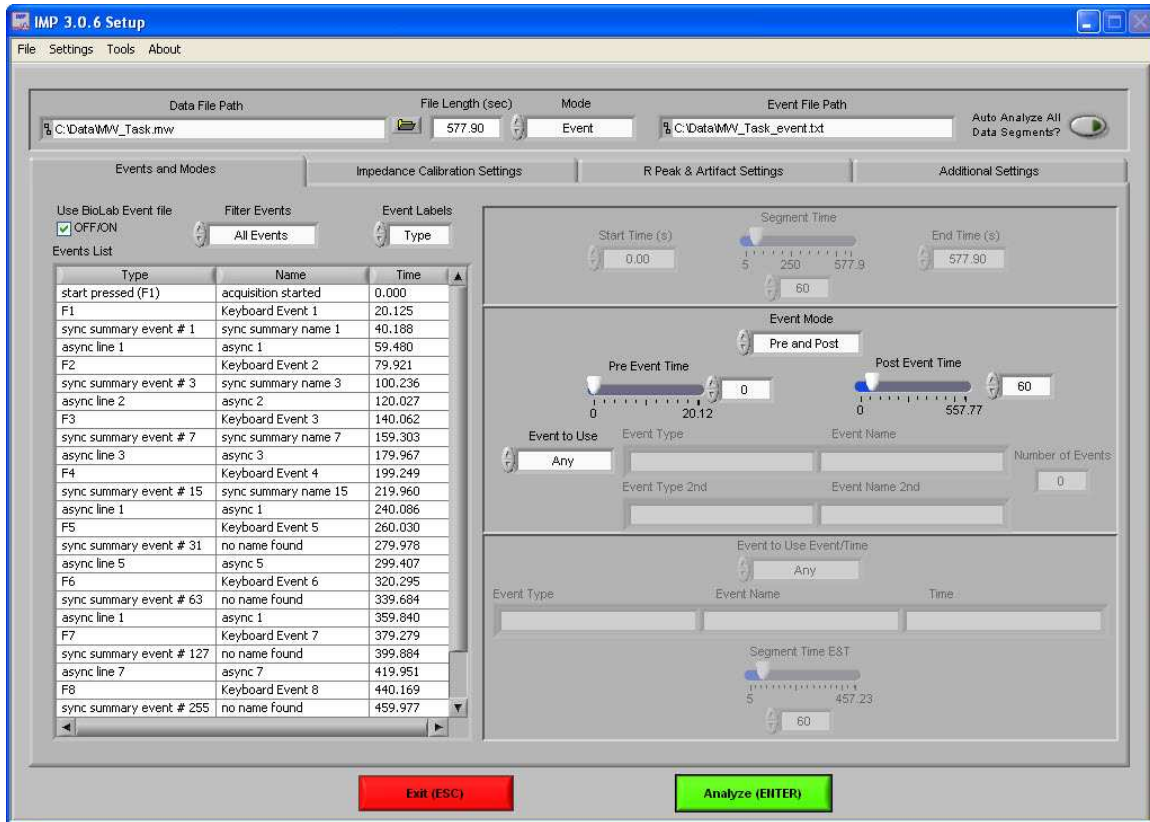
Sampling Frequency (Hz): This indicator displays the Sampling Frequency as read from the input file.

Application Name: This indicator displays the analysis application that is currently running.

Use BioLab Event File: This control allows the user to specify whether to use the event file created by BioLab in the event-based analysis rather than the Event channel.

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.

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.

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

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.

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

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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.

All changes to settings in the Setup screen are saved to a configuration file automatically whenever analysis is initiated or the application is exited.

The following options are available from the menu bar:

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.

Show Summary Screen: This option enables/disables the summary screen popup before analysis is started.

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: Opens the ASCII-MW converter (see Appendix A).

About:

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

The first tab on the screen, titled Events and Modes, 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.

Time Mode: In time mode, the following parameters are available:

Start Time: Used to set the time at which the first analysis segment will start

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

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

Event Mode: The list to the left of the event controls displays all of the events detected in either the BioLab Event 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 Labels” control.

There are 4 viewing modes available in event mode:

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

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

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Pre and Post: This is a combination of the previous 2 modes in which both the length of the data before and after a specified event can be set.

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, and then selecting the desired event from the list and dragging it to the box labeled “Event Type”. In Event to Event mode, two specific events to go between can be selected. The number of events box shows the total number of events of the specified type which will be shown during analysis.

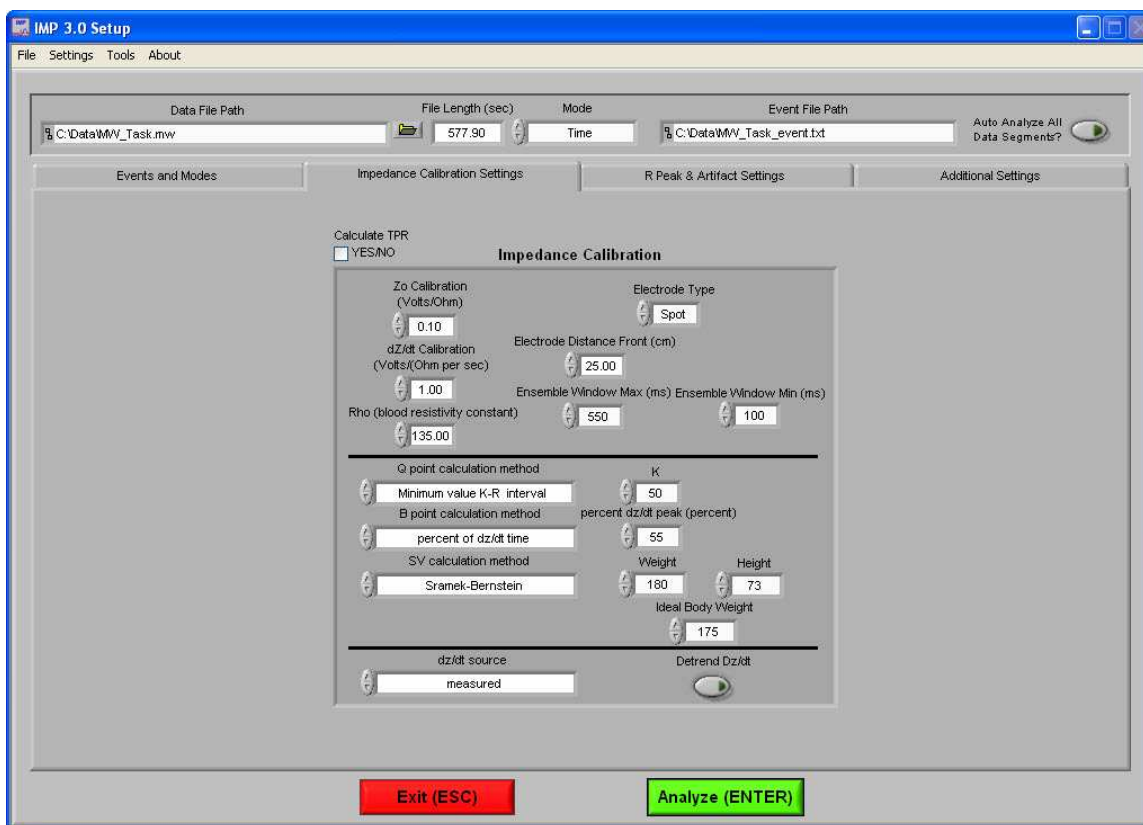
Event and Time: Event and Time mode combines the previous two modes to allow the selection of a specific event to use as a starting point and then to proceed through analysis in time mode from that point. The following parameters are available:

Event to Use Event/Time: 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: 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

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.



Calculate TPR: This control enables the calculation for Total Peripheral Resistance and requires the Excel worksheet generated by the MindWare BP application.

Z0 Calibration (Volts/Ohm): 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.

Dz/dt Calibration (Volts/Ohm per Second): 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.

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

Electrode Distance Front (cm): 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 are being used, measure from the center of electrode 2 to the center of electrode 3.

Electrode Distance Back (cm): This control sets the distance in centimeters for the rear (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 are being used, measure from the center of electrode 2 to the center of electrode 3.

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

Ensemble Window Max (ms): This control sets the window size (in ms) for the end of the ensemble period.

Ensemble Window Min (ms): This control sets the window size (in ms) for the beginning of the ensemble period.

Q Point Calculation Method: 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.)

B Point Calculation Method: 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.

Max Slope Change: This method places the B at the point of maximum change in slope on the dZ/dt waveform before the peak.

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 EKG 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: 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: This control defines the method used in determining the value of dZ/dt.

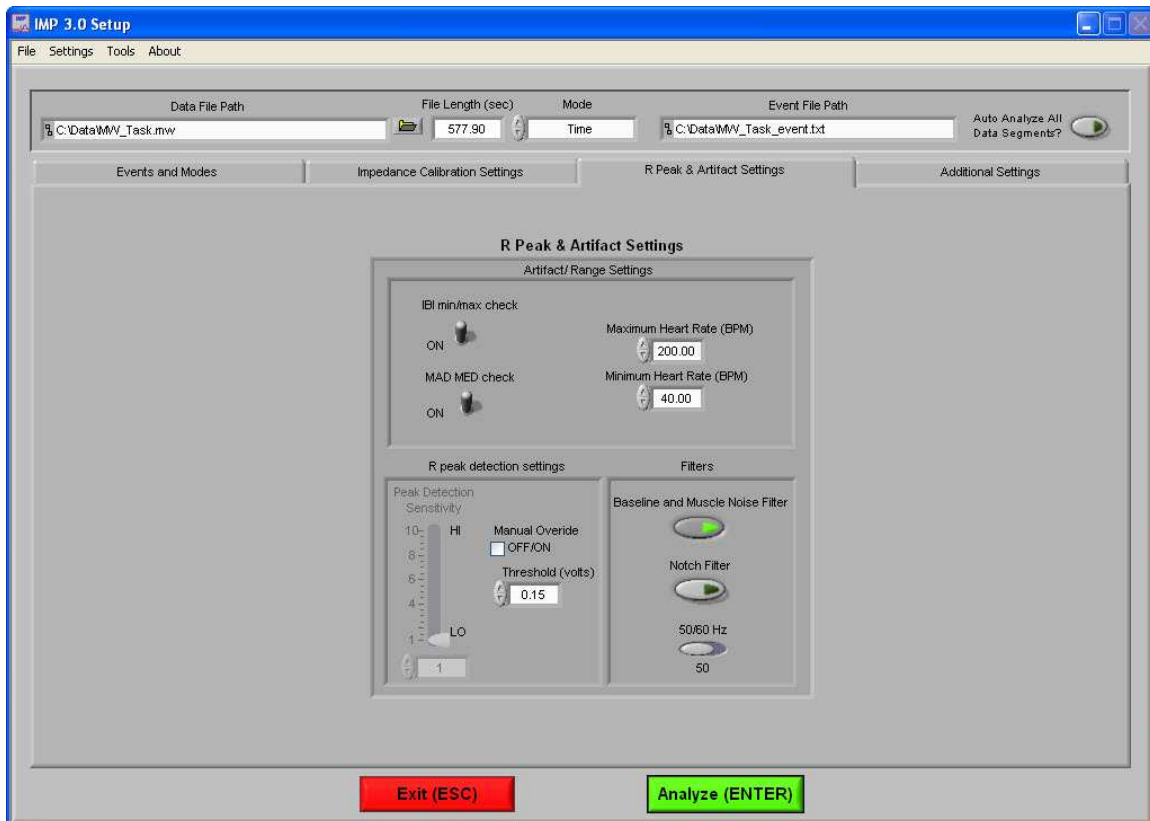
Measured: This method is used when a dZ/dt channel has been collected with the data.

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

Detrend dZ/dt: This control compensates for the DC shift in dZ/dt.

IMP 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.



MAD/MED Check: This control enables or disables the application of MAD/MED criteria to the heart beat detection.

IBI Min/Max Check: This control enables or disables the application of IBI Min/Max criteria to the heart beat 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): This control allows for the selection of the minimum expected heart rate in the data series. This value will be the maximum IBI threshold.

Maximum Heart Rate (BPM): This control allows for the selection of the maximum expected heart rate in the data series. This value will be the minimum IBI threshold.

Baseline and Muscle Noise Filter: This control enables or disables the muscle noise filter. This filter applies a band pass filter (.25 to 40 Hz) to the data.

50/60 Hz Notch Filter: This control enables or disables the 50/60 Hz notch filter.

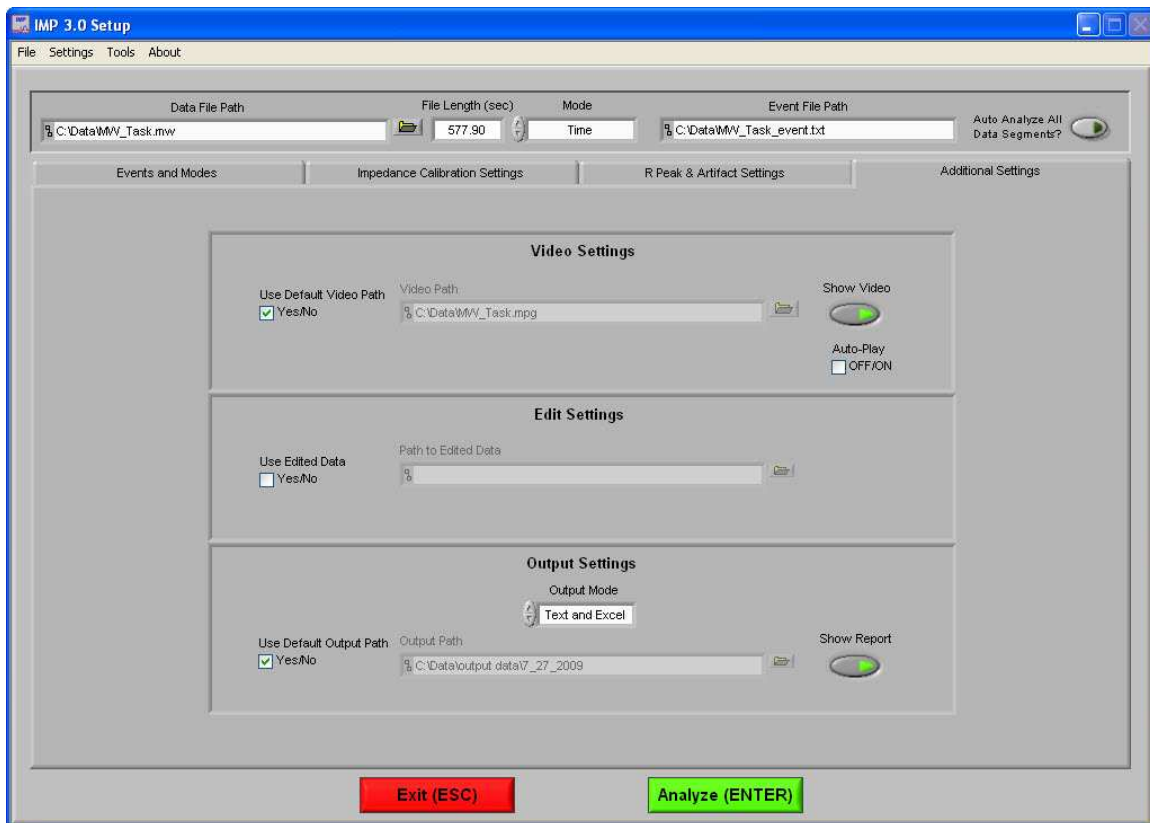
Peak Detection Sensitivity: This control is used to set the sensitivity of the dynamic peak picking algorithm from 1 (Minimum Sensitivity) to 10 (Maximum Sensitivity.)

Manual Override: This control is used to disable the dynamic peak detector and switches to the absolute threshold mode.

50/60 Hz: This control is used to select the frequency of the notch filter.

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.



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

Use Default Video Path: This selects whether the default video associated with the file will be used, or a video can be specified in its place.

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

Auto-Play: When this is turned on, the specified video will automatically begin playback when a new segment is selected. Otherwise, the video will not begin playback until it is started by the user.

Edit Settings: 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: The following parameters are available to specify the type and location of the output files:

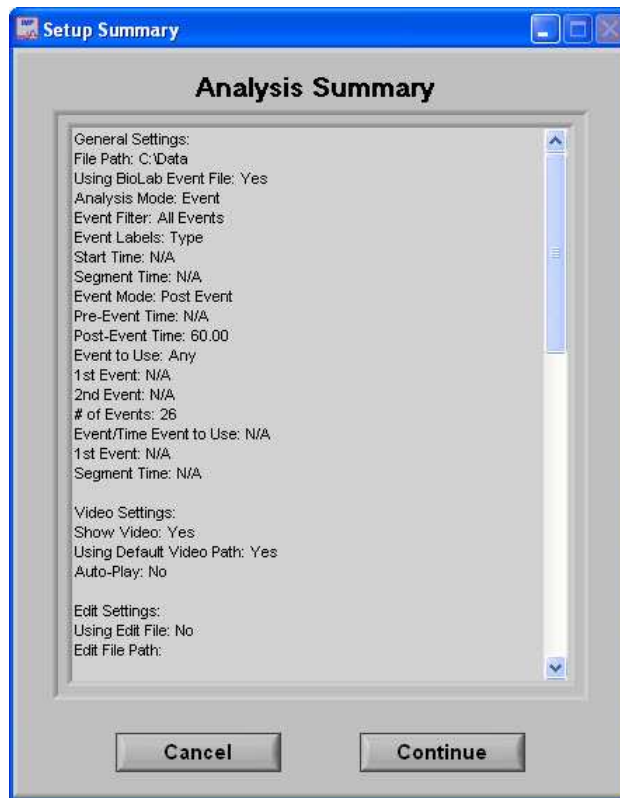
Output Mode: Either a text file (.txt), an excel spreadsheet (.xls) or both can be output at the end of analysis.

Use Default Output Path: 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: 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.

Section 3: Analysis

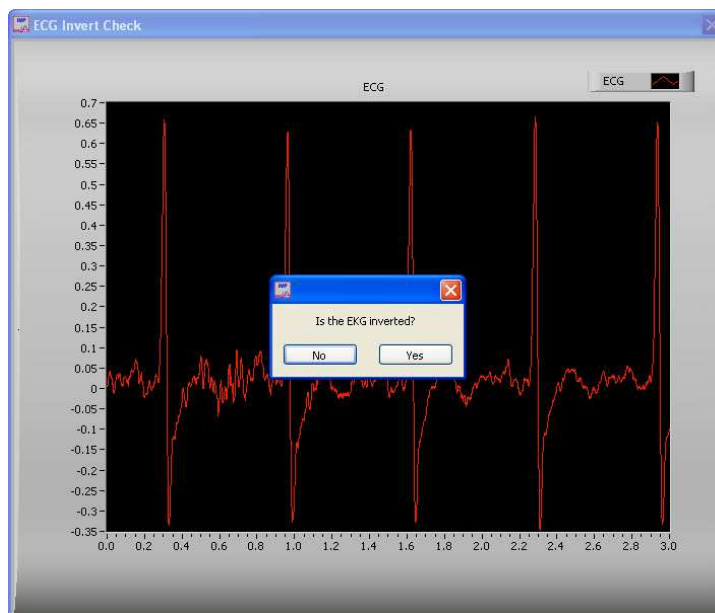
When the Analyze button is pressed, if the summary screen has been enabled then the Analysis Summary screen is displayed, showing the various settings from the Setup screen.



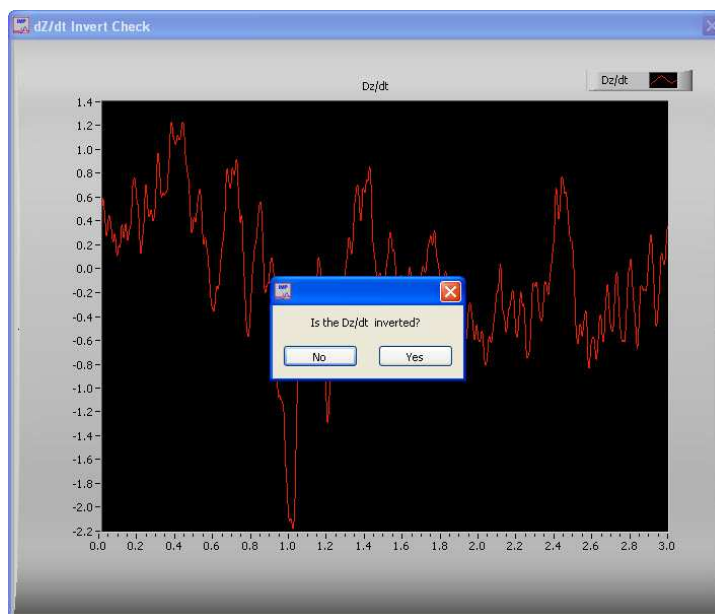
Cancel: This control will return the user to the Setup screen to adjust analysis settings before continuing.

Continue: This control will begin analysis using these settings.

At this point, the user will be shown a segment of data from the channel mapped as ECG. 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.



Next, the user will be shown a segment of data from the channel mapped as dZ/dt (or the calculated signal from Z_0). The user can then invert the dZ/dt signal if required.



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One of the next screens made visible is the Controls screen, which initially sits just above the Impedance Analysis window.



The Controls screen is the interface for sequencing through each data segment as well as viewing the program status indicators, editing data, and writing the output file. From here, the user can select the next data segment to analyze, write the statistical information to the output file, or quit to return back to the Setup screen.

Current Segment: The Current Segment control allows the user to switch from one data segment to another. Clicking the up/down 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: This indicator displays the name of the data file being analyzed.

Write: 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: This control is used to terminate the current session and return the user to the Setup screen.

Edit R's: 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.

R Peak and Artifact: The R Peak and Artifact control allows the user to modify the values in the R-Peak and Artifact Settings without having to exit this analysis sequence.

Systolic Editor: This control switches the window to the Systolic Points Editor which allows the user to move the placement of Q, R, B and X points.

Video Settings: The Video Settings control allows the user to modify the video settings from the Setup screen without having to exit this analysis sequence.

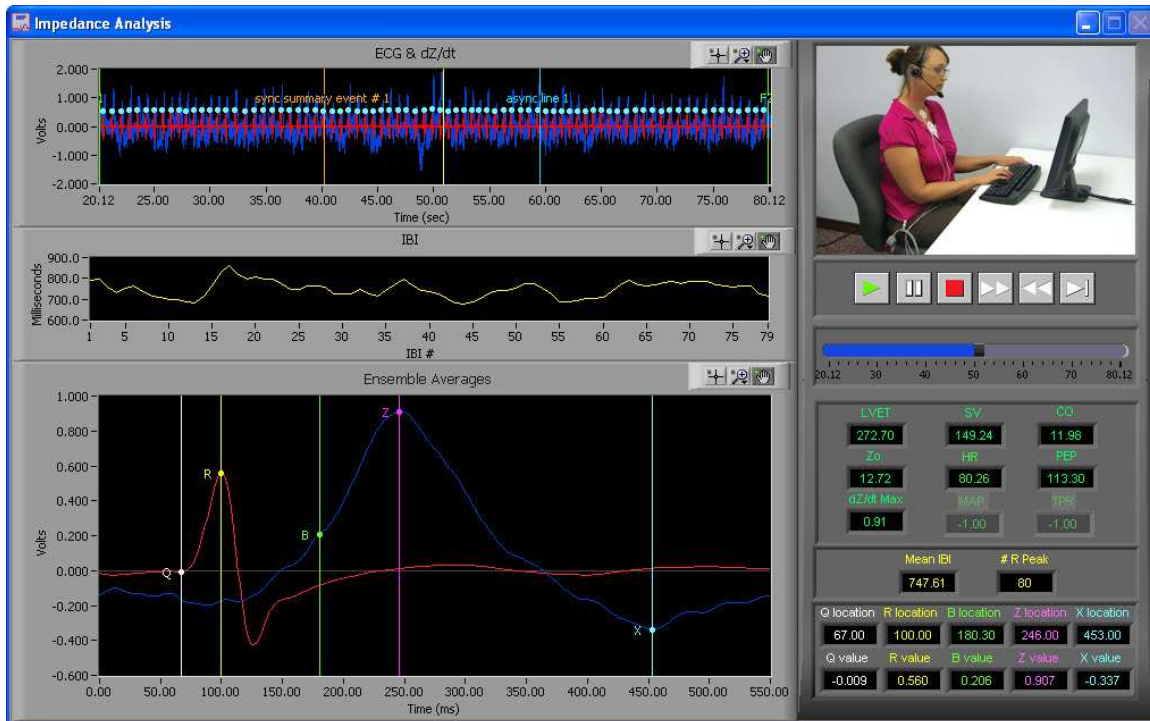
Writing: The Writing indicator will be illuminated when the current segment results are being written to the output spreadsheet.

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

Edit: 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.

IMP Analysis

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



There are three plots visible on this screen:

ECG & dZ/dt: The values plotted on the ECG & dZ/dt window are a beat to beat analog waveform. Also shown on this plot are the event markers and the position cursor. The event markers are labeled with either the event name or type (as specified in the Setup screen) and are color coded by type (Keyboard = Green, Summary = Orange, Individual = Blue). The position cursor can be dragged anywhere within the current dataset, at which point the video will be updated to reflect this new position.

IBI: The values plotted in this window are the IBI Time Series of ECG.

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

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.

Position Slider: 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 and dZ/dt plot will be updated to reflect the new position.

By right-clicking the video and selecting Undock from the run-time menu, the video will be removed from the analysis window and re-opened in its own resizable, floating window.



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To return the video to the analysis window, right-click the floating video window and select Dock from the run-time menu.

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.



ECG Ensemble Elements: 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.

Below the video/ensemble plot and the video controls, in the lower right hand corner of the Impedance Analysis screen are the calculated stats about the current data segment:

LVET	SV	CO		
272.70	129.10	10.36		
Zo	HR	PEP		
12.72	80.26	113.30		
dZ/dt Max	MAP 2	TPR		
0.91	-1.00	-1.00		
Mean IBI		# R Peak		
747.61		80		
Q location	R location	B location	Z location	X location
67.00	100.00	180.30	246.00	453.00
Q value	R value	B value	Z value	X value
-0.009	0.560	0.206	0.907	-0.337

LVET: The Left Ventricle Ejection Time (LVET) is defined as the distance (in ms) between the X point in dZ/dt and the B point in dZ/dt .

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

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

Zo: This is the Mean Impedance and is represented by the average Z_o in Ohms.

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

PEP: 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: This indicator represents the maximum value of dZ/dt in Ohms of the ensemble waveform.

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

Mean IBI: The values in this array represent the inter-beat interval values scaled in seconds.

#R Peaks: The values in this array represent the number of R peaks that were detected within the window.

Q Location: This is the location of the Q component of ECG.

R Location: This is the location of the R component of ECG.

B Location: This is the location of the B component of dZ/dt .

Z Location: This is the location of the Z component of dZ/dt .

X Location: This is the location of the X component of dZ/dt .

Q Value: This is the amplitude of the Q component of ECG.

R Value: This is the amplitude of the R component of ECG.

B Value: This is the amplitude of the B component of dZ/dt .

Z Value: This is the amplitude of the Z component of dZ/dt .

X Value: This is the amplitude of the X component of dZ/dt .

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Section 4: Output File

	A	B	C	D	E	F	G	H	I
1	Version	IMP v3.0A							
2	Date	3/18/2009							
3	Time	4:17 PM							
4	File Name	C:\Data\MW_Task.mw							
5	Analysis Mode	Event							
6	Event Filter	All Events							
7	Start Time	N/A							
8	Segment Time	N/A							
9	Event Mode	Pre and Post							
10	Pre-Event Time	0							
11	Post-Event Time	60							
12	Event to Use:	Any							
13	1st Event	N/A							
14	2nd Event	N/A							
15	# of Events	26							
16	Event/Time Event to Use	N/A							
17	1st Event	N/A							
18	Segment Time	N/A							
19									
20	Sampling Frequency	1000							
21	Volts Full Scale	10							
22	A/D Resolution	16 Bit							
23	50/60 hz notch filter	Off							
24	baseline/muscle noise filter	On							
25	Zo cal factor	0.1							
26	Dz/dt cal factor	1							
27	Rho(blood resistivity)	135							
28	Electrode Type	Spot							
29	Electrode distance back	25							
30	Electrode distance front	N/A							
31	Q point method	Minimum value K-R interval							
32	R minus constant	N/A							
33	K constant	50							
34	B point method	percent of dz/dt time							
35	dz/dt peak minus constant	N/A							
36	percent dz/dt	55							
37	C	N/A							
38	dz/dt source	measured							
39	Detrend Mode	Off							
40	SV Calculation method	Kubicek							
41	Weight	N/A							
42	Height	N/A							
43	Ideal Body Weight	N/A							
44	Ensemble Window Min	100							
45	Ensemble Window Max	550							
46									
47	Segment Number	1	2	4					
48	Heart Rate	80.256007	80.575246	78.173912					
49	LVET	272.7	269.35	262.9					
50	SV	129.101096	124.602867	119.285737					
51	CO	10.361138	10.039907	9.325033					
52	ZD	12.716176	12.680148	12.66429					
53	PEP	113.3	111.65	111.1					
54	dZ/dt Max	0.907286	0.881548	0.862474					
55	Event	F1	sync summary event # 1	F2					
56	Event Time	20.125	40.188	79.921					
57	# of R's Found	80	80	78					
58	Mean IBI	747.607595	744.64557	767.519481					
59	TPR	-1	-1	-1					
60	Q Location	67	67	67					
61	R Location	100	100	100					
62	B Location	180.3	178.65	178.1					
63	Z Location	246	243	242					
64	X Location	453	448	441					
65	First ECG Time	20.443	40.912	80.223					

There are three different output modes:

Text (.txt): Two .txt files will be created, one containing the Impedance Statistics and the other containing the IBI series for each segment as tab-delimited spreadsheet files.

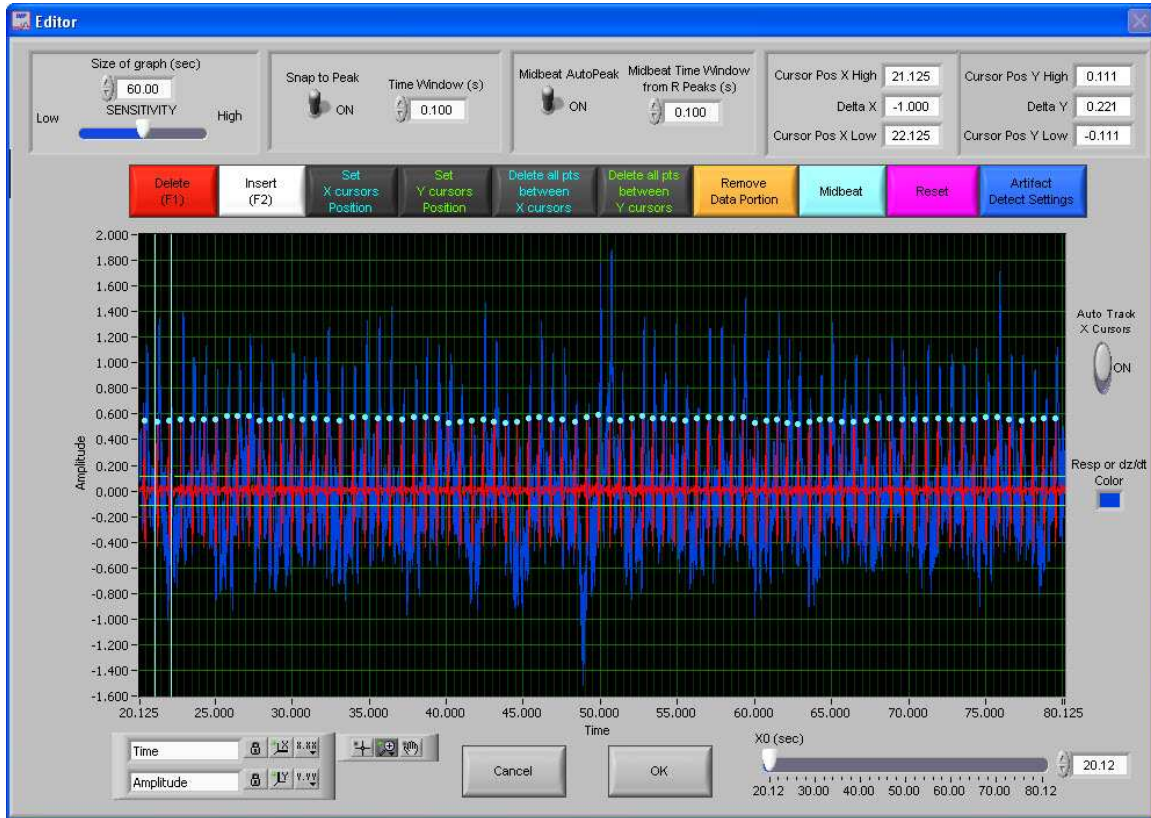
Excel (.xls): An Excel spreadsheet file will be created containing two worksheets:

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.

Text and Excel: Outputs both .text files and an Excel spreadsheet file as specified above.

Section 5: R Peak Editor



The R Peak Editor 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. The artifact detection algorithms can also be turned on or off from within the editor.

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.

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.

ECG waveform graph: 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. 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.

Auto-Track Cursors: 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: 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.

X0 (seconds): 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.

Size of Graph (seconds): 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: 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. The time window control sets the size of the time window centered about where the mouse is clicked (ie: If the user clicked on a point at 10 seconds, the snap to peak function will cut out 250ms to the left and 250ms to the right of this point and determine the peak value within this range.) 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.

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Midbeat Auto Peak Control and Time Window from R Peak Control: 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. The time window control defines the amount of time from each selected R Peak to go before finding a peak value (ie: If point 1 is at 1 second and point 2 is at 2 seconds and the time window is on 100ms, then the midbeat algorithm will find the peak value in the window from 1.1 seconds to 1.9 seconds.)

Set X Cursor Position: 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: 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): This control latches when pressed until it is 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): This control latches when pressed until it is 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: All points within the boundary defined by the vertical blue cursors will be removed.

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

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

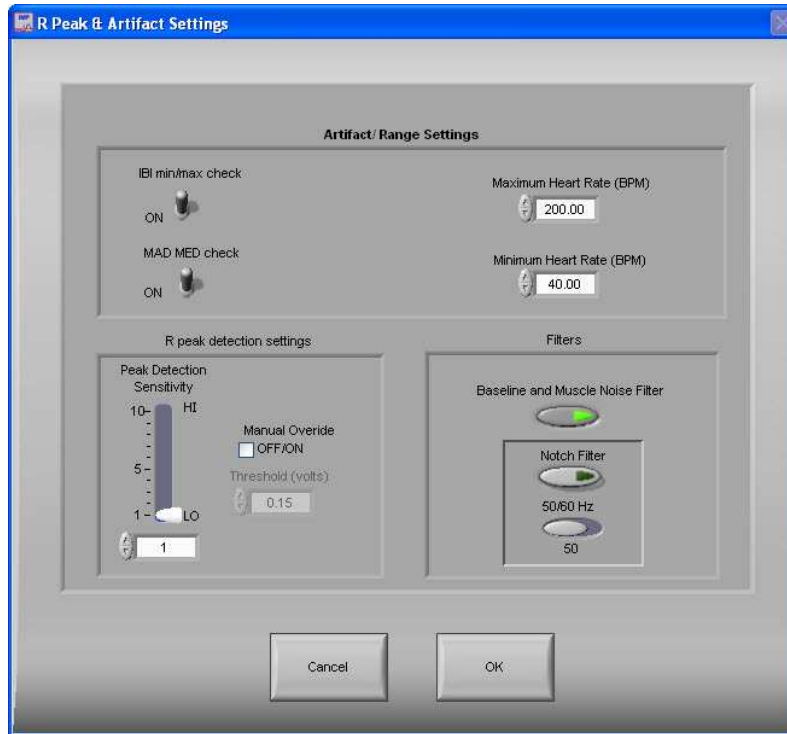
Midbeat: This control will mark a Midbeat point between two points selected with the cursor window and described above in the Midbeat controls sections.

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

Artifact Detect Settings: Allows the user to turn on and off the artifact detection algorithms and settings.

OK and Cancel: When editing is complete and the user wants the changes to transfer back to the analysis screen, select OK. When the user selects Cancel, the data that has been edited will not be transferred and the editing will be lost.

Section 6: R Peak and Artifact Settings



The R Peak and Artifact Settings window allows the user to change these settings without exiting the analysis session.

MAD/MED Check: This control enables or disables the application of MAD/MED criteria to the heart beat detection.

IBI Min/Max Check: This control enables or disables the application of IBI Min/Max criteria to the heart beat 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): This control allows for the selection of the minimum expected heart rate in the data series. This value will be the maximum IBI threshold.

Maximum Heart Rate (BPM): This control allows for the selection of the maximum expected heart rate in the data series. This value will be the minimum IBI threshold.

Baseline and Muscle Noise Filter: This control enables or disables the muscle noise filter. This filter applies a band pass filter (.25 to 40 Hz) to the data.

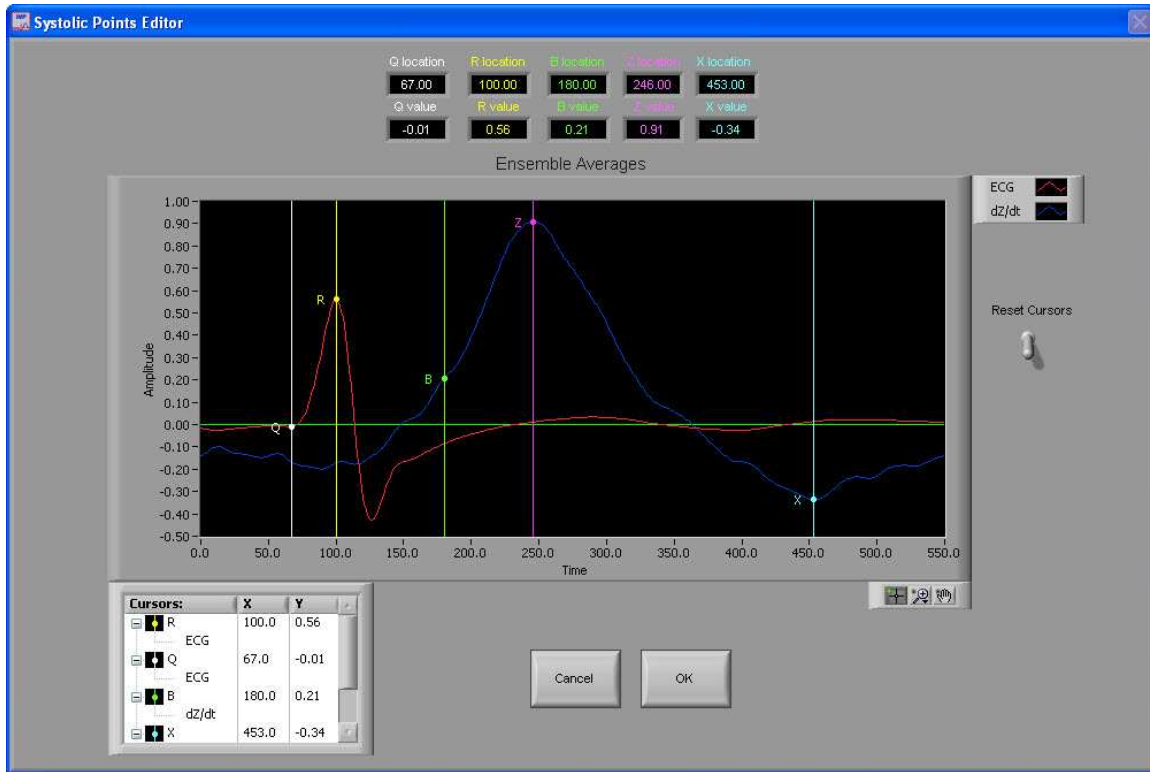
50/60 Hz Notch Filter: This control enables or disables the 50/60 Hz notch filter.

Peak Detection Sensitivity: This control is used to set the sensitivity of the dynamic peak picking algorithm from 1 (Minimum Sensitivity) to 10 (Maximum Sensitivity.)

Manual Override: This control is used to disable the dynamic peak detector and switches to the absolute threshold mode.

50/60 Hz: This control is used to select the frequency of the notch filter.

Section 7: Systolic Points Editor



The Systolic Points Editor allows for the calculated placement of Q, R, B and X 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.

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

Cancel and OK: 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.

Section 8: Video Settings

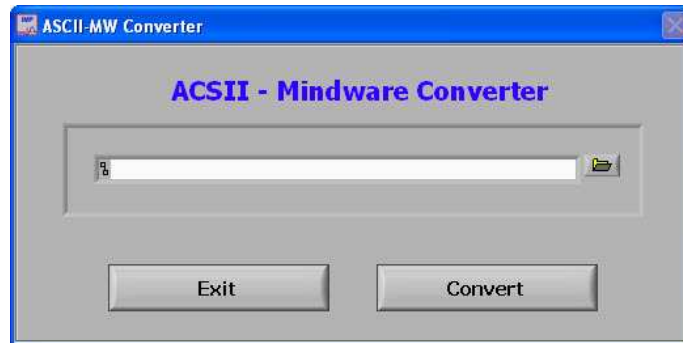


The Video Settings Window allows the user to modify these settings without exiting the current analysis setting.

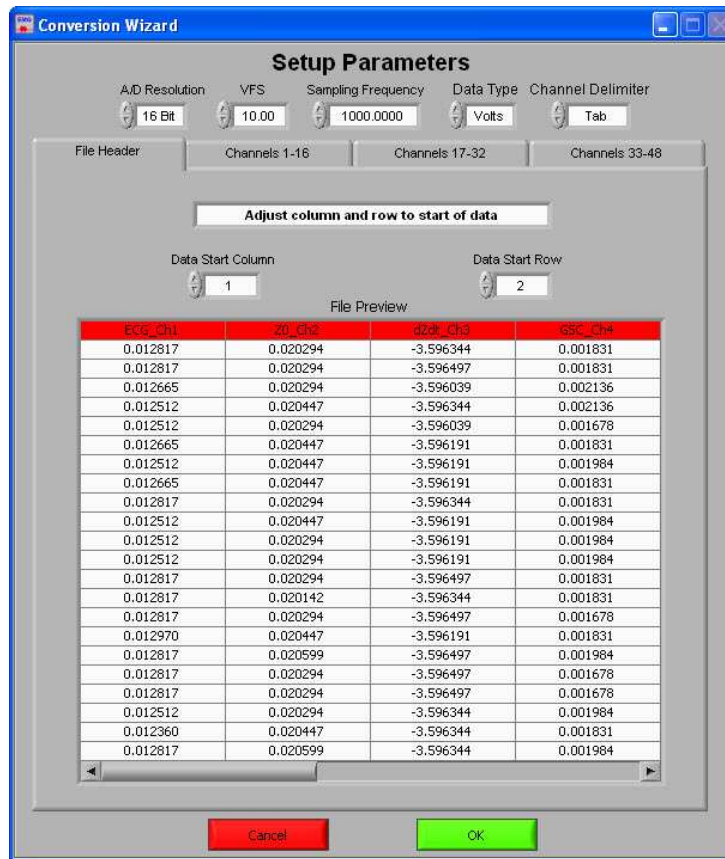
Show Video: Sets whether the video will be shown during analysis or not.

Auto-Play: When this is turned on, the specified video will automatically begin playback when a new segment is selected. Otherwise, the video will not begin playback until it is started by the user.

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.



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.

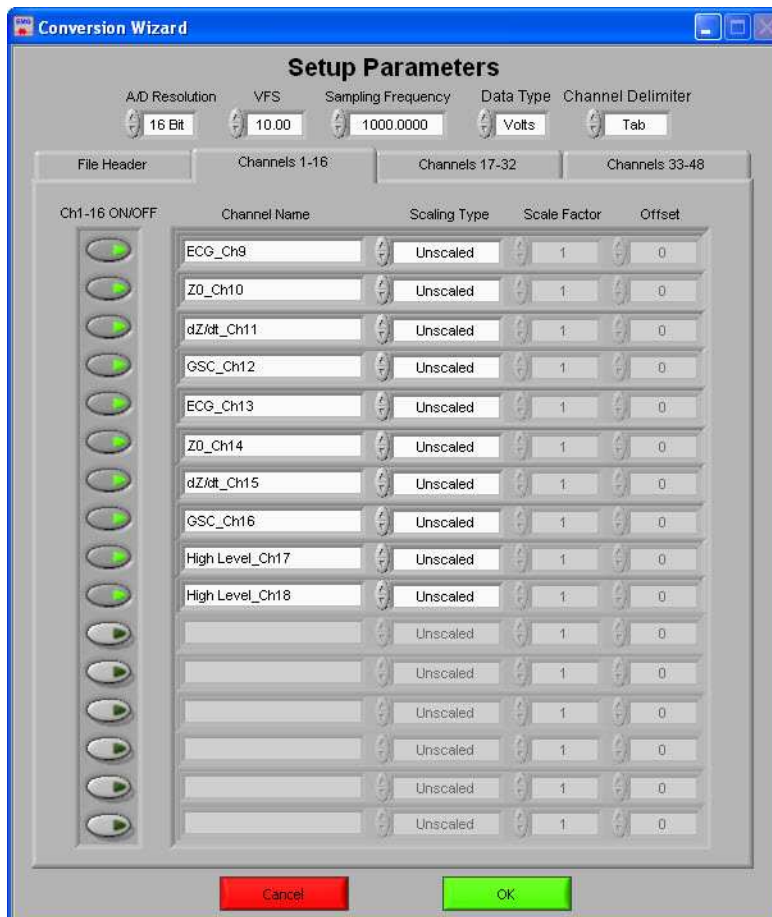
Channel Delimiter: This control specifies the character which is used to separate data channels in the file.

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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.



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.

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