

MindWare Electromyography (EMG) Analysis
User Reference Guide
Version 3.0.12

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The available channel names are read from a text file called *EMG Channels* which is saved in the following location:

C:\Documents and Settings*user_name*\Application Data\MindWare\EMG 3.0

This text file can be modified to contain additional custom channel names not listed in the default file.

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 EMG analysis, only EMG channels are required. These channel types correspond to electrode locations during the EMG data acquisition. 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.)

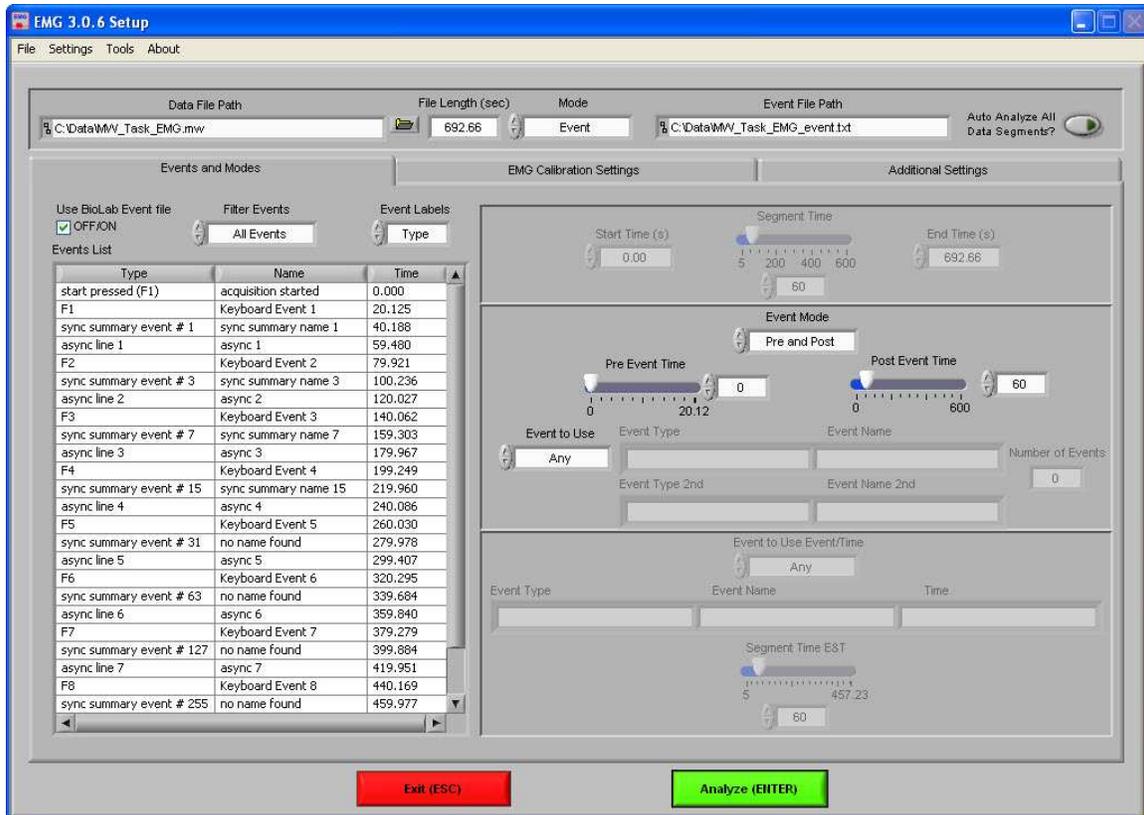
Sampling Frequency (Hz): This indicator displays the Sampling Frequency as read from the input file.

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.

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.

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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.

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.

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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.

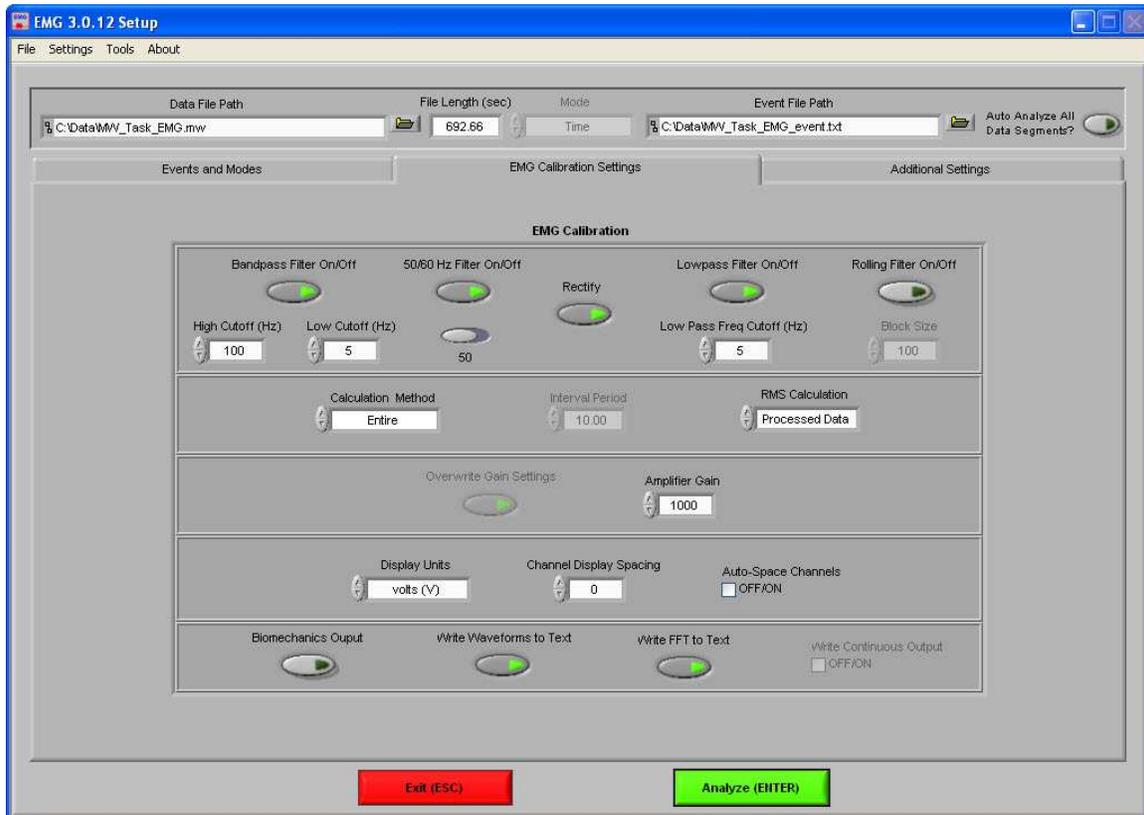
Event and Time: Event and Time mode combines the previous two modes to allow the selection of a specific event to use as a starting point and then to proceed through analysis in time mode from that point. The following parameters are available:

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

EMG Calibration Settings

The second tab on the screen, titled EMG Calibration Settings, allows the user to enable various cutoff and noise canceling filters, specify a calculation method, and set channel display spacing.



Bandpass Filter On/Off: This control enables or disables the band pass filter.

High Cutoff (Hz): This control defines the high cutoff frequency of the band pass filter.

Low Cutoff (Hz): This control defines the low cutoff frequency of the band pass filter.

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

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

Rectify: This control enables the full wave rectification of the processed EMG signal.

Low Pass Filter On/Off: This control enables or disables the low pass filter.

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Low Pass Freq Cutoff (Hz): This control defines the low cutoff frequency of the low pass filter.

Rolling Filter On/Off: This control toggles the rolling filter on or off.

Block Size: This control sets the bin size for the rolling filter.

Calculation Method: This control defines the mode for which the voltage measures for EMG RMS, Mean and Integral will be determined. It does not apply to the spectral measurements. There are two selections available; Entire and Interval. In Entire mode, the above values will be the mean across the total window period. In Interval mode, the window period will be the same as in the Entire mode, however, these measures are divided into fixed time segments as set by the Interval Period.

Interval Period: This control defines the interval length in seconds.

RMS Calculation: This control specifies whether the RMS value is calculated from the raw or processed EMG signal.

Overwrite Gain Settings: This control specifies whether to use gain settings in MindWare file or the value in the Amplifier Gain control. In files created in earlier versions of BioLab (2.x) this control is always selected.

Amplifier Gain: This control specifies the gain of the amplifier used to acquire the EMG signals. When using a MindWare file created with BioLab 2.4 and later, this value is automatically read from the file and this control is not available to change.

Display Units: This control specifies the units in which the EMG signals will be displayed. The options available are volts (V), millivolts (mV), or microvolts (uV).

Channel Display Spacing: This control sets the spacing of the channels on the EMG plot in the analysis window (in volts). When this value is set to zero, the channels will be overlaid.

Auto-Space Channels: When enabled, the value in the Channel Display Spacing control will be ignored and the channels will be spaced according to the largest peak in the data for full spacing of the channels.

Biomechanics Output: This control specifies whether to write the Biomechanics-style output file during analysis. This option is automatically selected when multiple files have been opened simultaneously. For more information on this style of output please see **Section 4: Output File**.

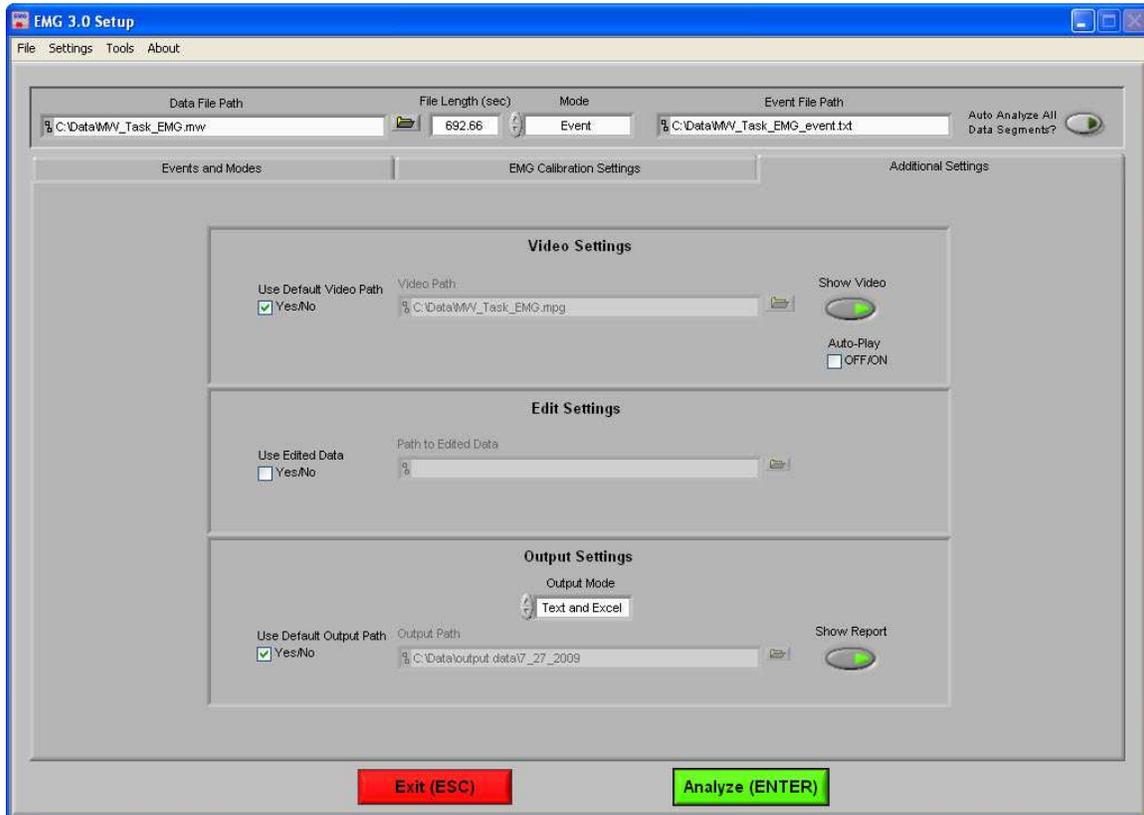
Write Waveforms to Text: This control specifies whether to write the raw, processed, and FFT waveforms for each channel to a tab-delimited text file when writing the output of a segment.

Write FFT to Text: This control specifies whether to write the FFT of each channel to a tab-delimited text file when writing the output of a segment.

Write Continuous Output: Applies only to auto-analyze mode. When in auto-analyze mode, selecting this will write all raw and processed waveforms into a continuous file as the file is analyzed. The FFT waveforms will still be written by segment.

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:

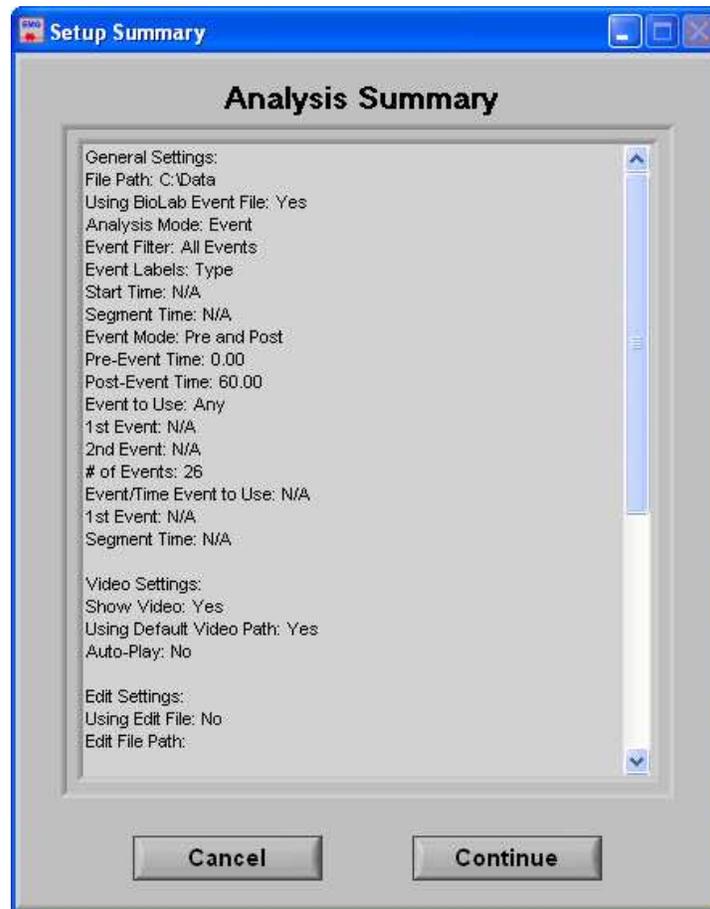
Output Mode: Either a text file (.txt), an excel spreadsheet (.xls) or both can be output at the end of analysis.

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.

One of the next screens made visible is the Controls screen, which initially sits just above the EMG 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. If multiple files have been opened simultaneously, this indicator will drop down to display all file names.

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.

Spline Editor: This control switches the window to the graphical editor. The user can then spline between data points for any of the mapped channels.

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.

EMG Analysis

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



There are three plots visible on this screen:

EMG: The values plotted on the EMG window are an analog waveform. The channels of data are offset from one another according to the Channel Display Spacing control on the Setup screen. Shown above are three channels of EMG data separated using the Auto-Space Channels feature. Also shown on this plot are the event markers, the interval cursors, 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.

Processed EMG: The values plotted in this window are the EMG waveform after it has been processed by the bandpass filter, lowpass filter, 50/60 Hz notch filter, and rectifier. These processing settings correspond to the EMG Calibration Settings on the Setup screen. The channel that is shown is specified by the channel selector on the right hand side of the screen below the video controls. Its color corresponds to the channel color in the EMG plot.

EMG Power Spectrum: The values plotted in this window are the spectral output of the channel specified in the channel selector on the right side of the screen below the video controls. Its color corresponds to the channel color in the EMG plot.

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 EMG 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.

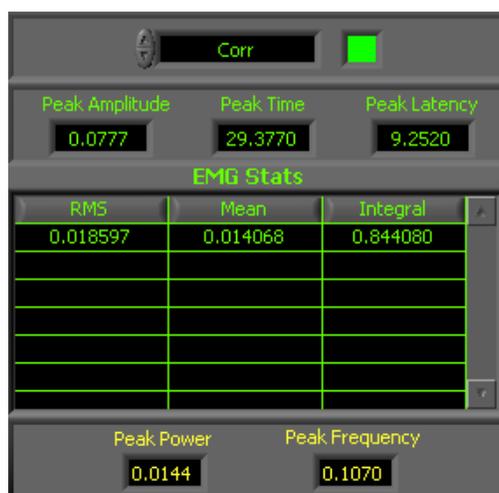


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To return the video to the analysis window, right-click the floating video window and select Dock from the run-time menu.

In the event that either the video is undocked or there was no video selected to be shown during setup, the video display will remain blank.

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



Channel Selector: The control at the top of the EMG stats represents the channel that these stats pertain to. The values of the channel selector correspond to the names of each of the mapped EMG channels, and the color box to the right denotes that channel's color in the EMG, Processed EMG, and EMG Power Spectrum plots.

Peak Amplitude: This value represents the peak amplitude as seen in the Processed EMG plot.

Peak Time: This value represents the time at which the peak amplitude occurs in the Processed EMG plot.

Peak Latency: This value represents the time from the start of the current segment to the peak amplitude in the Processed EMG plot.

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

RMS: This value represents the RMS of either the Processed or Raw EMG signal based on setting in the EMG Calibration Settings.

Mean: This value represents the Mean of the Processed EMG.

Integral: This value represents the integral of the Processed EMG.

Peak Power: This value represents the power at the peak frequency in the EMG Power Spectrum.

Peak Frequency: This value represents the peak frequency in the EMG Power Spectrum.

Section 4: Output File

	A	B	C	D	E	F
1	Version	EMG v3.0A				
2	Date	3/23/2009				
3	Time	2:16 PM				
4	File Name	C:\Data\MW_Task_EMG.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	Bandpass Filter On/Off:	On				
24	High Cutoff (Hz):	200				
25	Low Cutoff (Hz):	0.5				
26	Lowpass Filter On/Off:	On				
27	Lowpass Freq Cutoff (Hz):	5				
28	50/60 Hz Notch Filter:	60				
29	Rectify On/Off:	On				
30	Calculation Method:	Entire				
31	Interval Period:	N/A				
32	Channel Display Spacing:	0				
33	Auto-Space Channels:	Yes				
34						
35	Segment Number					
36	Event					
37	Event Time	1	2		4	
38		F1	sync summary event # 1		F2	
39		20.125	40.188		79.921	
40						

There are three different output modes when Biomechanics Output has not been enabled:

Text (.txt): Two .txt files will be created:

Filename_EMG_stats_time.txt: This text file contains the calculated statistics from the specified segment of data.

Filename_EMG_Channel Stats_time.txt: This text file contains the channel stats of each mapped EMG channel from the specified segment of data.

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

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

Channel Stats: This worksheet contains the channel stats of each mapped EMG channel from the specified segment of data.

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

When in interval mode, an additional worksheet and text file will be created called **Interval Stats**, which contains the RMS, mean, and integral from each of the intervals in the current data segment.

If specified on the EMG Calibration Settings tab on the Setup screen, three additional output files will be created containing the raw, processed, and FFT waveforms of all mapped EMG channels in a tab-delimited format.

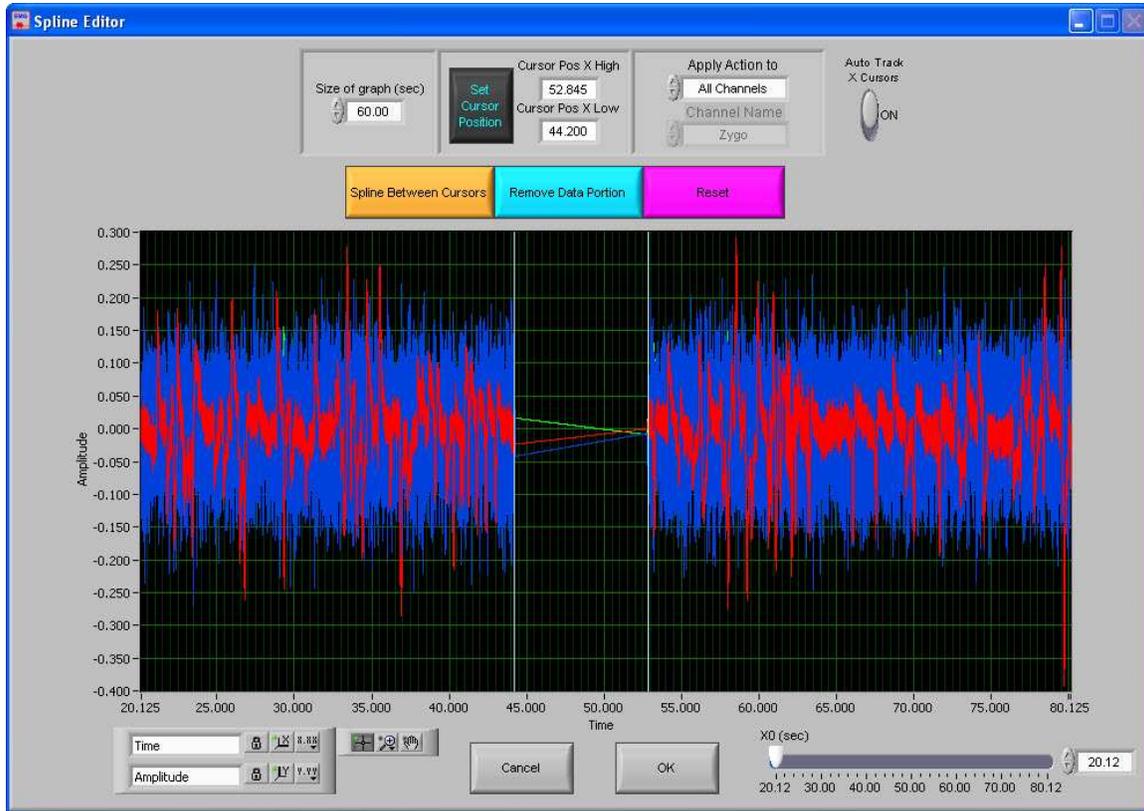
When Biomechanics mode has been enabled, the Excel and Text stat files as described above are not written. Instead, for data file that has been opened there is a text file written containing all setup information, stats calculated on the EMG Analysis screen, and processed waveforms in tab-delimited column form. This file is named

FileName_EMG_continuous_volts.txt

If enabled, the FFT of each of these waveforms is also written to a separate text file named

FileName_EMG_FFT.txt

Section 5: Spline Editor



The Spline Editor is an easy to use, yet powerful tool allowing the user to spline between any two data points for up to 32 simultaneous channels. It is a graphical based editor and will carry any modification that is made back to the analysis screen.

All mapped EMG channels are available for editing in this window. Each individual channel has a specific color that corresponds to it. All channels can be edited simultaneously, or each individual channel can be selected for editing.

There is a set of blue vertical cursors. These cursors represent the data points between which the splining will occur. They can be dragged freely to any location on the plot, or they can be set using the Set Cursor Position control.

EMG waveform graph: The EMG waveforms are displayed in their respective colors. These colors correspond to the channel colors in the EMG Analysis screen. 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 set the data points between which the data will be edited. These cursors can be dragged freely to a desired location.

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.

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.

Apply Spline/Reset To: This control has two values (All Channels and Single Channel) which determine whether the next action (either Spline or Reset) applies to all mapped EMG channels or only to the current channel selected in the Channel Names control.

Channel Names: This control determines which channel is displayed on the graph for editing. Its values correspond to the mapped EMG channels in the data. This control is only enabled when editing/resetting a single channel.

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.

Spline Between Cursors: This control connects the two data points specified by the X Cursors with a line, or splines the data between the two cursors. This action can either be applied to a single channel or to all channels.

Remove Data Portion: This control replaces all data points between X cursors with zero. This action can either be applied to a single channel or to all channels.

Reset: This control resets the EMG signals to the original state when the editor was first entered. This action can either be applied to a single channel or to all channels

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: 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.

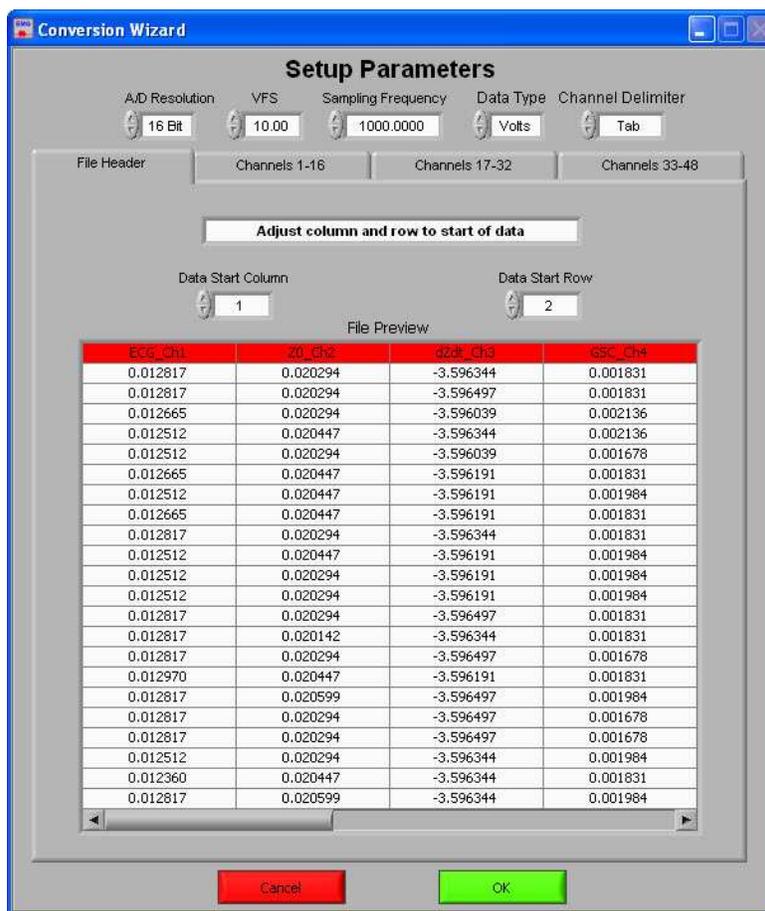
Auto-Play: When this is turned on, the specified video will automatically begin playback when a new segment is selected. Otherwise, the video will not begin playback until it is started by the user.

Appendix A: ASCII-MW Converter



The ASCII-MW Converter allows the conversion of any text file containing data in tab-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.

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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.

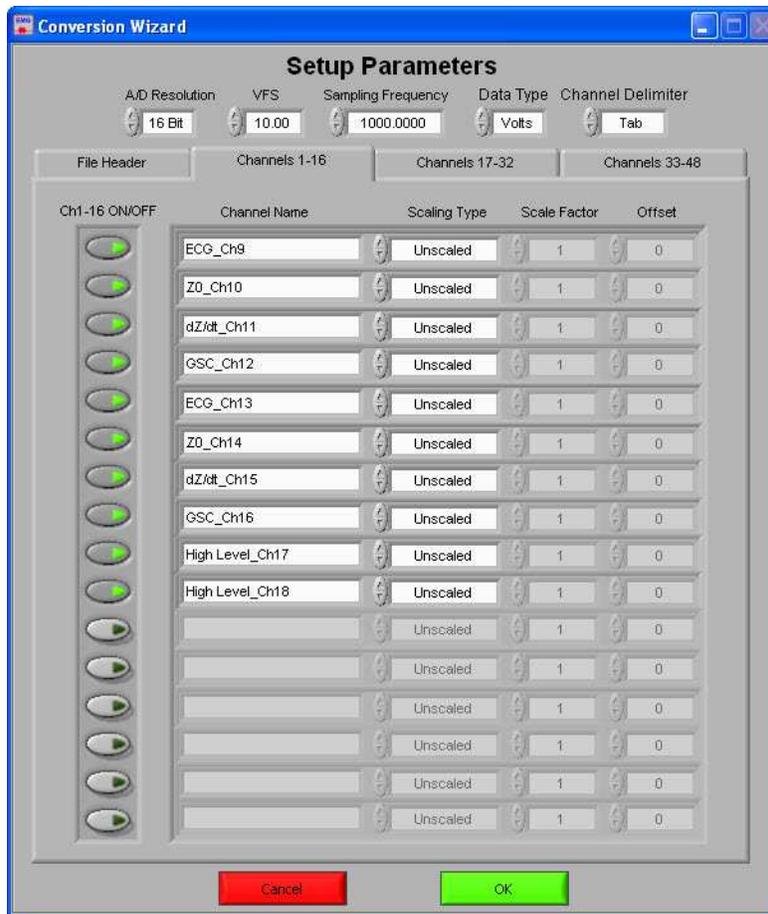
Data Type: This control specifies whether the data in the file is in volts or A/d counts.

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.



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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