Sierra Wave Help Manual

Version 11

Part Number: 100813-620

Table Of Contents

Welcome To Sierra Wave

Welcome to the **Cadwell Sierra Wave™ Help System**. To use the help system, expand the book chapters to the left (by clicking on the plus signs), then click on the topics you wish to learn more about.

Sierra Wave with 2 Channel amplifier on the "Point Of Care" lightweight cart.

REV. 11, 2010

DJn

Introduction & Setup

General Description

The **Cadwell Sierra Wave**™ is a complete **2** or **4** channel electromyography and evoked potential acquisition system. The Wave is designed from the ground up to take full advantage of the Windows™ operating system.

The Wave can be configured in a **portable** or **desktop** version. The portable version comes with a laptop computer and soft-sided carrying case for greater mobility.

The desktop version comes with a tower or mini-tower PC and an LCD monitor.

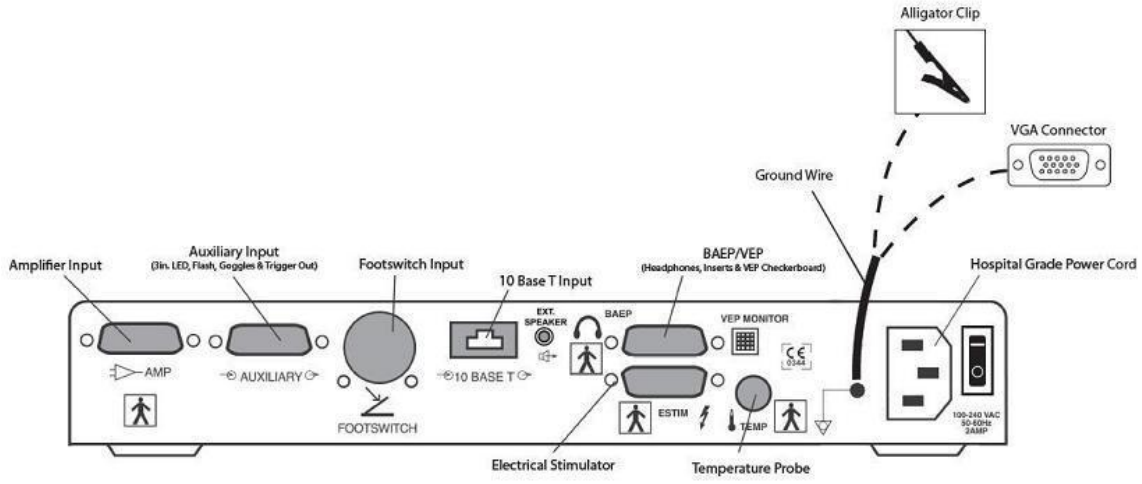
Both a lightweight and hospital-grade cart are available.

The Sierra Wave basic system includes a 2 Channel amplifier with EMG, NCV, F Wave, H Reflex, RNS, Blink Reflex, Somatosensory Evoked Potentials, and Report Generation using Microsoft Word.

Optional programs include Single Fiber EMG, Stimulated Single Fiber EMG, Macro EMG, Auditory Evoked Potential, Visual Evoked Potential, P300 Cognitive Evoked Potential, Quantitative EMG (Multi-MUP and Interference Pattern), Motor Unit Number Estimation, and RR Interval.

Laptop model with 2 Channel Amplifier and Electrical Stimulator

System Connections



LAPTOP

1. Peel the liner of the Velcro patches on the top of the Sierra instrument and carefully align the laptop above and press down to attach the patches to the laptop bottom.
2. Plug one end of the network cable into the Ethernet network port on the laptop and the other end into the connector labeled 10 BASE T on the Sierra rear panel.
3. Connect one end of the Y-shaped power cord into the receptacle on the rear of the Sierra base unit, connect the other end of the cord into the AC adapter for the laptop. Connect the AC adapter to the connector on the rear panel of the laptop labeled DC IN.
4. Connect printer cable (if applicable) to laptop's printer port (parallel or USB).
5. Connect mouse (if applicable) to laptop's mouse port.
6. Attach the grounding wire from the base unit to the laptop's grounding wire (alligator clip) or the external video connector (VGA connector shell).
7. Plug all power cords into hospital grade wall outlets. (Do not use a power strip or surge protector)
8. If you are using a cart, follow the instructions included with the cart to ground the cart with the instrument.

9. Connect the Amplifier to the Sierra base unit using the amplifier cable supplied.
10. Plug all accessory items (footswitch, stimulator etc…) into their respective inputs on the rear panel of the Sierra base.

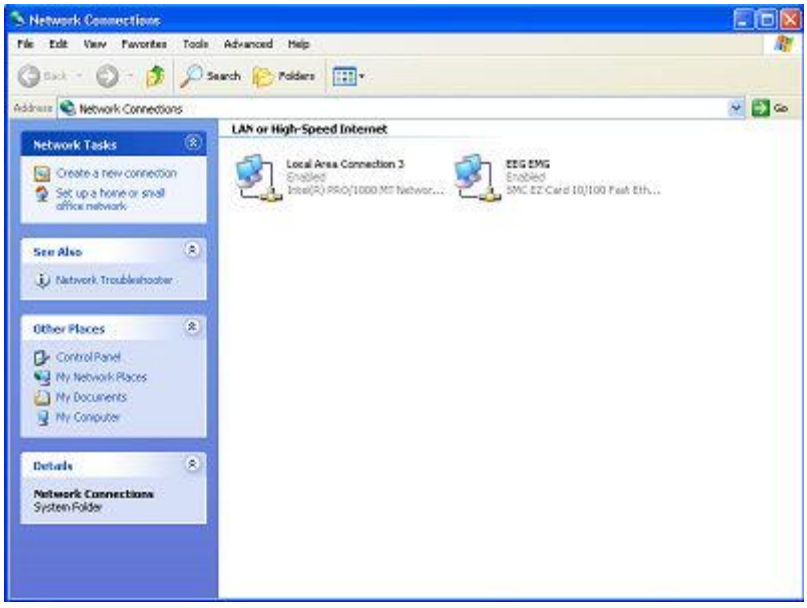
DESKTOP (Console)

1. Place Monitor on Monitor shelf. Place Wave base unit on shelf below.
2. Plug one end of the network cable into the Ethernet network port on the computer and the other end into the connector labeled 10 BASE T on the Sierra rear panel.
3. Connect the main power cord into the receptacle on the rear of the Sierra base unit.
4. Connect printer cable (if applicable) to computer's printer port (parallel or USB).
5. Connect the keyboard and mouse to computer's designated ports.
6. Plug all power cords into hospital grade wall outlets. (Do not use a power strip or surge protector)
7. If you are using a cart, follow the instructions included with the cart to ground the cart with the instrument.
8. Connect the Amplifier to the Sierra base unit using the amplifier cable supplied.
9. Plug all accessory items (footswitch, stimulator etc…) into their respective inputs on the rear panel of the Sierra base.

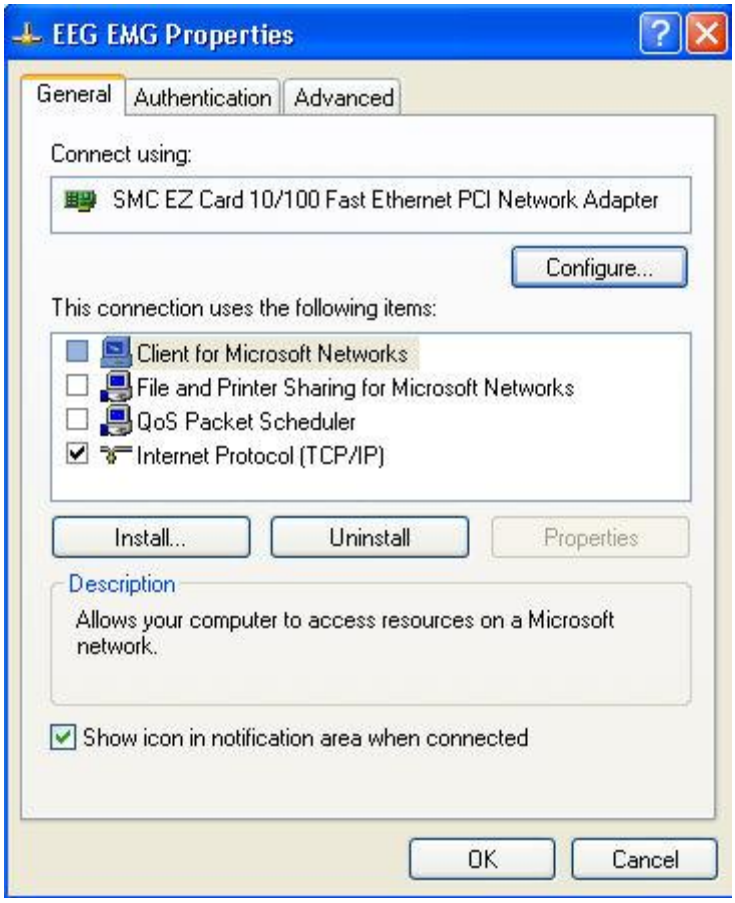
Network Card Configuration

Configuring the Network Card (port) for the Sierra Wave Base

1. If necessary, install a network card in the computer. Follow the manufacturer's installation instructions.
2. **Login** as a User that has administrative access rights.
3. Click **Start**, then **Control Panel**, then **Network and Internet Connections**.
4. Click on **Network Connections**. The Network Connections window will be displayed. A separate icon will be displayed for each network card that is installed in the PC. By default, the name given to each network card is "Local Area Connection". You can rename the icons to something more descriptive by right-clicking on the icon and then selecting Rename. For example, you might want to change the name to Sierra, or maybe to EMG_EEG as shown in the picture below.



5. To configure the network properties; **Right click** over the appropriate icon and then select **Properties**. The properties window will be displayed as shown in the next picture.

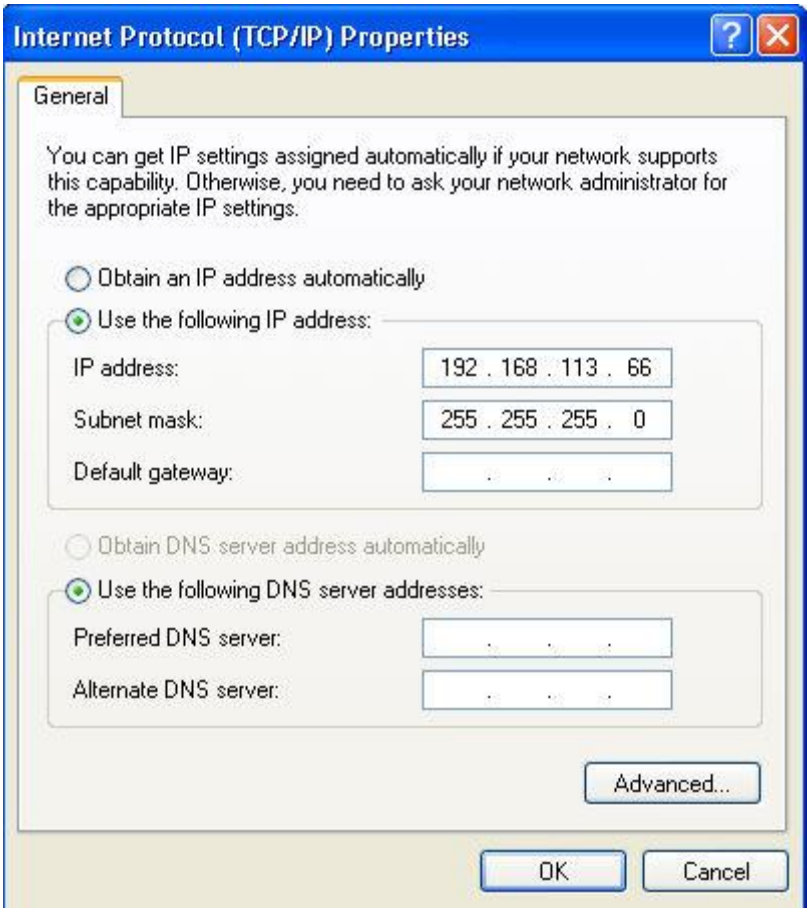


6. First, **remove the check marks** next to Client for Microsoft Networks, File and Printer Sharing for Microsoft Networks, and QoS Packet Scheduler. Be sure to leave the check mark next to Internet Protocol (TCP/IP).

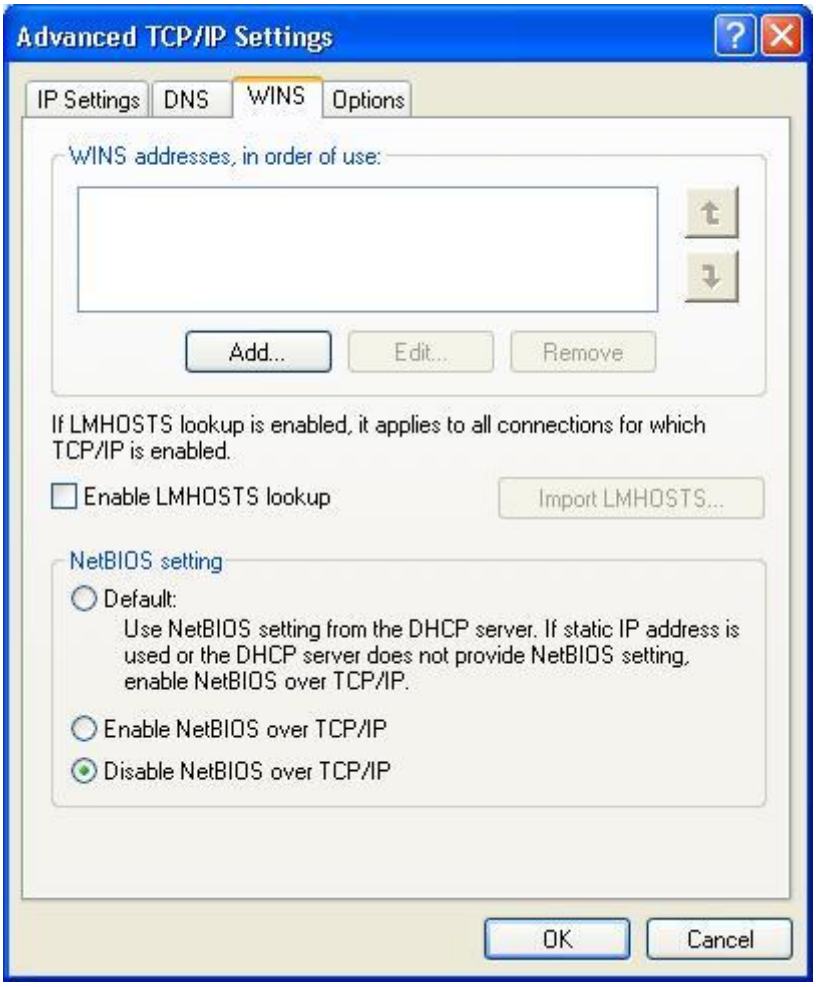
7. Optional: Place a check mark next to "Show icon in notification area when connected" if you want Windows to tell you when the connection to the Cadwell system has been made. When the connection is made you will see a message displayed in the lower right hand corner of the desktop.

8. Select the **Internet Protocol (TCP/IP)** and then click on the Properties button.

9. Select **"Use the following IP address"**. Enter **192.168.113.66** for the IP Address. Enter **255.255.255.0** for the subnet mask.

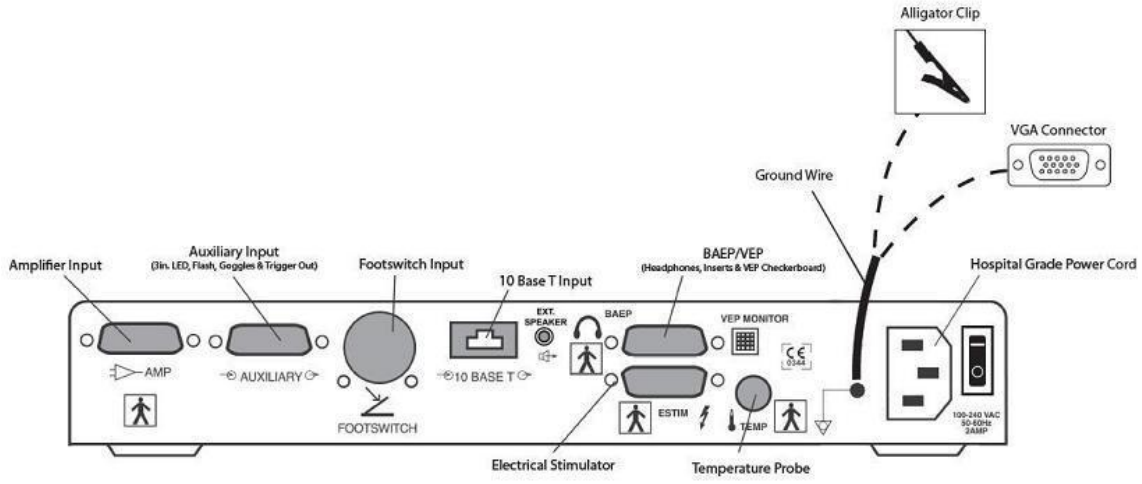


10. Click the **Advanced** button, then click the **WINS tab**. **Remove the check mark** next to **"Enable LM Hosts lookup"** and then select **"Disable NetBIOS over TCP/IP"** as shown in the following picture.



11. Click **OK**, click **OK** again, then click **Close**.

Back Panel Connections



AMPLIFIER - Plug in 2 or 4 channel Amplifier.

AUXILLIARY - Plug in LED Goggles, Trigger Out cable, 3" LED Checks or Flash.

FOOTSWITCH - Plug in Footswitch

10 BASE T - Network "Patch" cable attached to computer's network port (communication between the Wave base unit and the PC occurs over this cable).

EXT SPEAKER - Connection for external speaker (Please read external speaker specifications).

BAEP/ VEP Monitor - Plug in Auditory Headphones, Inserts, Bone Transducer or VEP Monitor.

ESTIM - Plug in Electrical Stimulator.

TEMP - Plug in Temperature Probe.

● - Attach grounding wire(s).

100-240 VAC - 2Amp fuse located on bottom of base.

Custom Keyboard

Standard Keyboard

International Keyboard

Function keys (F1, F2, F3, F4) - The operations assigned to these function keys change depending on the test protocol that is active. The description for the current function is located in the lower left of the screen.

Study keys (S1, S2, S3, Select  **)** - Programmed to select your most common study lists. The Select button will bring up the entire Study List/Test Menu.

Knobs (1, 2, 3, 4) - The operations assigned to these knobs change depending on the test protocol that is active. The description for the current functions is located in the lower right of the screen.

On (Power) Indicator - Bright green when the base unit has power.

Volume  - Adjusts the speaker volume.

Print  - Programmable report generation key.

Report  - Programmable report generation key.

Next  - Advances to the Next test protocol in the Study Window.

View  - Toggles the Trace window to a maximized view, pressing a second time returns the window to its original size.

Patient  - Opens the Patient Information Window.

Imped  - Opens the Impedance Window.

OK  - Closes various Pop-Up Windows. (Impedance, Patient Information etc...)

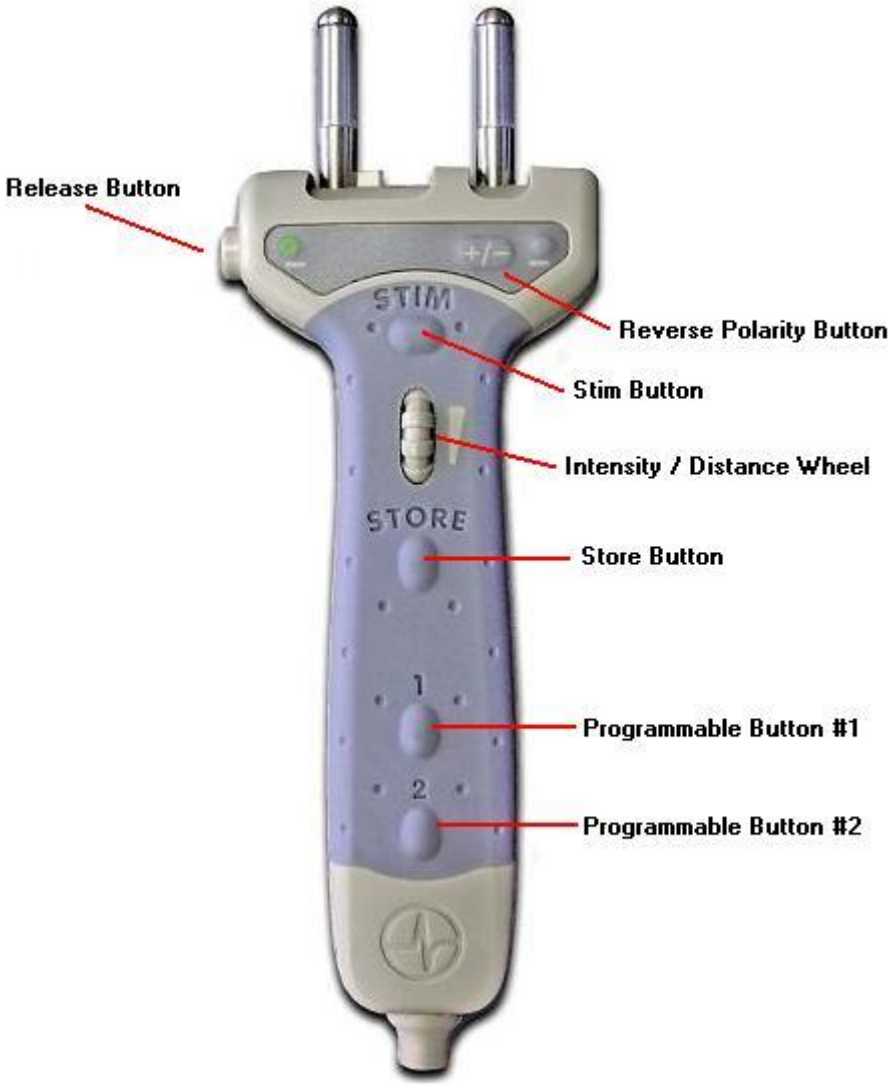
Store  - Stores the active trace(s).

Clear  - Clears the active or selected stored trace.

Single  - Delivers a single stimulus.

Run/Stop  - Delivers repetitive stimulations. Press again to Stop stimulation.

Electrical Stimulator



Reverse Polarity button (+/-):

Press this button to select the Cathode (i.e., the negative stimulus probe). A green LED indicates which probe is the Cathode. For routine nerve conduction studies the Cathode (-) should be oriented closest to the recording electrodes.

***** For **F Wave** and **H Reflex** test protocols: The Cathode (-) should be positioned away from the recording electrodes (i.e., Cathode proximal, Anode distal).

Stim button:

NCV protocol:

Press once and release to deliver a single electrical stimulus. Press and Hold for two seconds, then release to initiate repetitive stimulation.

 The Press and Hold feature can be disabled in the System Setup window.

SEP protocol:

Press once and release to deliver repetitive electrical stimulus.

Intensity / Distance Wheel:

Turn toward the stimulus probes to increase the intensity, turn towards the cable to lower stimulus intensity. In the NCV test protocol the wheel can be used to enter distance measurements.

Store button:

Press to store the active (white) trace.

Programmable buttons 1 & 2:

These two buttons are programmable per Test protocol. In the NCV test protocol button 1 is used to reverse stimulator polarity and button 2 is used to enter distances.

Release button:

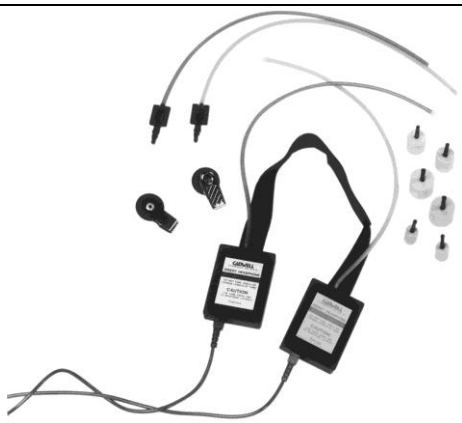
The stimulus probes can be angled to 3 positions besides the normal straight ahead position. Press and hold the release button while moving the probe tips up or down. Release the button to lock the probes into their new position.

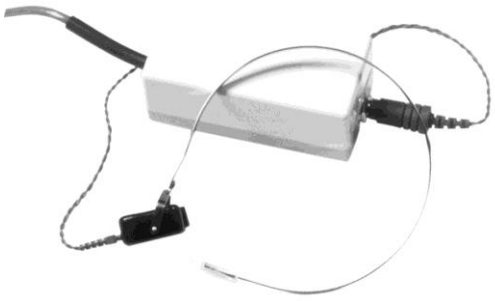
Stimulus Probes:

The probe spacing can be narrowed for testing smaller patients. The probes can also be removed to allow bar electrodes to be connected to the stimulator.

Auditory Stimulators

Auditory Stimulators

	**Acoustically shielded headphones** The headphones feature 10-W speakers, adjustable headband, and color-coded earphones for easy right/left identification.
	**Lightweight headphones** Recommended for pediatric use, these headphones feature 10-W speakers and adjustable headband.
	**Insert earphones** The insert earphones feature 10-W compatible speakers with 1-ms acoustic delay. They are useful for intraoperative applications, ECochG testing, and BAEP testing in infants.

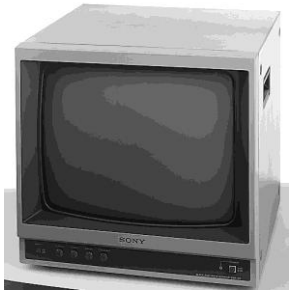
	**Auditory bone transducer** The auditory bone transducer is useful for assessing peripheral hearing loss and/or head trauma.

The auditory stimulator (headphones of both the cup and insert type) output a 100µS square wave (pulse) which is heard as a click. The output level is user adjustable from -10 to 95 dB nHL. Contralateral masking is also available and is user is adjustable from 0 to 80 dB below stimulus level. Extended exposure to high sound pressure levels can result in permanent hearing loss. While the effect of high sound pressure levels differ greatly between individuals it is possible that exposure to levels of 75dB nHL for several hours can cause permanent hearing loss. As the sound pressure levels go up the acceptable exposure time goes down. Where possible avoid stimulating at high levels for extended periods of time.

Avoid prolonged use of high sound pressure levels which may cause permanent hearing impairment.

Visual Stimulators

Visual Stimulators

	**Monochrome VEP monitor** The monitor presents reversing black-and-white checkerboard stimuli for full-, half-, and quarter-field testing. Fixation point (small or large) and check sizes are controlled by software.
	**LCD Television VEP monitor** The monitor presents reversing black-and-white checkerboard stimuli for full-, half-, and quarter-field testing. Fixation point (small or large) and check sizes are controlled by software. *Requires BNC-to-RCA Adapter (PN# 277072-000) and software version 10.0.128 or higher.
	**3-in (8-cm) LED stimulator** The LED stimulator presents reversing black-and-red checkerboard patterns in 0.25-in (7-mm) check sizes. It can also function as a flash stimulator.

	**LED goggles** The goggles present LED flash stimuli to the left, right, or both eyes and are useful for intraoperative applications.
	**Single-intensity flash stimulator** Repetition rate and start and stop controlled by software.

Photic (Flash) Stimulation:

The photic stimulator using flash tube technology outputs a pulse of white light with a pulse width of approximately 10uS. The flash can be manually triggered or set to flash repeatedly at a rate between 1 and 25 Hz. The flash energy is 1.5 million candle or less. UV energy is blocked by a protective filter incorporated into the lens. While there are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. They have been proven to be safe when used at distances of 18 inches or more on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

The photic stimulator using LED technology outputs a pulse of white light with a pulse width of several milliseconds. The flash can be manually triggered or set to flash repeatedly at a rate between 1 and 60 Hz. The LED produces no UV energy. The flash energy is much less that output by a flash tube stimulator and the pulse width is adjusted to give the same perceived brightness. While there are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. They have been proven to be safe when used at distances of 18 inches or more on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

The photic stimulator goggles use LED technology and output a pulse of red light (650nm nominal wavelength) with a pulse width of 10 milliseconds. The flash can be manually triggered or set to flash repeatedly at a rate up to 10 Hz. The LED produces no UV energy. The flash energy is in accordance with EN 60825-

1 which covers the safety of laser and LED products. While there are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. The goggles have been proven to be safe when used on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

 **Avoid prolonged use of high light output which may cause permanent visual impairment.**

Getting Started - The Basics

Turning Equipment On and Off

To turn equipment On.

1. Connect the amplifier, stimulators, and other accessories (if not already connected).
2. Turn equipment on in the following order:
    - Sierra Wave base unit
    - Monitor (for desktop configuration only)
    - Printer
    - Computer

 If you are using the isolation transformer and cart power switches, you will need to turn on the cart power switch and then the computer.

To turn the equipment Off.

 Do not turn the Sierra Wave instrument base on or off while a patient is connected.

Turn off equipment in the following order:

1. Close all programs that are running on the computer.
2. On the Windows taskbar, click Start, Shutdown, Turn Off the Computer.
3. Turn off the Sierra Wave base unit, Monitor (for desktop configuration only), and Printer.

 If you are using the isolation transformer and cart power switches, turn off only the cart power switch after you have shutdown the computer. The monitor, printer, Wave base unit, and isolation transformer power switches can remain on. The next time you start the system, turn on the cart power switch and then the computer.

 You do not need to disconnect the amplifier, stimulators, or accessories. You can leave them connected.

Starting the Sierra Wave Program

To Start the Sierra Wave program

Start the Sierra Wave software on your computer in one of the following ways:

- Double-click the **Sierra Wave** icon on the Windows desktop.
- Click the Windows **Start button,** select **All Programs**, **Cadwell,** and then **Sierra Wave**.

If you receive a Communication Error message.

Close the Sierra Wave program and make sure the Sierra Wave base unit is turned On, and that the network cable is attached securely between the computer and the Sierra Wave base unit. Then, restart the Sierra Wave program.

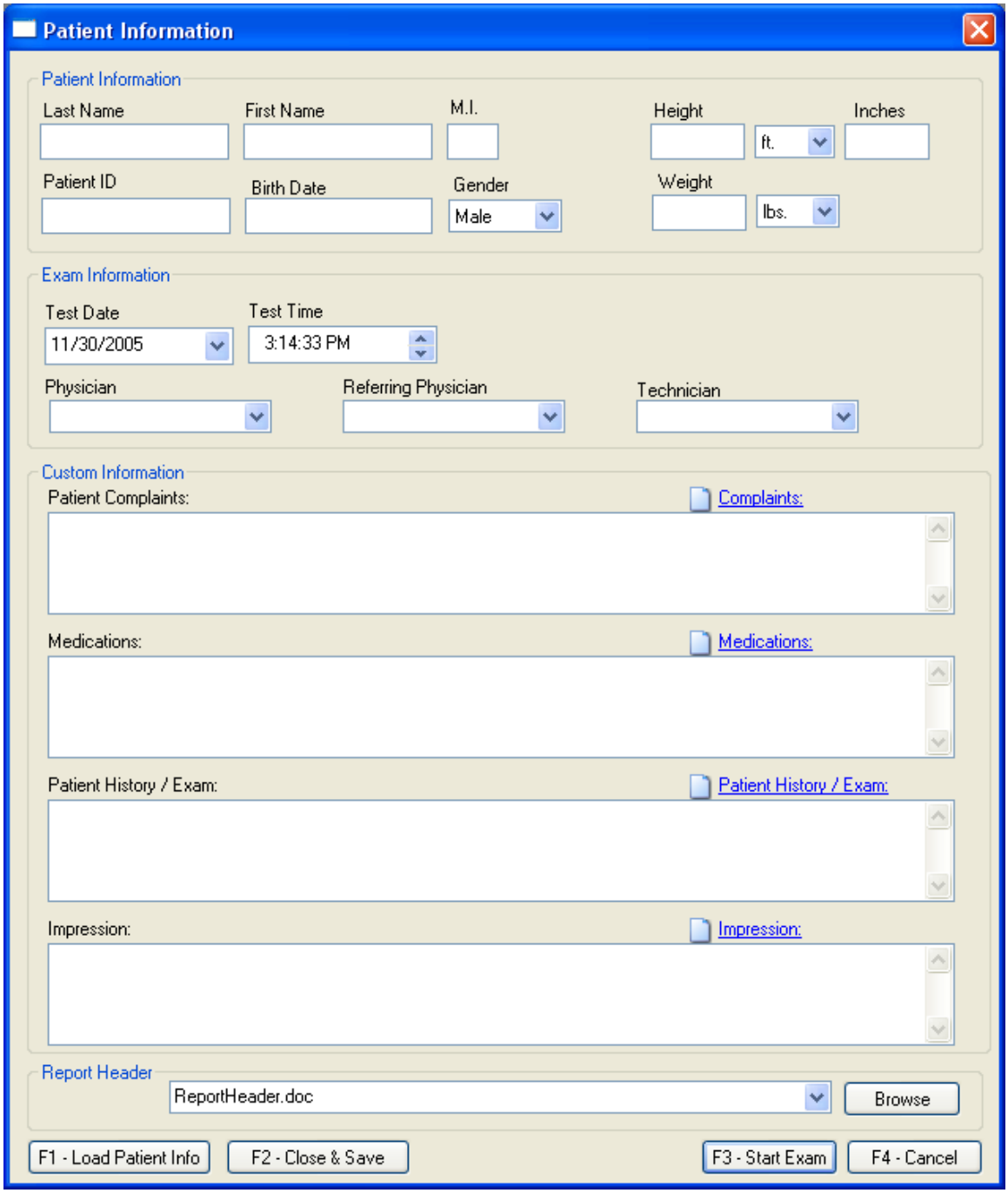
If you are working on a **Reader station** (no acquisition hardware attached) the communication error can be disabled. Click here for instructions on how to do this.

Starting a New Exam and entering Patient Information

To start a New Exam and enter Patient Information use one of the following methods.

- Press **F1 - New Exam**.
- Select **Enter Patient Info** from the **File Menu**.
- Press the **Patient** key on the Sierra Wave base unit.
- Select a **Study** or an individual **Test Protocol** from the **Study/Test** menu

All of these methods will display the following Patient Information Window.



Patient Information window

A blinking cursor will automatically be displayed in the **Last Name** field. You can use the **tab key**, **mouse**, or **Knob #1** on the Sierra Wave base unit to move from field to field.

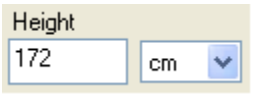
At a minimum, you should enter a **Last Name** and **First Name**, this is what the Sierra Wave program uses to create the patient's data file.

The **Test Date** and **Test Time** will automatically be entered for you, and can be modified if needed.

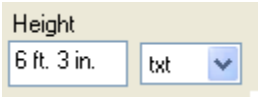
Height can be entered in the following units:

- **Feet and Inches**

- **Centimeters** (cm) - required when using the prediction equations in NCV, F Wave, and H Reflex.

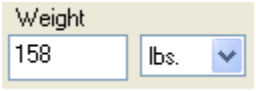


- **Text** (txt) - for backwards compatibility with older patient data or when using different measurement units.

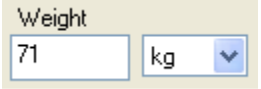


Weight can be entered in the following units:

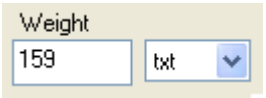
- **Pounds** (lbs.)



- **Kilograms** (kg)



- **Text** (txt) - for backwards compatibility with older patient data or when using different measurement units.



To use the **Custom Information** fields, you will need to click the mouse in the field prior to entering information.

The **Report Header** can be selected from the drop-down list or by clicking on the Browse button. The report header can also be selected from within the System Setup window.

The following buttons are shown at the bottom of the window:

F1- Load Patient Info: Allows previously entered patient information to be loaded from a saved patient information file (*.cpi) or from a patient data file (*.sd).

F2- Close & Save: Allows the entered patient information to be saved in a file, it can later be retrieved using the Load button.

F3 - Start Exam: Saves the entered patient information and then displays the Study Menu. You can then select the Study or individual Test protocol that you would like to use.

F4 - Cancel: Closes the patient information window and discards all information.

 The patient information can be edited at any time after starting an exam. Simply press the **Patient** key on the Sierra Wave base unit, or select **Patient Information** from the **Edit** menu.

 You can also start an exam without entering any patient information. Simply select **F3 - Start Exam** and go directly into the Study or Test Protocol and begin testing. If you do not enter any patient information during the exam, the program will prompt you for it when you close the patient's exam.

Related Topics:

Editing Patient Information during an Exam

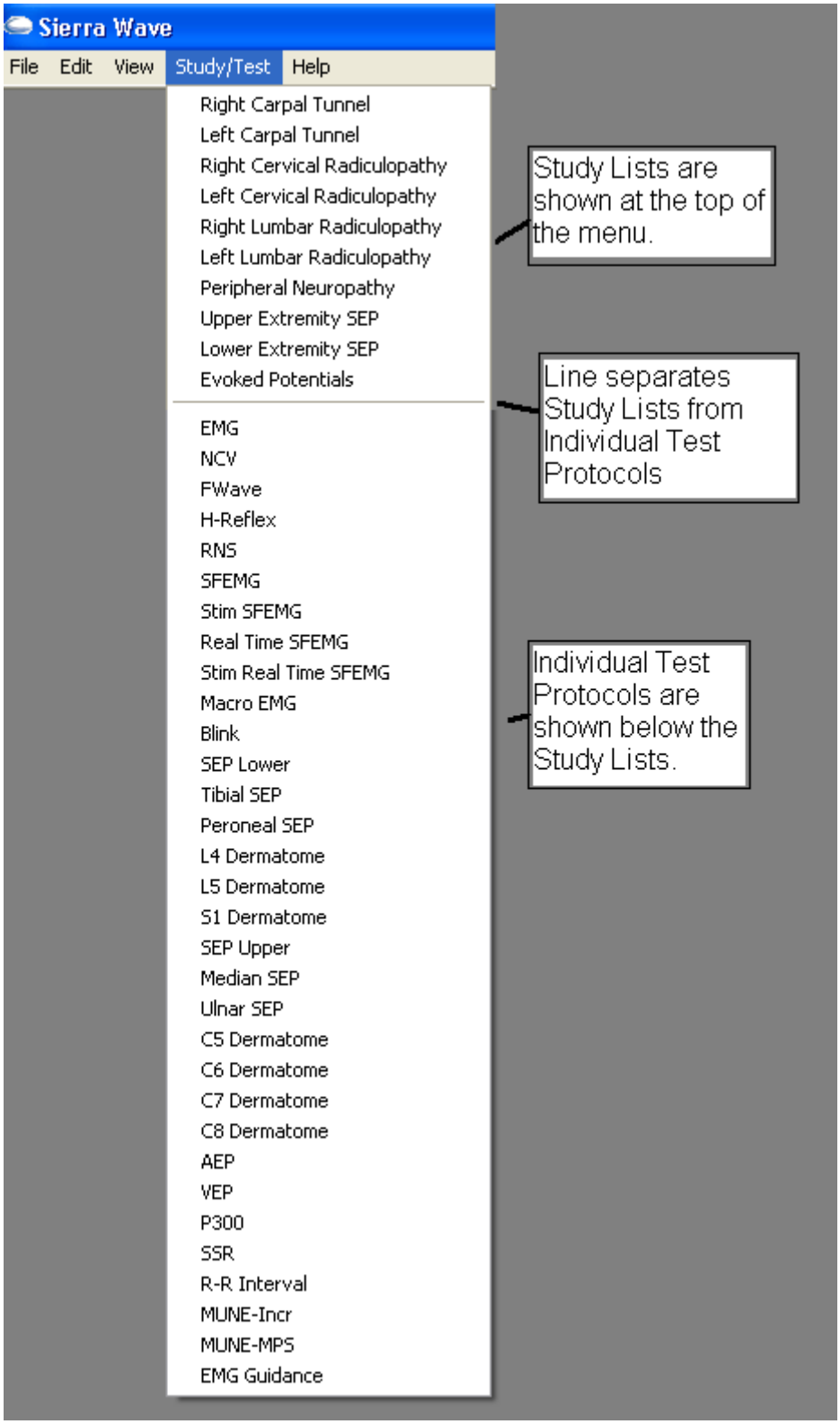
Custom Information Fields

Selecting a Study or Test Protocol

There are various ways to select a Study or individual Test protocol.

From the Patient Information window:

Click the **F3 - Start Exam** button. The patient information will be saved and the **Study/Test** menu will be automatically displayed. Use the **mouse**, or **Knob #1** to select a Study or an individual Test protocol.


Sierra Wave
File
Edit
View
Study/Test
Help
Right Carpal Tunnel
Left Carpal Tunnel
Right Cervical Radiculopathy
Left Cervical Radiculopathy
Right Lumbar Radiculopathy
Left Lumbar Radiculopathy
Peripheral Neuropathy
Upper Extremity SEP
Lower Extremity SEP
Evoked Potentials
EMG
NCV
FWave
H-Reflex
RNS
SFEMG
Stim SFEMG
Real Time SFEMG
Stim Real Time SFEMG
Macro EMG
Blink
SEP Lower
Tibial SEP
Peroneal SEP
L4 Dermatome
L5 Dermatome
S1 Dermatome
SEP Upper
Median SEP
Ulnar SEP
C5 Dermatome
C6 Dermatome
C7 Dermatome
C8 Dermatome
AEP
VEP
P300
SSR
R-R Interval
MUNE-Incr
MUNE-MPS
EMG Guidance
Study Lists are shown at the top of the menu.
Line separates Study Lists from Individual Test Protocols
Individual Test Protocols are shown below the Study Lists.

If a Study is selected, all the tests included in the Study will be displayed in the Study window and the first test protocol listed in the Study will automatically be initialized and will be ready for data acquisition.

If an individual Test is selected, the test protocol will be loaded. If the test uses a muscle or nerve list, this list will be displayed so you can choose the muscles or nerves you wish to examine. Once selected, these nerves or muscles will be displayed in the Study window.

Outside the Patient Information window:

Use the **Study/Test** menu or the **Study keys** on the Sierra Wave base unit.

- Click on the **Study/Test** menu with the mouse and then select the Study or Test protocol of interest.
- Press the **Select key** on the Sierra Wave base unit. The Study/Test menu will be displayed, use the **mouse** or **Knob #1** to select the Study or individual Test protocol of interest.
- Press the **S1**, **S2**, or **S3** keys on the Sierra Wave base unit. The Study or Test Protocol assigned to the key will be loaded.

Related Topics:

Study Key Assignments

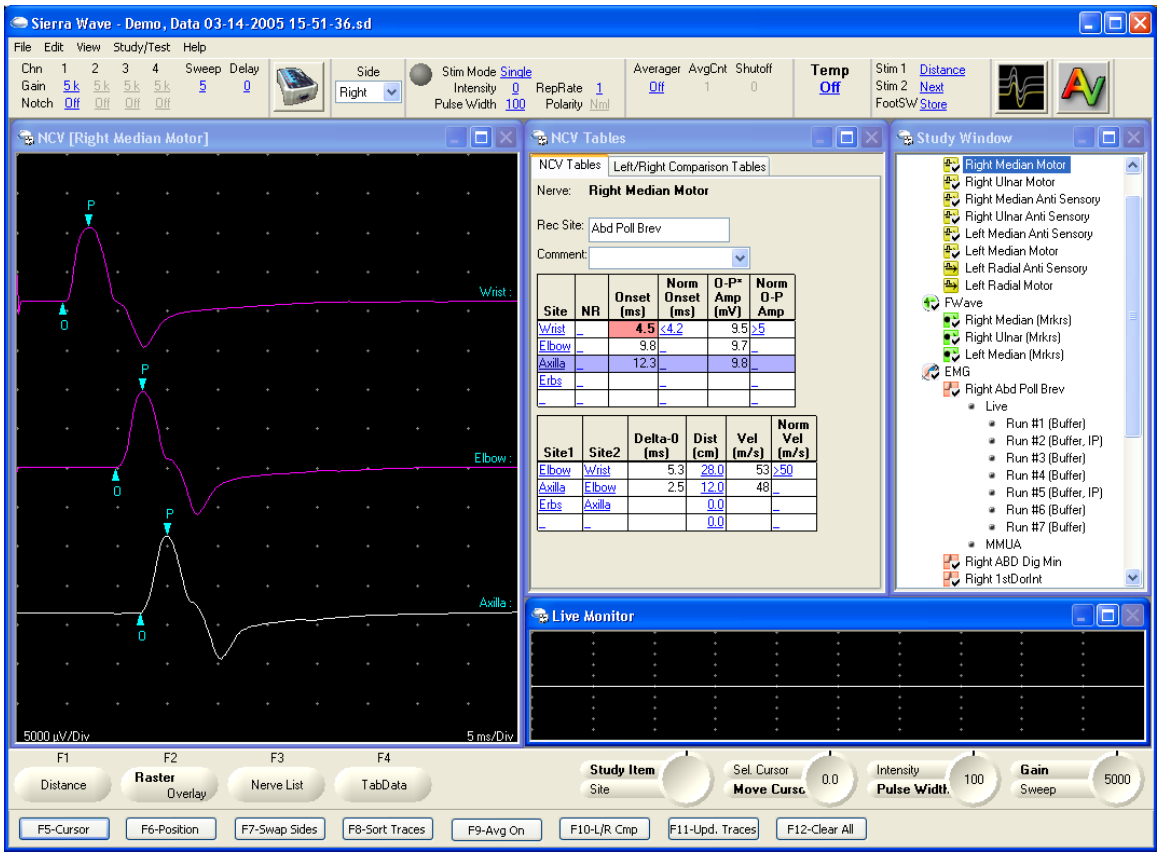
Study Menu

Study Menu Setup Window

Description of Screen Layout

The Sierra Wave screen is composed of three main windows; the **Trace** window, **Study** window, and **Measurements / Cursor Table** window. The **Amplifier / Stimulator** controls can be displayed in either a window or toolbar format. An optional **Live Monitor** window is available in the NCV, F Wave, H-Reflex, Blink Reflex, and RNS test protocols.

The bottom of the screen shows the current **function key** and **knob assignments** for the Sierra Wave base unit.



Sierra Wave Screen showing the Trace, Study, and Cursor Table windows, the Amplifier / Stimulator Controls toolbar, and Live Monitor window.

The **color scheme** used throughout the help topics is **Factory Default 1**. For more information on changing the Sierra Wave's color scheme go to the Color Editor topic.

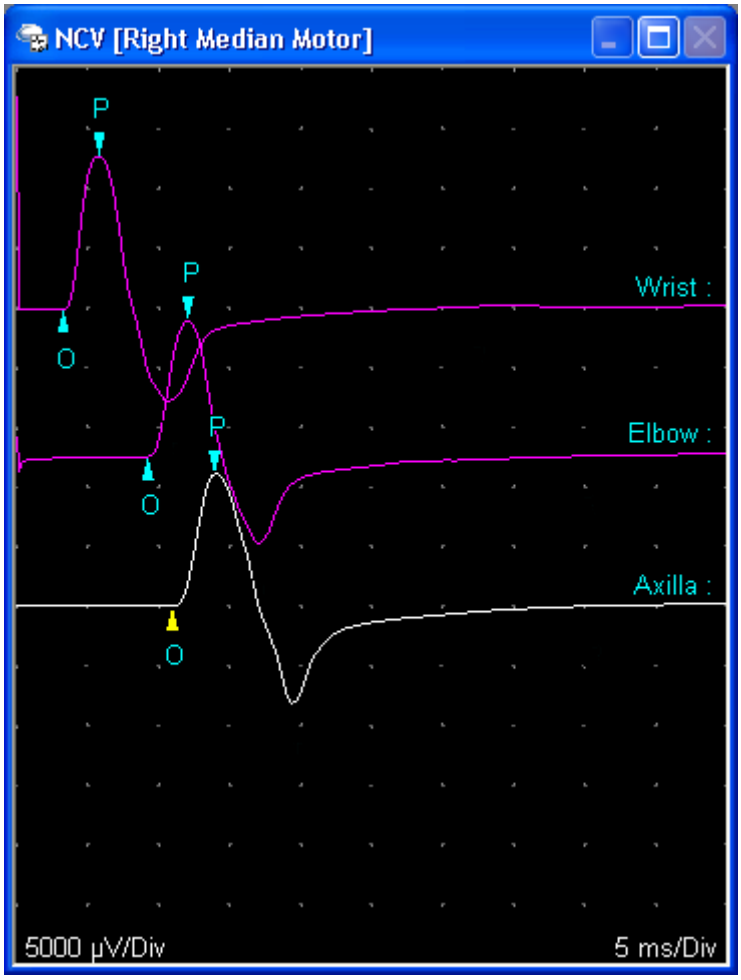
Trace Window

The **Trace** window displays the electromyographic and evoked responses acquired from the patient.

Live or **Averaged** traces are displayed in **"white"** color. **Stored traces** are displayed in **"purple"** color. Traces that have been **selected** for manipulation are shown in **"yellow"** color.

Pressing the **View** key on the Sierra Wave base unit will maximize the Trace window to fill the entire screen. To return the Trace window to its original size & position, press the View key a second time.

The major divisions of this window are displayed in a white grid or dot pattern. The **Display Gain** (vertical scale in microvolts per division) and **Sweep Speed** (horizontal scale in milliseconds per division) are shown in the lower left and right of this window respectively.

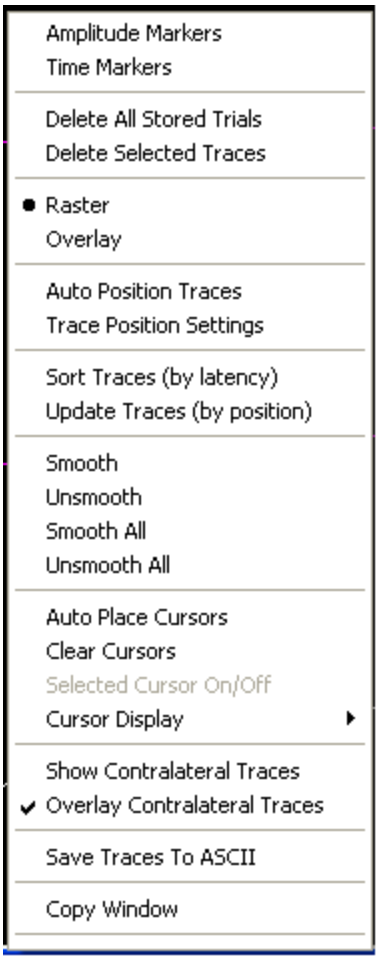


NCV Trace window

Trace Window Context Menu

In true Windows fashion, the Trace window supports a Context menu.

The Context menu, also known as the **right click menu**, is accessed by right clicking the mouse anywhere over the trace window. The functions that are available in the context menu will vary depending on the test protocol that is currently loaded.



Context menu for NCV Trace window.

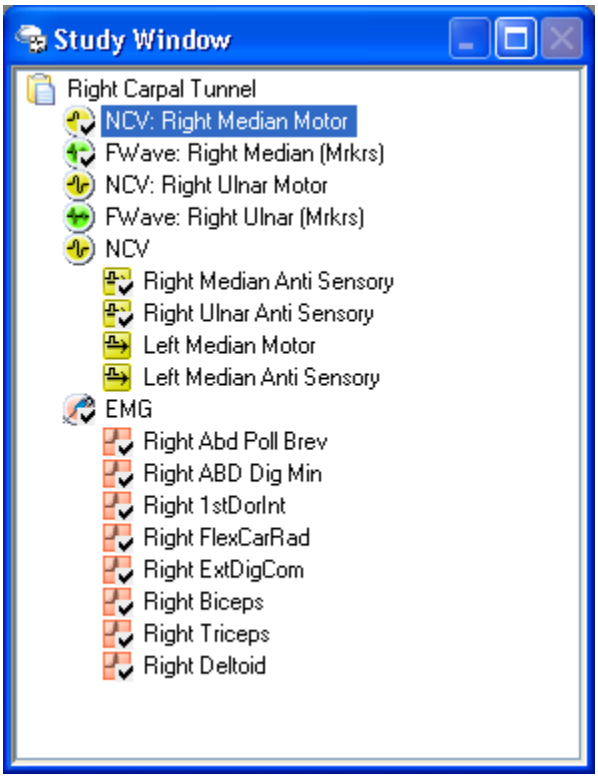
Study Window

The **Study** window has several functions:

- Lists the test protocols that have been pre-selected and grouped into the selected Study List (e.g., lists the tests for the Right Carpal Tunnel Study).
- Automatically adds to the list other test protocols, not originally part of the Study list, as they are selected from the Study/Test menu or nerve and muscle lists.
- Provides an easy way to change from one test protocol to another or go back and review a previous test.
- Shows which test protocols have been completed by placing a checkmark on the test protocol's icon.

Use **Knob #1 (Study Item)**, on the Sierra Wave base unit, to move the highlight up and down through the Study window. If you stop the highlight on a test protocol for more than **1.5 seconds**, that protocol will be loaded.

Alternatively, click on a test protocol with the **left mouse button** to load it.



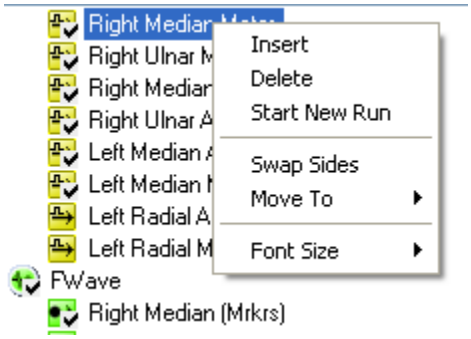
Study window.

Study Window Context Menu

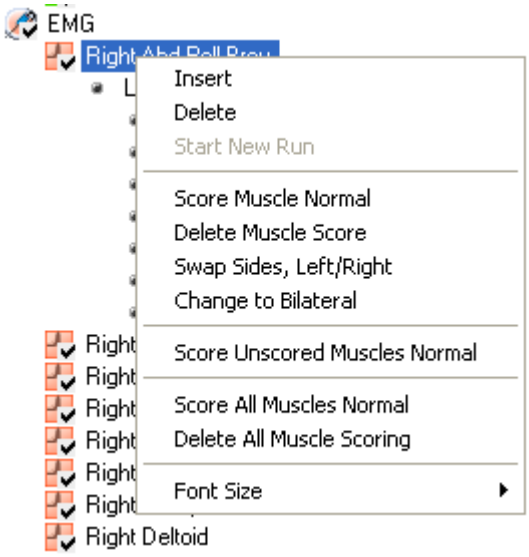
The Study window has a Context menu, also known as the **right click menu.** It is accessed by right clicking the mouse over a blank area within the Study window, or by right clicking over a test protocol name. The functions that are available in the context menu will vary depending on what you right clicked over.

When right clicking over a blank area, not over a test protocol name:

When right clicking on a test protocol name:



Over an NCV test.



Over an EMG test.

For more detailed information on using the Study Window, see the topic Study Window Overview.

Controls Window or Controls Toolbar

The Amplifier & Stimulator controls can be configured in either a **window** or **toolbar** format. This preference can be saved on a per test protocol basis. In software version 5.5 or higher, the default format is the Controls Toolbar enabled.

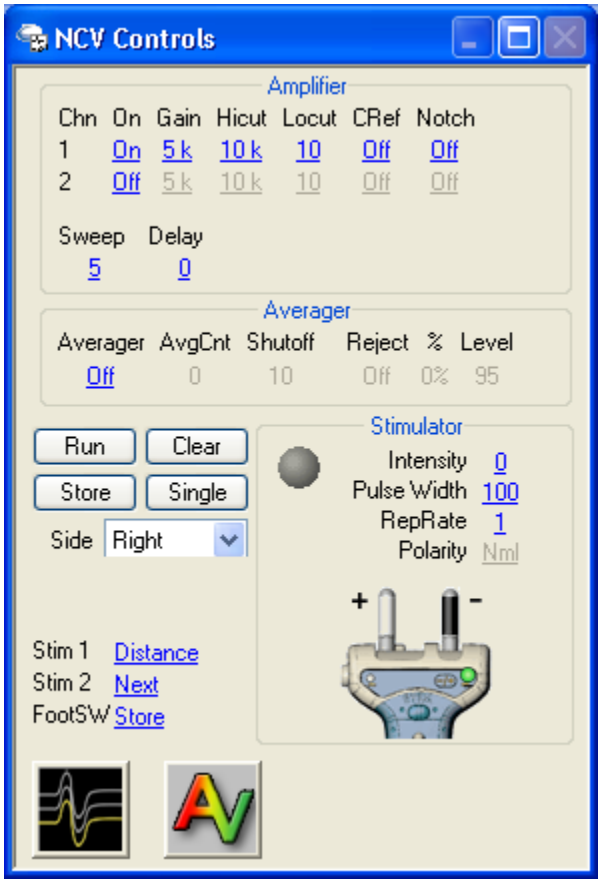
To turn the Controls Toolbar On or Off, select the option called **"Test Control Bar"** from the **View** menu.

Controls Window

The Controls window displays the **Amplifier**, **Averager**, and **Stimulator** settings for the test protocol. It also contains a **Side control** and buttons representing the same **Acquisition keys** found on the Wave's base unit (i.e., Run/Stop, Single, Store, and Clear). The current settings for the **Footswitch** and **Programmable buttons** on the electrical stimulator can also be found here.

Blue colored and underlined items can be changed or edited by clicking on them with the left mouse button. Drop down lists can also be changed by clicking on the drop down arrow .

There is no Context menu for the Controls window.



Controls Window for NCV test protocol.

Controls Toolbar

The Controls toolbar displays the **Amplifier**, **Averager**, **Side**, and **Stimulator** settings for the test protocol in a toolbar format across the top of the screen. The current settings for the **Footswitch** and **Programmable buttons** on the electrical stimulator can also be found here.

Blue colored and underlined items can be changed or edited by clicking on them with the left mouse button. Drop down lists can also be changed by clicking on the drop down arrow .

Controls Toolbar for NCV test protocol.

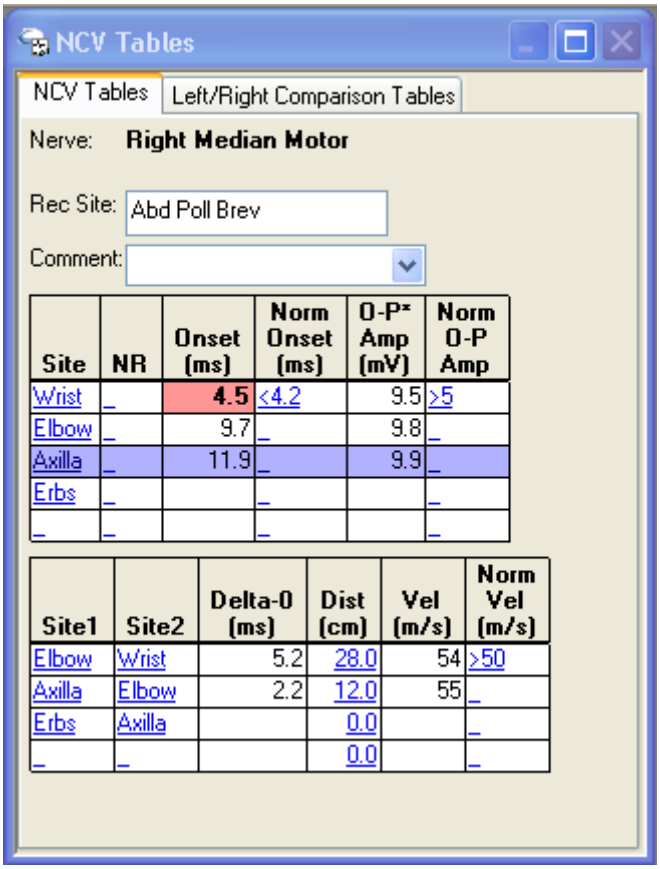
Right click over the toolbar to turn Off/On various sections of the toolbar controls and to change the **Font Size**.

Using the Toolbar format allows more room for the remaining windows.

Measurements / Cursor Table Window

The **Measurements / Cursor Table** window has several functions.

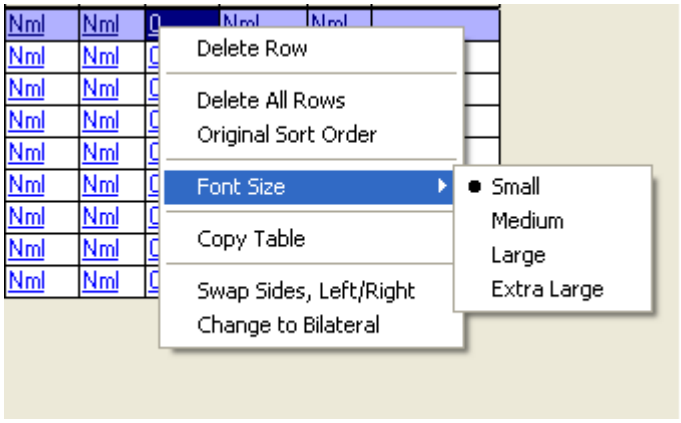
- It displays the values for trace features that have been identified after placement of the latency and amplitude markers or auto-cursors. The type of table shown in this window will vary depending on the test protocol that is currently selected.
- It displays the muscle scoring table in the EMG protocol.
- It displays the IP Analysis plots in the Interference Pattern Analysis mode.
- It displays the MUA Table in the Single Motor Unit Analysis (SMUA) mode.



NCV Tables window.

Measurements / Cursor Table Window Context Menu

In the EMG, NCV, and RNS test protocols the Measurements / Cursor Table window supports the use of the Context menu.



EMG Muscle Score Table Context menu.

Live Monitor Window

A Live Monitor window is available in the NCV, F Wave, H-Reflex, Blink Reflex, RNS, and MUNE test protocols.

When this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.

To Enable the Live Monitor window:

1. Start the Sierra Wave program.
2. Select a test protocol, NCV for example.
3. From the **Edit** menu, select **Current Test**.
4. Click on the **General Settings** tab.
5. Check the box labeled, **“Show Live Monitor”**.
6. Click **OK**.
7. Adjust the size and positions of the windows on the screen.

8. From the **Edit** menu, select **Save Test Parameters** to update the default settings for the test. From now on the test protocol will display the Live Monitor Window.

The Gain and Sweep Speed of the Live Monitor window are the same as the main Trace window.

Function Keys F1 - F4

The bottom left of the screen shows the program functions currently assigned to the **F1-F4** function keys on the Sierra Wave base unit. These functions will vary depending on the test protocol that is currently selected.

These functions can also change with the status of the test protocol. For example, when you Stop the EMG trace, by pressing the Run/Stop button, the functions of the F1 & F2 keys change. When you return to Run mode, by pressing the Run/Stop button again, the functions of these keys go back to their original settings.

In all test protocols, the **F4** function key is reserved for **TabData**. Pressing this key will display the TabData window which includes a list of all the tests performed on the patient as well as various summary tables.

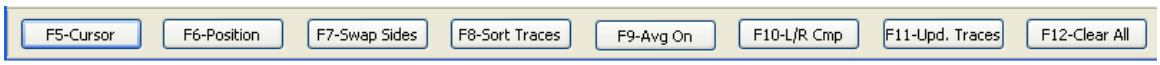
Some function keys toggle back and forth between two functions. The currently selected function is displayed in bold text.

F1-F4 Function Keys for NCV test.

PC Toolbar (Function Keys F5 - F12)

Additional program functions can be accessed using the **F5-F12** function keys on the PC's keyboard. A PC function key toolbar, that shows the current assignments for these additional function keys, can be enabled from the View menu. Simply select **View**, then click on **PC Function Key Menu**.

The PC function key toolbar is displayed below the F1-F4 function keys on the screen.



PC Function Key Toolbar for the NCV test.

In all test protocols the **F5** function key is assigned to **Cursors**, and the **F6** function key is assigned to **Position**. The remaining F7-F12 keys will vary depending on the test protocol that is currently selected.

If you press **F5-Cursors** or **F6-Position** to enter these modes, simply press the function key a second time, or press the **OK** key on the base unit to exit these modes when you are finished using them.

The PC function toolbar does not have to be visible to use the program functions assigned to it.

Knobs 1 - 4

The bottom right of the screen shows the program functions currently assigned to the four **Knobs** on the Sierra Wave base unit. These functions will vary depending on the test protocol that is currently selected and the status of that test (i.e., running or stopped).

The functions of the knobs also change if you enter the **Cursor** or **Position** mode by pressing the **F5** or **F6** function keys.

Many knobs have dual functions. Pressing the knob will toggle back and forth between the two functions. Once the appropriate function is selected, turn the knob to perform that function

Initially in all test protocols, Knob #1 is reserved for selecting tests from the Study window, Knob #4 is reserved for changing Gain and Sweep Speed settings.

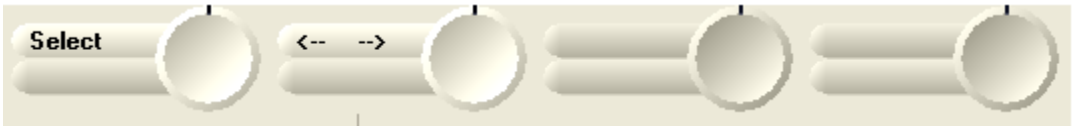
Knobs that change parameters such as Gain, Sweep Speed, Intensity, or knobs that move Cursors will display the associated value on the knob graphic.

Knob functions for NCV test.

All functions that can be done with the knobs can also be done using the mouse.

Pressing the **ALT** key on the PC keyboard or the **Select** key on the Wave base unit will toggle **Knob #1** to **Select** and **Knob #2** to **Move Left/Right**. This allows the program menus (File, Edit, View, Study/Test) at the top of the screen

to be accessed using these knobs. Press the **ESC** key on the PC keyboard or **F4-Close Menu** on the Wave base unit to exit from this mode.



Knob changes as result of pressing ALT key.

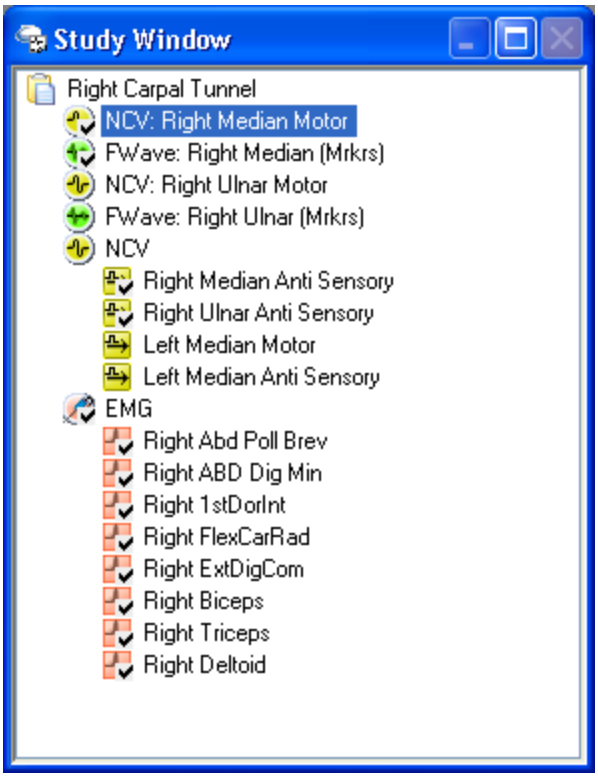
Using the Study Window

The **Study** window has several functions:

- Lists the test protocols that have been pre-selected and grouped into the selected Study List (e.g., lists the tests for the Right Carpal Tunnel Study).
- Automatically adds to the list other test protocols, not originally part of the Study list, as they are selected from the Study/Test menu or nerve and muscle lists.
- Provides an easy way to change from one test protocol to another or go back and review a previous test.
- Shows which test protocols have been completed by placing a checkmark on the test protocol's icon.

To Select a Test within the Study window:

- Use **Knob #1 (Study Item)**, on the Sierra Wave base unit, to move the highlight up and down through the Study window. If you stop the highlight on a test protocol for more than **1.5 seconds**, that protocol will be loaded.
- Alternatively, click on a test protocol with the **left mouse button** to load it.



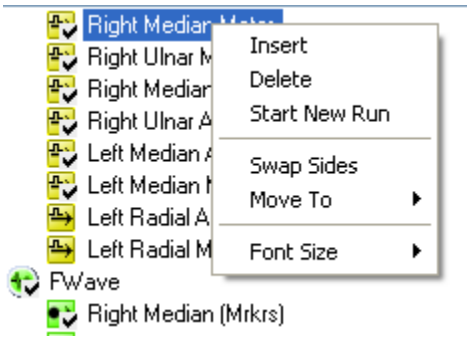
Study window.

Study Window Context Menu

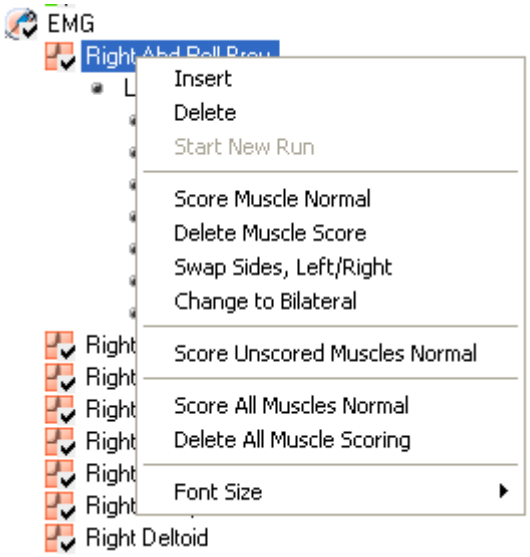
The Study window has a Context menu, also known as the **right click menu.** It is accessed by right clicking the mouse over a blank area within the Study window, or by right clicking over a test protocol name. The functions that are available in the context menu will vary depending on what you right clicked over.

When right clicking over a blank area, not over a test protocol name:

When right clicking on a test protocol name:



Over an NCV test.



Over an EMG test.

Test Types within the Study Window:

Each test protocol is indicated by a color coded icon. The Table below summarizes the available tests and their associated icon.

Test Icons:		
Test Type:	Icon:	Description:
EMG		Pink color with blue needle hub.
NCV		Yellow color with CMAP trace.
F Wave		Green color with F Wave trace.
H Reflex		Orange color with H Reflex trace.
RNS		Violet color with RNS decrementing trace.
Blink		Blue colored eye.
SFEMG		Pink color with red needle hub.
SSFEMG (Stim-SFEMG)		Pink color with violet needle hub.
Real Time SFEMG		Pink color with red needle hub.
Macro EMG		Pink color with red needle hub.
SEP		Blue with bar electrode.
VEP		Blue with checkerboard pattern.
AEP		Blue with headphones.
P300		Blue with target.
RR Interval		Red Heart
MUNE (MPS and Incremental)		Blue color with CMAP trace.
EMG Guidance		Pink color with blue needle hub.

For more detailed information on using the Study Window, see the topic Study Window Overview.

NCV - Basic Operation

Select the NCV Test:

- **If a Study has already been selected**, simply click on a nerve name (i.e., Right Median Motor) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual NCV test protocol from the Study/Test menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing routine NCV data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the nerve being tested.

Typical Settings

	Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
Motor Nerves	2k to 5k	10k	10	5.0
Sensory Nerves	10 to 20	2k	10	2.0

2. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Verify Stimulation Sites and Segments**

   The selected nerve's recording site name, stimulation site names, and defined segments are shown within the **NCV Tables** window.

Nerve name and recording site name.

The **Site table** displays the stimulation site names, one per row. This table will display the onset or peak latency, amplitude measurements, duration and area measurements, and normal values. By default, the first stimulation site's row is highlighted as soon as the nerve is selected. The name of this site also appears on the active (white) trace's label.

Site	NR	Onset (ms)	Norm Onset (ms)	O-P* Amp (mV)	Norm O-P Amp
Wrist	_	3.9	<4.2	13.3	>5
Elbow	_	9.7	_	12.6	_
Axilla	_	11.6	_	12.1	_
Erbs	_		_		_
_	_		_		_

Site table with Erbs stimulation site selected.

The **Segment table** displays the segments over which velocity calculations are to be made. Each row in this table represents one segment. This table has a column for entering distances and for displaying the calculated and normal velocity.

Site1	Site2	Delta-0 (ms)	Dist (cm)	Vel (m/s)	Norm Vel (m/s)
Elbow	Wrist	5.8	30.0	52	>50
Axilla	Elbow	1.9	12.0	63	_
Erbs	Axilla		0.0		_
_	_		0.0		_

Segment table.

4. Electrode Placement

Attach the electrodes to the patient.

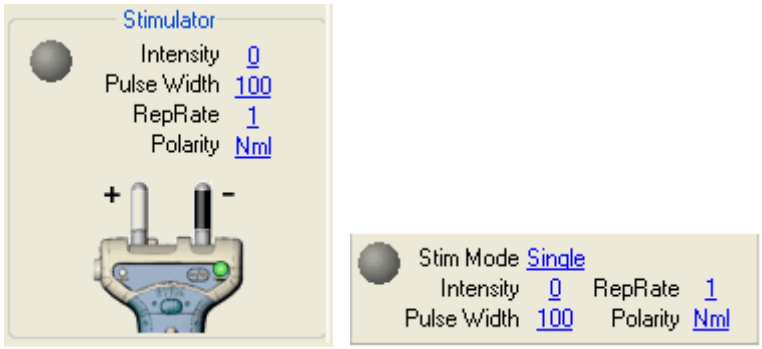
5. Check Stimulator Polarity

For Nerve Conductions Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **NCV Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

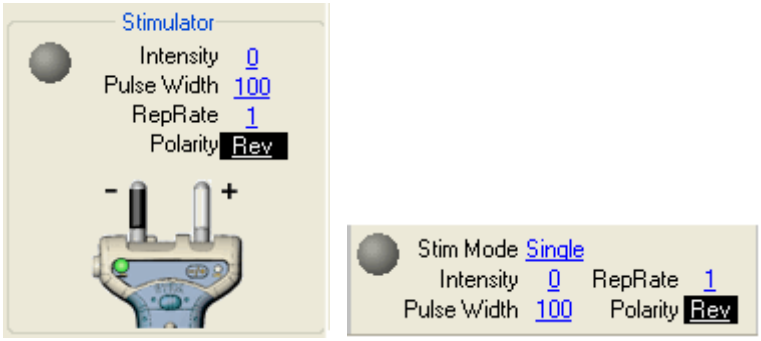
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the cathode (-). The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

6. Stimulate the first Site

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

The **Single key** on the Sierra Wave base unit can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

Continue to increase the intensity level and stimulate until a supra-maximal response is acquired. If the response is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain /Sweep)** on the Sierra Wave base unit.

8. If necessary, Adjust Auto Cursors

Auto Cursors are placed on the response as soon as it is displayed. The cursors are **Onset (O)**, **Peak (P)**, **Trough (T)** and **Recovery (R)**. The configuration of the Site and Segment tables determines which of the four cursors are placed on the trace. The positions of these cursors can be adjusted by performing one of the following actions;

- By using **Knob #2 (Sel Cursor / Move Cursor)** on the Sierra Wave base unit.
- By clicking on them with the **left mouse button** and dragging them to their new position.

For the correct placement of the auto-cursors the response must meet or exceed certain amplitude and slope criteria. When these criteria are not met the cursors will be placed on the response in the following pattern.

Pattern of auto-cursor placement when amplitude criteria is not met.

The Peak (P) cursor will be positioned at the third division with the Onset (O) cursor placed one-quarter division in front and the Trough (T) and Recovery (R) cursors placed one-quarter and one-half division respectively following it. If you believe that there is a response present you can move the cursors to their appropriate positions, or if there really is no response present, you can mark the response as "NR" in the Site table.

9. Store the Response

To store the response and advance to the next stimulation site, perform one of the following actions;

- Press the **Store button** on the **Electrical Stimulator handle**.
- Press the **Store key** on the **Sierra Wave base unit**.

- Press the **Footswitch** pedal (assuming the pedal has been programmed with the Store function.)
- Click the **Store button** in the **NCV Controls** window.

When the response is stored the color of the trace changes from **white to purple** and the next row in the Site table is automatically highlighted.

If the nerve has only one stimulation site, it is not necessary to store the response. The Sierra Wave will automatically keep the trace when you change nerves or test protocols.

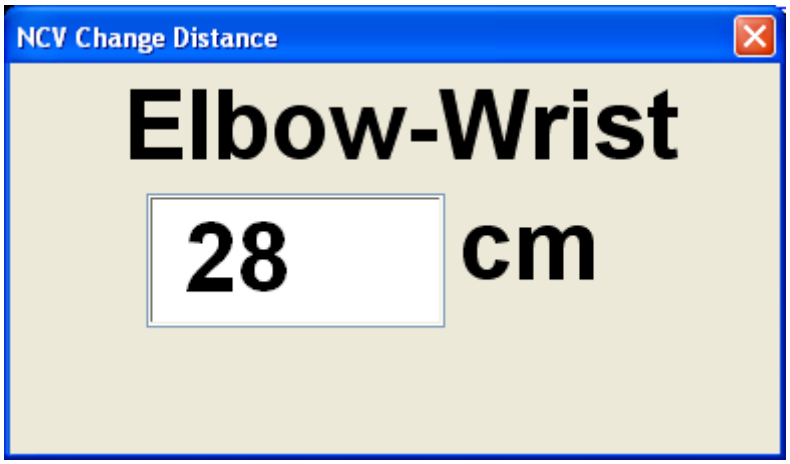
10. Stimulate and Store Additional Sites

Continue to stimulate and store additional sites on the nerve.

11. Enter Distance to calculate Velocity

Measure the distances for each segment and enter the values (in centimeters) into the segment table. There are two ways to enter the distance.

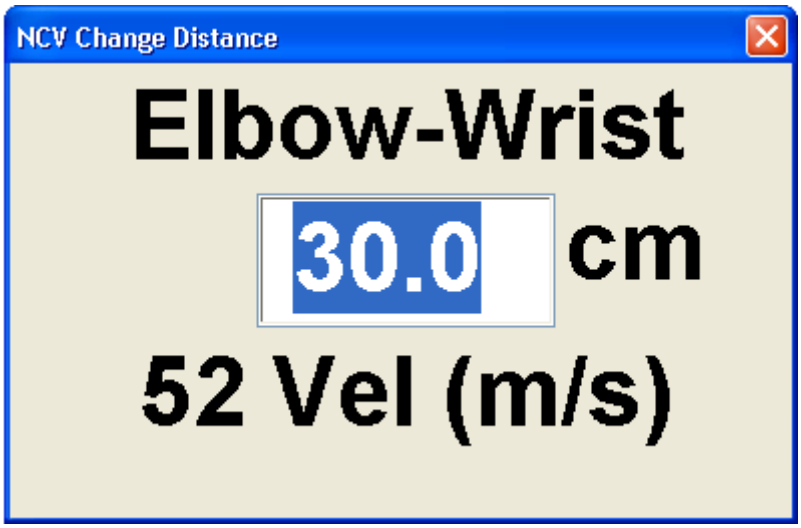
- Press the **Distance key** on the **Sierra Wave base unit** or **click** on the appropriate distance field with the **mouse**. The first distance field will become activated and a small pop-up window is displayed showing the segment name and a place for the distance measurement, type the distance value and then press the **Enter key**. *You can also press the Distance key a second time instead of pressing the Enter key.*



Distance pop-up window.

- Press **Programmable button #1** on the **Electrical Stimulator handle**. A small pop-up window is displayed showing the segment name, distance value, and velocity. Now, **turn the wheel on the stimulator handle to increase or decrease the distance value in**

0.5 cm increments. When the correct distance value is reached, press **Programmable button #1** a second time or press the **Enter key**.



Distance pop-up window.

12. Compare Left vs. Right side Data & Traces (optional)

This feature allows for easy comparison of the latency, amplitude, and velocity differences between the left and right sides of a nerve. It also allows for a visual comparison of the traces obtained for each side.

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side and a table of difference values.

Normal values can be entered for the side-to-side difference measurements with abnormal values flagged by the program.

Press the **F10 - L/R Cmp** function key a second time to return to the standard NCV display.

13. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

14. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another NCV nerve in the **Study** window.
- **Click** on another NCV nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

EMG - Basic Operation

Select the EMG Test:

- **If a Study has already been selected**, simply click on an EMG muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the muscle name. Notice that as soon as any muscle is selected within the EMG test protocol, all the muscles are automatically added to the muscle score table.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG test protocol from the Study/Test menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that as soon as any muscle is selected, it is displayed within the Study window and is automatically added to the muscle score table.

 The **Automatic Muscle Scoring** feature can be disabled in the **EMG Test Setup** window. When this feature is disabled the muscles in the Study window are not automatically added to the muscle score table. You will need to use the **F2 (Muscle Sel/Score)** knob or the **Left mouse button** to manually add the appropriate muscles to the scoring table.

Once the muscle has been selected. Follow these steps for performing routine EMG data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate.

   Typical Settings for EMG

   Gain = 100 or 200 uV/Div

   Hicut = 10k Hz

   Locut = 10 - 30 Hz

   Sweep Speed = 10.0 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Insert the Needle Electrode**

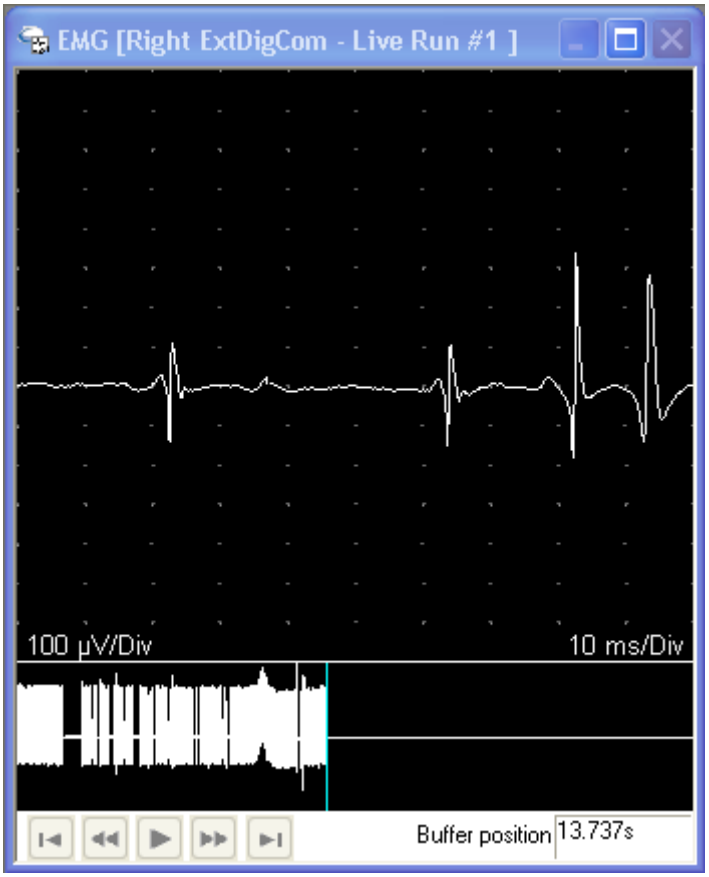
4. Adjust Volume

Increase or decrease the Sierra Wave's internal speaker by using the **Volume Knob** on the left hand side of the base unit.

5. Select Live or Capture Acquisition Mode

Use the **F1 (Live / Capture)** function key to toggle between these two acquisition modes.

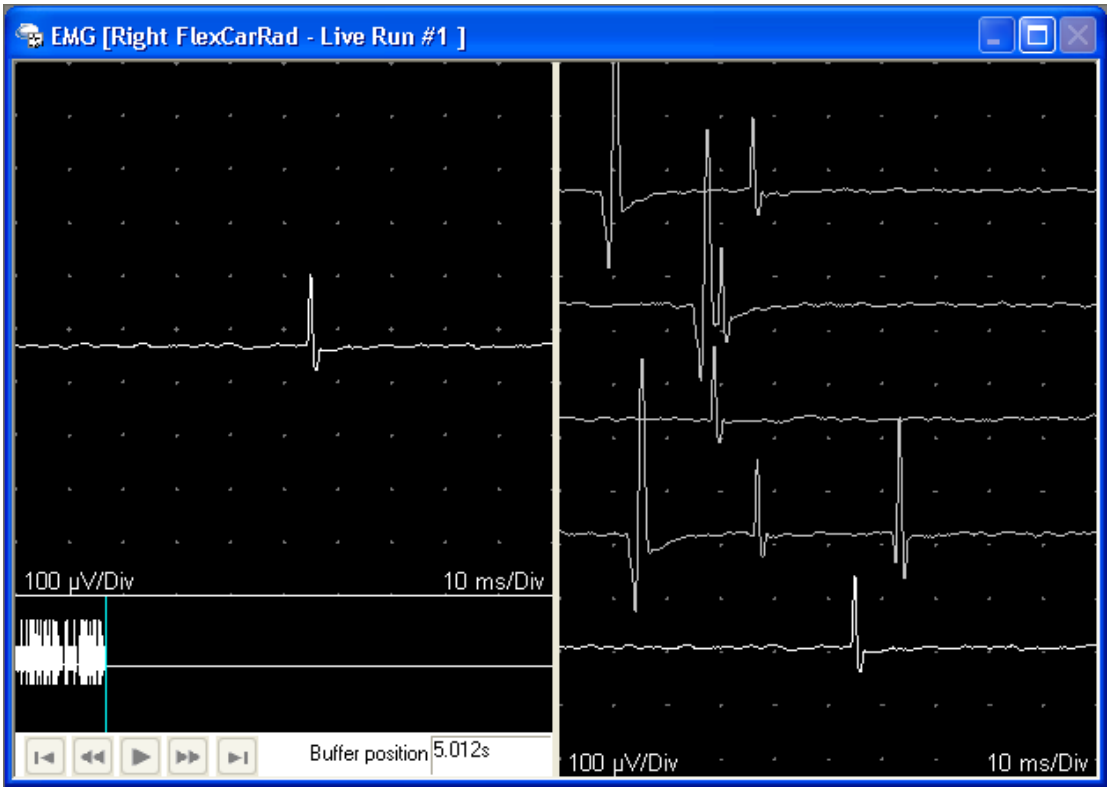
Live Mode: In Live mode free-running EMG is displayed in the Trace window and a compressed view of the EMG Live Buffer is displayed below this. A moving blue marker shows the current position within the buffer. At any time data acquisition can be stopped and the data in the Live Buffer can be reviewed or played back (see step #7 below). The EMG protocol always defaults to the Live data acquisition mode.



EMG - Live mode

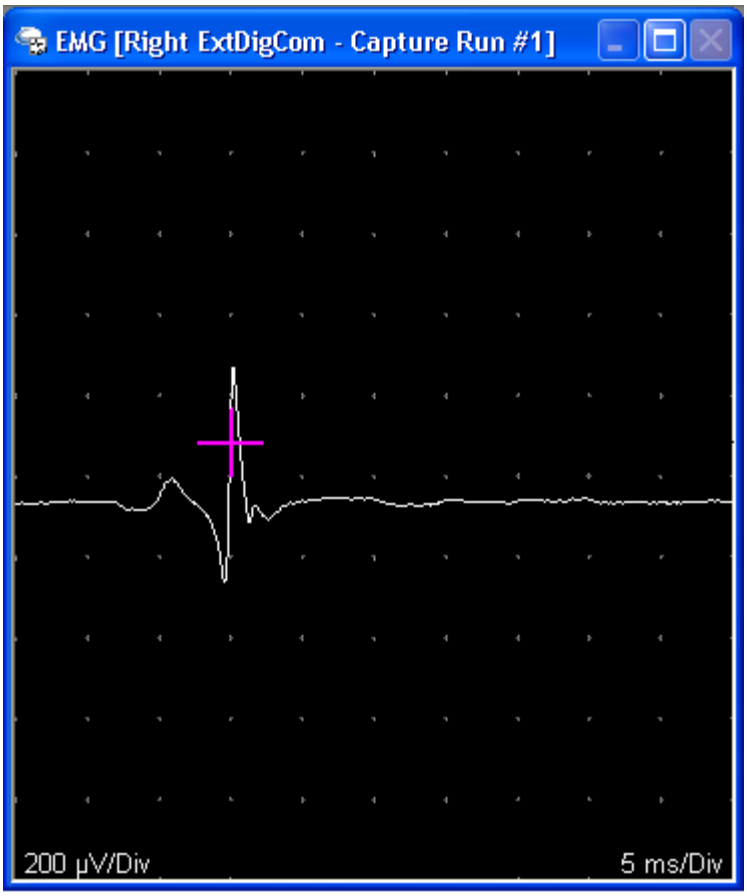
Live Mode with Raster Display: An optional Raster Display can be enabled by pressing the **F11 (Raster)** function key. When this feature is enabled the Trace window is split into two equal sections; the left half showing the live EMG data and the compressed buffer, the right half showing consecutively

rastered EMG traces. Click here for more information on the Raster Display option.



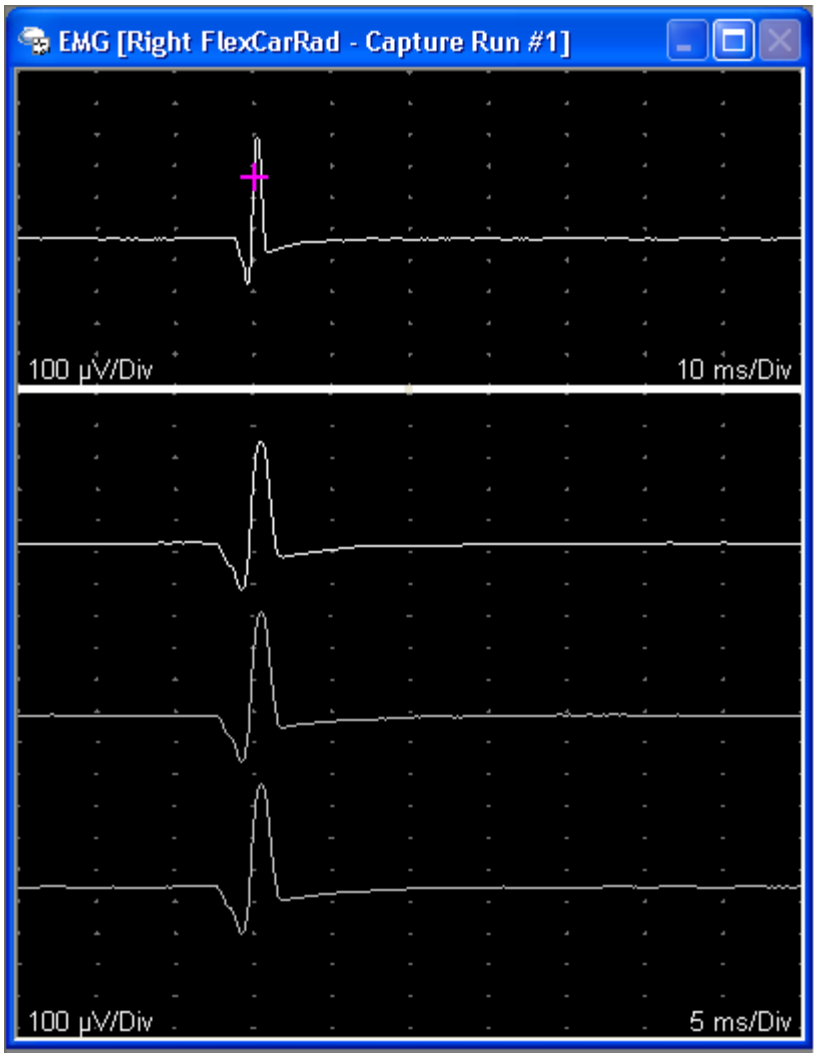
Live EMG mode with Raster Display enabled.

Capture Mode: In Capture mode a voltage level trigger and delay marker are displayed within the Trace window. The level of the voltage trigger can be adjusted using **Knob #3 (Trigger Lvl)**. When EMG activity exceeds the trigger level (in either the negative or positive direction) the sweep is captured momentarily and is repositioned with the crossing point at the delay marker. This allows for easier visualization of motor unit potentials. At any time data acquisition can be stopped and up to 50 captured sweeps can be reviewed (see step #7 below).



EMG - Capture mode

Capture Mode with Capture Window: An optional Capture Window can be enabled by pressing the **F11 (Cap Wnd)** function key. When this feature is enabled the trace window is split into two sections; the top section shows the live EMG trace and the trigger level and delay indicator, the bottom section shows a rastered display of the most recently captured traces. Click here for more information on the Capture Window option.



Capture Mode with Capture Window enabled.

6. Adjust Gain & Sweep

During EMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

You can also use the mouse to change these settings in the **EMG Controls window** or **Controls Toolbar**.

7. Stop Data Acquisition and Review (optional)

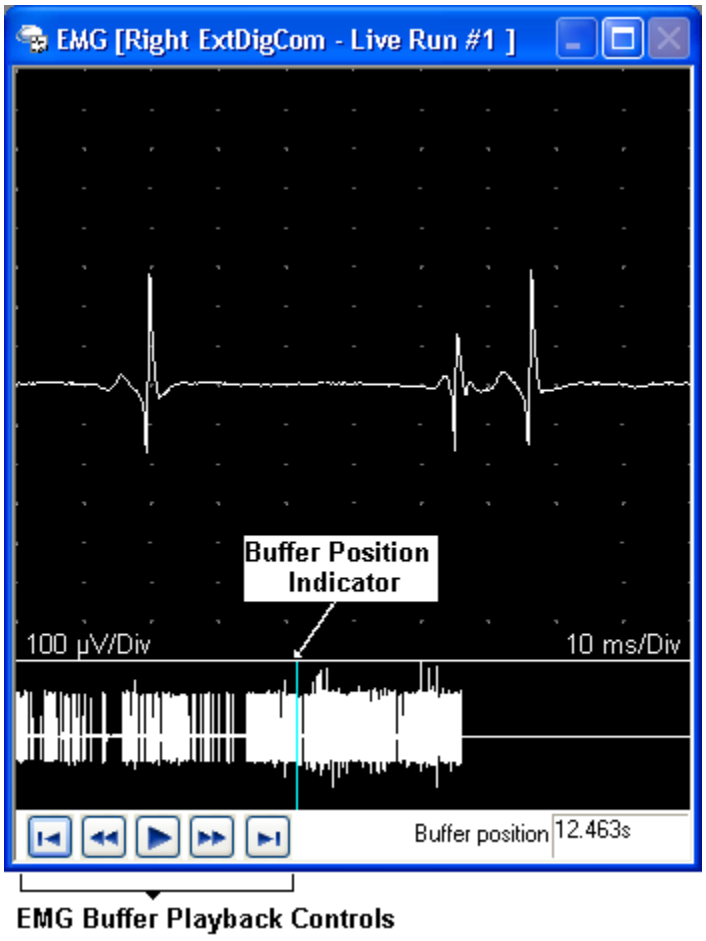
To stop data acquisition perform one of the following actions;

- Press the **Run/Stop key** on the **Sierra Wave base unit.**

- Press the **Stim button** on the **Electrical Stimulator handle**.
- Press the **Footswitch** pedal.
- Click on the **Stop button** in the **EMG Controls** window.

Stopped Live EMG:

Review the Live Buffer - move backwards and forwards in the Live EMG buffer by turning **Knob #1 (Review / Play-Stop)**, press the knob to replay the buffer. You can also review by dragging the blue marker back and forth within the compressed buffer area using the mouse.



EMG - Stopped Live mode

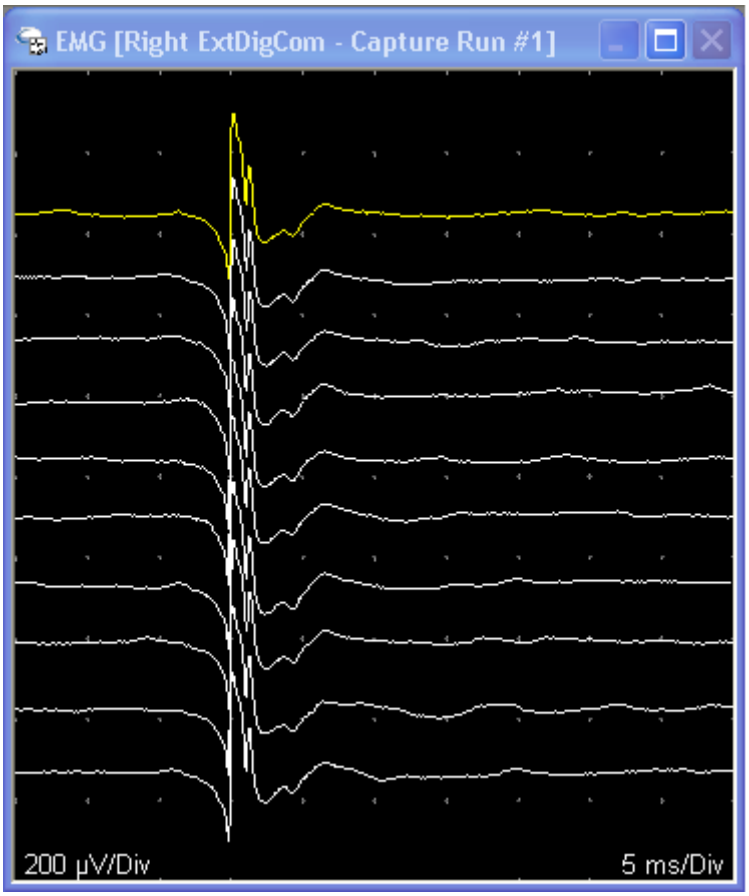
Store a Snapshot - press the **F1 (Store Snap Shot)** function key or the **Store key** on the Sierra Wave base unit to store the currently displayed sweep. The stored sweep will be displayed in purple.

Store the entire Live Buffer - press the **F2 (Store Live Buffer)** function key. The trace will be displayed in blue indicating that the entire buffer has been stored.

Manual MUP Tool - **right click** the mouse over the motor unit potential (MUP) of interest, then select **MUP Tool** from the pop-up menu. The motor unit potential is shown centered within a MUP window and quantitative measurements are shown in the table below. Click **OK** to save the MUP and include it in the final report, click **Cancel** to discard the MUP.

Stopped Capture EMG:

Review Captured Sweeps - use **Knob #4 (Trace Sel /Delete)** to review through the captured traces, press the knob to delete the selected trace (selected trace is displayed in yellow color). Press the **F2 (Raster / Overlay)** function key to superimpose all the captured traces.

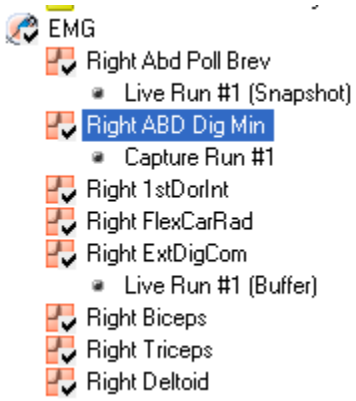


EMG - Stopped Capture mode

Store Captured Sweeps - press the **Store key** on the Sierra Wave base unit or click on the **Store button** within the EMG Controls window. The stored traces will be displayed in purple.

Prior to storing any EMG traces, Use **Knob #2 (Muscle Sel)** to highlight the correct muscle name in the Study window. This will ensure that the EMG data will be stored with the correct muscle name.

As EMG is stored, you will see a new **node** appear in the Study window below the muscle name. This indicates what has been stored for this muscle. The example below shows a Snapshot stored for the Right Abd Poll Brev muscle, a Capture run stored for the Right ABD Dig Min muscle, and a Live Buffer stored for the Right ExtDigCom muscle.



Example of stored EMG nodes in the Study window.

8. Return to Data Acquisition Mode

If you stopped either Live or Captured data acquisition, perform one of the following actions to resume data acquisition;

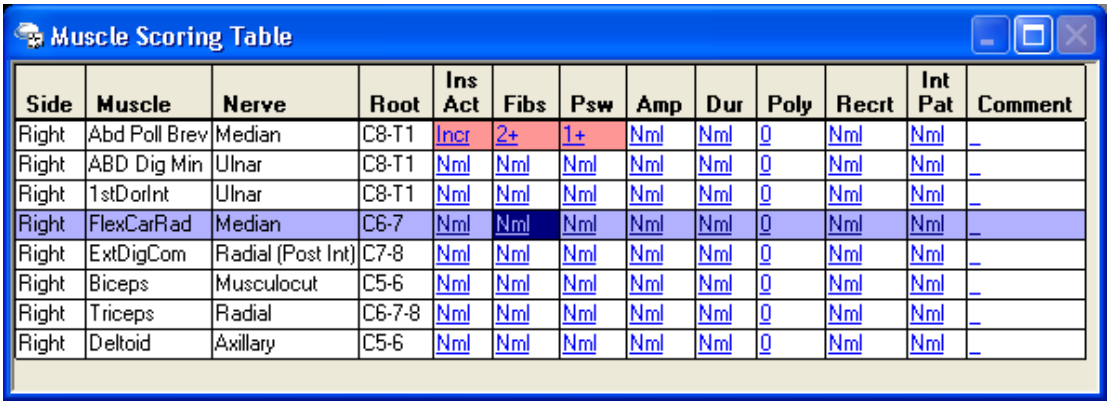
- Press the **Run/Stop key** on the **Sierra Wave base unit**.
- Press the **Stim button** on **Electrical Stimulator handle**.
- Click the **Run button** in the **EMG Controls** window.

9. Modify Muscle Scoring

With the **Automatic Muscle Scoring** feature enabled, as soon as a muscle is selected in the Study window, or added to the Study window using the **F3 (Muscle List)** function key, it is automatically added to the **Muscle Scoring Table** and is scored as normal.

To change the muscle scoring for a muscle:

- Turn **Knob #3 (Score Table / Modify)** until the highlight is over the scoring field that you want to change, press the knob to pop up a list of choices, turn the knob to highlight one of the choices and press again to select it.
- Using the **left mouse button**, click on the scoring field that you want to change. From the pop up list of choices click again to make a selection.



Muscle Scoring Table

Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Right	Abd Poll Brev	Median	C8-T1	Incr	2+	1+	Nml	Nml	0	Nml	Nml	_
Right	ABD Dig Min	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	ExtDigCom	Radial (Post Int)	C7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. Select Next Muscle

Turn **Knob #2 (Muscle Sel / Delete Score)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the muscle from the list.

Move the Needle Electrode to the new muscle and repeat the above steps as necessary.

It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

11. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected tests traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

12. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the Sierra Wave base unit and select a Test Protocol from the **Study/Test** menu.

F/H Basic Operation

Select the F Wave or H Reflex Test:

- **If a Study has already been selected**, simply click on an F Wave or H Reflex nerve name (i.e., Right Median) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual F Wave or H Reflex test protocol from the Study/Test menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing routine F Wave or H Reflex (Markers mode) data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

Typical Settings

	Gain (uV/Div)	Split Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
F Wave	5k	500	10k	20	5.0 or 10.0
H Reflex	2 - 5k	500	10k	20	10.0

2. **Electrode Placement**

   Attach the electrodes to the patient.

3. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

4. **Check Stimulator Polarity**

   For F Wave and H-Reflex Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

   The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **F/H Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate the Nerve

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical

stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit, or the **Single button** in the F/H Controls window, can also be used to deliver a single stimulus.

 **Repetitive stimulation** can be delivered by pressing the **Run/Stop button** on the Sierra Wave base unit or by clicking on the **Run button** in the F/H Controls window.

In general, F Waves are performed with supramaximal stimulus intensity, while H Reflex maximum amplitude occurs with sub-maximal stimulation intensity.

If the M Wave or F/H response amplitude is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change the gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain M / Gain F or H)** on the Sierra Wave base unit.

6. Store the Response

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

Stored traces will be displayed in "purple" color on the screen.

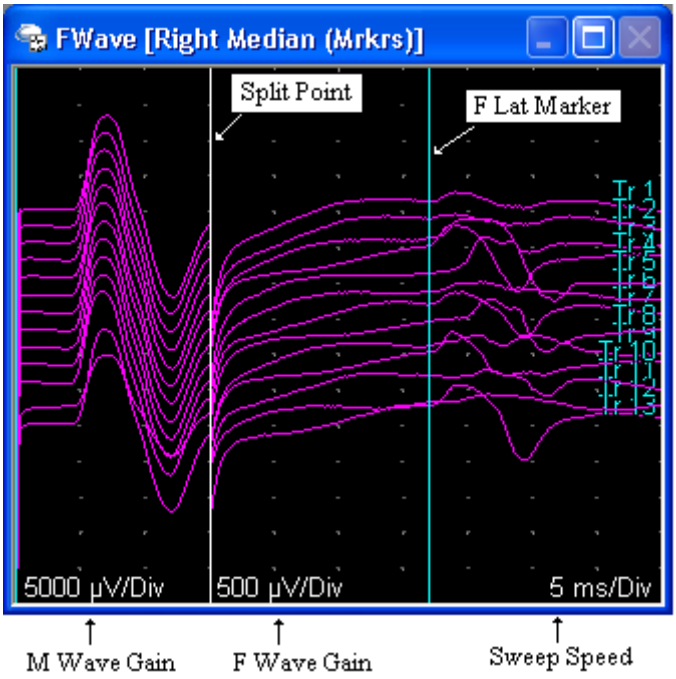
7. Continue to Stimulate and Store until 10 or 20 responses have been acquired.

8. Adjust Latency Marker

To adjust the latency marker, perform one of the following:

- Turn **Knob #2 (F/H Lat / M Wave Lat)** on the Sierra Wave base unit to move the F/H latency marker to the minimal F Wave latency or H Reflex onset latency. Changing the **F2 (Raster / Overlay)** function key to **Overlay mode** can be helpful when positioning the latency marker. The latency value is displayed in the **F/H Table** window.

- Press the **F8 (Auto F-Lat / Auto H-Lat)** function key. The program will automatically move the latency marker to the earliest onset latency. In addition, a pop-up window will show the latency value and the wheel on the stimulator handle can be used to adjust the position of the marker. Once the marker has been positioned, press the F8 function key a second time to exit this mode.



Example F Wave Trace window.

9. Compare Left vs. Right side Traces (optional)

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side.

The traces for each side are displayed in separate windows, stacked vertically on the screen. The top window contains the traces for the current side.

Press the **F10 - L/R Cmp** function key a second time to return to the standard F/H display.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., F Wave Markers, Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another F/H nerve in the **Study** window.
- **Click** on another F/H nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

RNS - Basic Operation

Select the RNS Test:

- **If a Study has already been selected**, simply click on the RNS muscle name within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the RNS test protocol from the Study/Test menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient.

Once the muscle has been selected. Follow these steps for performing RNS data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed. RNS typically uses the same settings as a motor NCV.

2. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Electrode Placement**

   Attach the electrodes to the patient.

   Active 1 Input: Belly of the muscle.

   Reference 1 Input: Tendon of the muscle.

   Ground Electrode: On stimulated limb or forehead.

4. **Check Stimulator Polarity**

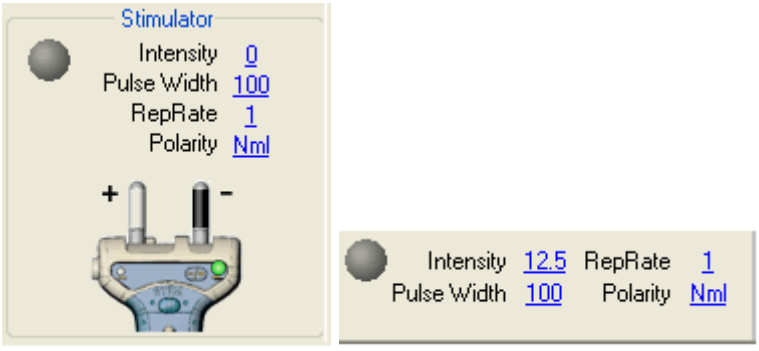
   For RNS Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

   The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

   Clicking on the **Polarity field** in the **RNS Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make

the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the Normal mode, the electrical stimulator image on the screen will show the Right-side probe as the cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the Reversed mode, the electrical stimulator image on the screen will show the Left-side probe as the cathode (-). The polarity field on the screen will indicate **Rev**.

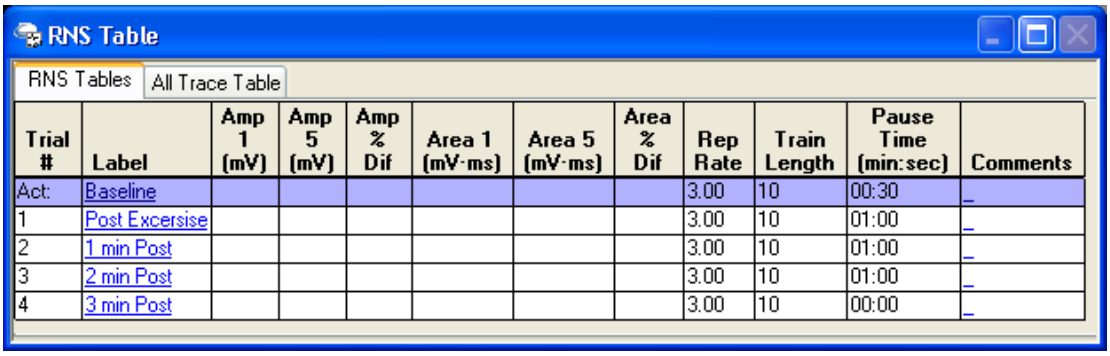
Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Check the RNS Table

The RNS test protocol supports a preprogrammed stimulus train table. This table controls the number of stimuli presented in each train, the repetition rate for the stimuli, the amount of time to pause before proceeding to the next stimulus train, and it also provides a convenient way to label each stimulus train.

The program allows for either manual or automatic delivery of the stimulus train table.



Trial #	Label	Amp 1 (mV)	Amp 5 (mV)	Amp % Dif	Area 1 (mV·ms)	Area 5 (mV·ms)	Area % Dif	Rep Rate	Train Length	Pause Time (min:sec)	Comments
Act:	Baseline							3.00	10	00:30	
1	Post Excersise							3.00	10	01:00	
2	1 min Post							3.00	10	01:00	
3	2 min Post							3.00	10	01:00	
4	3 min Post							3.00	10	00:00	

RNS Table.

If your stimulus train table is undefined, select **Current Test** from the **Edit** menu. Fill in the **Sequencer Setup** table in the lower left corner of the setup window, then click **OK**.

6. Check the General and Stimulator Settings

General Settings

Mode: Choices are **Train** or **Single**.

- **Train** - When the Stim button on the handheld stimulator or the Run/Stop button is pressed, a train of stimuli, corresponding to the highlighted row in the RNS Table, will be delivered.
- **Single** - When the Stim button on the hand held stimulator or the Single button is pressed, a single stimulus will be delivered. This mode is useful for determining supramaximal stimulation prior to delivering a train of stimuli.

Train #: The total number of stimuli that will be delivered to the patient when the program is set to the Train mode. The typical setting is four to eight. The maximum setting is 150. This value is updated from the RNS Table.

Spread: This is the distance (in horizontal divisions) that will separate the individual traces within the train. If this value is set to zero, the traces will be superimposed upon one another.

Response 1: Select the first response in the train that will be analyzed for amplitude and area measurements. Typically this is always set to number 1.

Response 2: Select the second response in the train that will be analyzed for amplitude and area measurements. In addition, the percentage difference between this response and the trace selected for Response 1 will be computed. This is typically set to number 4 or 5.

Auto Seq: Allows for either manual or automatic sequencing through the RNS Table. When set to **On**, the program will automatically deliver the trains specified in the RNS table (automatically pausing for the specified time after each train). When set to **Off**, the user must manually start each train after the appropriate pause time, by pressing the Run/Stop key for each train.

Stimulator Settings

Pulse Width: Set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

Rep Rate: Set the repetitive stimulus rate, in pulses per second (Hz). This is typically set to 3 Hz. This setting only applies when delivering repetitive (i.e., Train) stimulation, it does not apply during manual Single stimulus delivery.

7. Check Recording Setup

Press the **F1 (Train/Single)** function key to select **Single** mode. Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator controls section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit or the **Single button** within the on-screen RNS Controls window can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

Continue to increase the intensity level and stimulate until a supra-maximal response is acquired. If the response is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain /Sweep)** on the Sierra Wave base unit.

8. Deliver Stimulus Trains

Press the **F1 (Train/Single)** function key to select **Train** mode. Follow the instructions below for either Manual or Automatic Stimulus Train delivery.

Manual Stimulus Train Delivery:

Press the **Stim button** on the electrical stimulator handle. A train of stimuli will be delivered to the patient and a trace will be displayed for each stimulus within the train. The traces are stacked in a horizontal fashion (see Spread setting above).

After the Train is completed the program will automatically store the train and it will be displayed in a "purple" color.

 The **Run/Stop key** on the Sierra Wave base unit or the **Run button** within the on-screen RNS Controls window can also be used to deliver a train of stimuli.

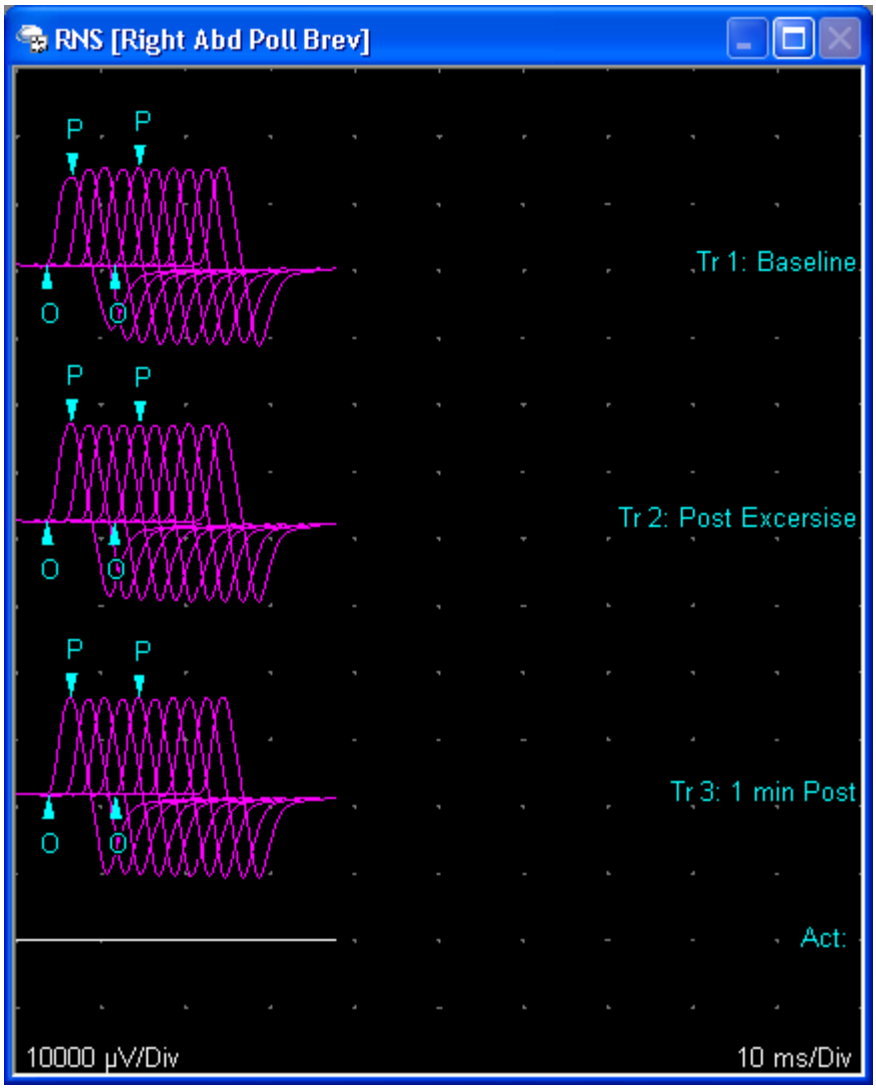
 20 milliseconds is acquired after each stimulus. This allows for a maximum repetition rate of 50 Hz during train stimulation.

After a train is automatically stored, a timer is started. The timer is displayed just below the side field in the RNS Controls window or at the top of the screen in the Controls Toolbar.

Use the timer to measure the time elapsed while the patient exercises the muscle or the time elapsed between successive stimulus trains. Typically, the patient will exercise the muscle for 30 seconds after the first train is delivered then another train will be delivered immediately after completion of exercise. Additional trains are then typically delivered at 1 minute intervals after this.

Press the **Run/Stop** key again to deliver the second stimulus train. Proceed in this fashion until all stimulus trains have been acquired.

 The timer automatically resets to zero after each train is stored. You can also manually reset the timer to zero by pressing the **F2 (Reset Timer)** function key on the Sierra Wave base unit.



Example RNS Traces

Automatic Stimulus Train Delivery:

Change the **Auto Seq.** control from **Off** to **On**. The first row in the RNS Table will be automatically selected.

Press the **Stim button** on the electrical stimulator handle. A train of stimuli will be delivered to the patient and a trace will be displayed for each stimulus within the train. The traces are stacked in a horizontal fashion (see Spread setting above).

After the Train is completed the program will automatically store the train and it will be displayed in a "purple" color. At this point the timer is started. The timer is displayed just below the side field in the RNS Controls window or at the top of the screen in the Controls Toolbar.

Once the timer reaches the preprogrammed pause time for the stimulus train, the program will automatically deliver the next stimulus train in the RNS Table.

Stimulation will continue in this manner until the last stimulus train is delivered.

You can stop the automatic sequencer at any time by changing the **Auto Seq.** control from **On** to **Off**.

9. Adjust Cursors (optional)

Onset (O) and **Peak (P)** cursors are automatically placed on the selected responses (see Response 1 and Response 2 settings above) as each train is acquired. The amplitude (onset to peak) and area (negative peak) of each response is calculated and displayed in the RNS table window.

The positions of these cursors can be adjusted by performing one of the following actions;

- By pressing the **F5 (Cursor mode)** function key and then using **Knob #1 (Sel Cursor / Move Cursor)** on the Sierra Wave base unit.
- By clicking on them with the **left mouse button** and dragging them to their new position.

The difference for both amplitude and area, between the two marked responses, is also automatically calculated and is displayed as a percentage (%). The equation used for this calculation is as follows;

$D = (V_{R2} - V_{R1}) / V_{R1} \times 100\%$

Where D = decrement or increment

V = value (amplitude or area)

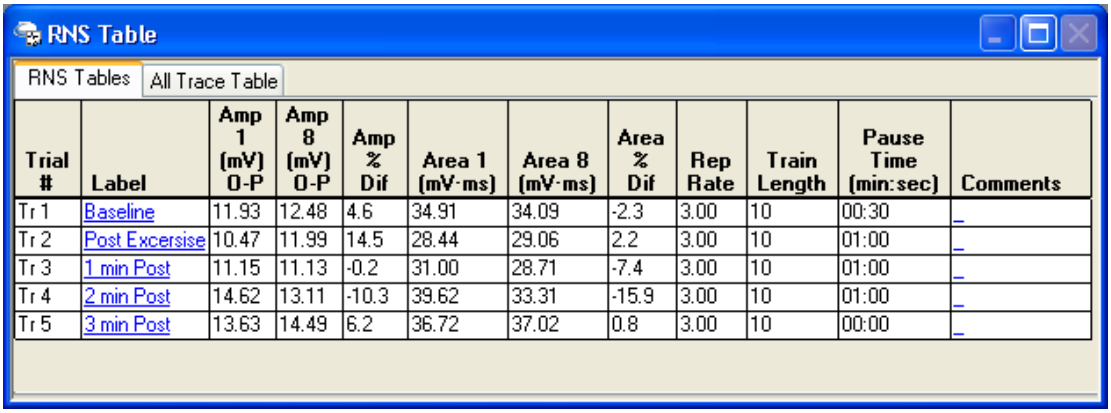
R1 = response 1

R2 = response 2

A decrement is displayed as a negative number, typically more than a **-10%** decrement is considered abnormal. An increment is displayed as a positive number.

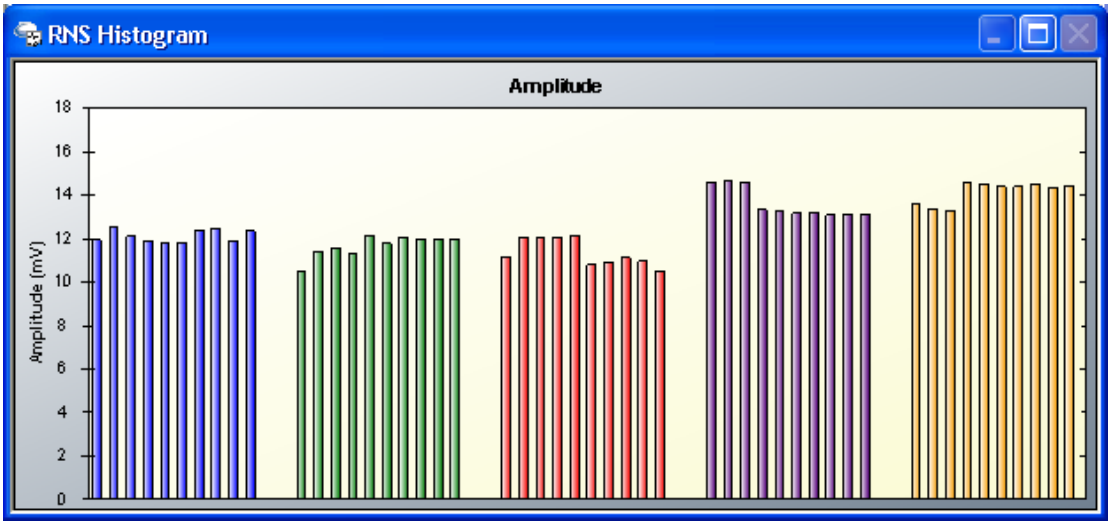
Peak-to-Trough amplitude measurements can also be selected in the RNS protocol's test setup window. In this case, **Peak (P)** and **Trough (T)** cursors will be automatically placed on the responses.

Use the **Comment** field in the RNS table to enter a notation for the train.



Trial #	Label	Amp 1 (mV) O-P	Amp 8 (mV) O-P	Amp % Dif	Area 1 (mV-ms)	Area 8 (mV-ms)	Area % Dif	Rep Rate	Train Length	Pause Time (min:sec)	Comments
Tr 1	Baseline	11.93	12.48	4.6	34.91	34.09	-2.3	3.00	10	00:30	_
Tr 2	Post Excersise	10.47	11.99	14.5	28.44	29.06	2.2	3.00	10	01:00	_
Tr 3	1 min Post	11.15	11.13	-0.2	31.00	28.71	-7.4	3.00	10	01:00	_
Tr 4	2 min Post	14.62	13.11	-10.3	39.62	33.31	-15.9	3.00	10	01:00	_
Tr 5	3 min Post	13.63	14.49	6.2	36.72	37.02	0.8	3.00	10	00:00	_

RNS Cursor Table



RNS Histogram Window

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Muscle or Test

To advance to the Next Muscle:

- Use **Knob #1 (Study Item / Site)** to highlight another RNS muscle in the **Study** window.
- **Click** on another RNS muscle in the **Study** window using the **mouse**.
- **Press** the **F3 (Muscle List)** function key on the **Sierra Wave base unit** and select another muscle from the muscle list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Blink - Basic Operation

Select the Blink Test:

- **If a Study has already been selected**, simply click on the Blink test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the Blink test protocol from the Study/Test menu.

Once the test has been selected. Follow these steps for performing Blink data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

   Typical Blink Settings

   Gain = 200 uV/Div

   Hicut = 5k Hz

   Locut = 10 Hz

   Sweep Speed = 10.0 ms/Div

2. **Electrode Placement**

   Attach the electrodes to the patient. Click here to view an example Blink setup.

   Connect the electrode leads from the patient's **left** side to the **Channel 1 inputs** on the amplifier, and connect the electrode leads from the **right** side to the **Channel 2 inputs**. Electrodes must be connected to the amplifier in this configuration to ensure proper display of test data.

   Active 1 Input: Belly of the Left orbicularis oculi muscle below the eye.

   Reference 1 Input: Left side of nose.

   Active 2 Input: Belly of the Right orbicularis oculi muscle below the eye.

   Reference 2 Input: Right side of nose.

   Ground Electrode: Forehead or cheek.

3. Select Side of Stimulation

Select the side, **Left** or **Right**, that will be stimulated first.

Trials collected during left-side stimulation are displayed in the top half of the screen with the response recorded on the ipsilateral side (e.g., Ch1 : L) positioned above the response recorded on the contralateral side (Ch2 : L).

Responses collected during right side stimulation display in the bottom half of the screen. Eliminating the need to change electrodes at the amplifier, the Sierra automatically inverts the order in which trials collected during right side stimulation are displayed so that the ipsilateral response (Ch2 : R) appears above the contralateral response (Ch1 : R).

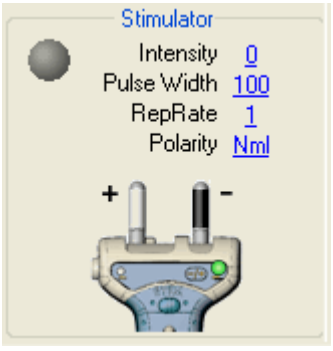
4. Check Stimulator Polarity

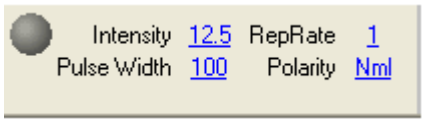
For Blink Reflex Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **Blink Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the Normal mode, the electrical stimulator image on the screen will show the Right-side probe as the cathode (-). The polarity field on the screen will indicate **Nml**.





Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the Reversed mode, the electrical stimulator image on the screen will show the Left-side probe as the cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient's supra-orbital nerve and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

The **Single key** on the Sierra Wave base unit can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

6. Store the Response

To store the response, perform one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Store key** on the Sierra Wave **base unit**.
- Press the **Footswitch** pedal.
- Click the **Store button** in the **Blink Controls** window.

When the response is stored the color of the trace changes from **white to purple**

7. Repeat Stimulation & Store additional responses

Generally, two trials are acquired per side.

8. Move Latency Markers (R1, R2i, R2c)

Three latency markers are utilized in the Blink test protocol. R1 is positioned at the onset of the ipsilateral R1 response. R2i is positioned at the onset of the ipsilateral R2 response. R2c is positioned at the onset of the contralateral R2 response.

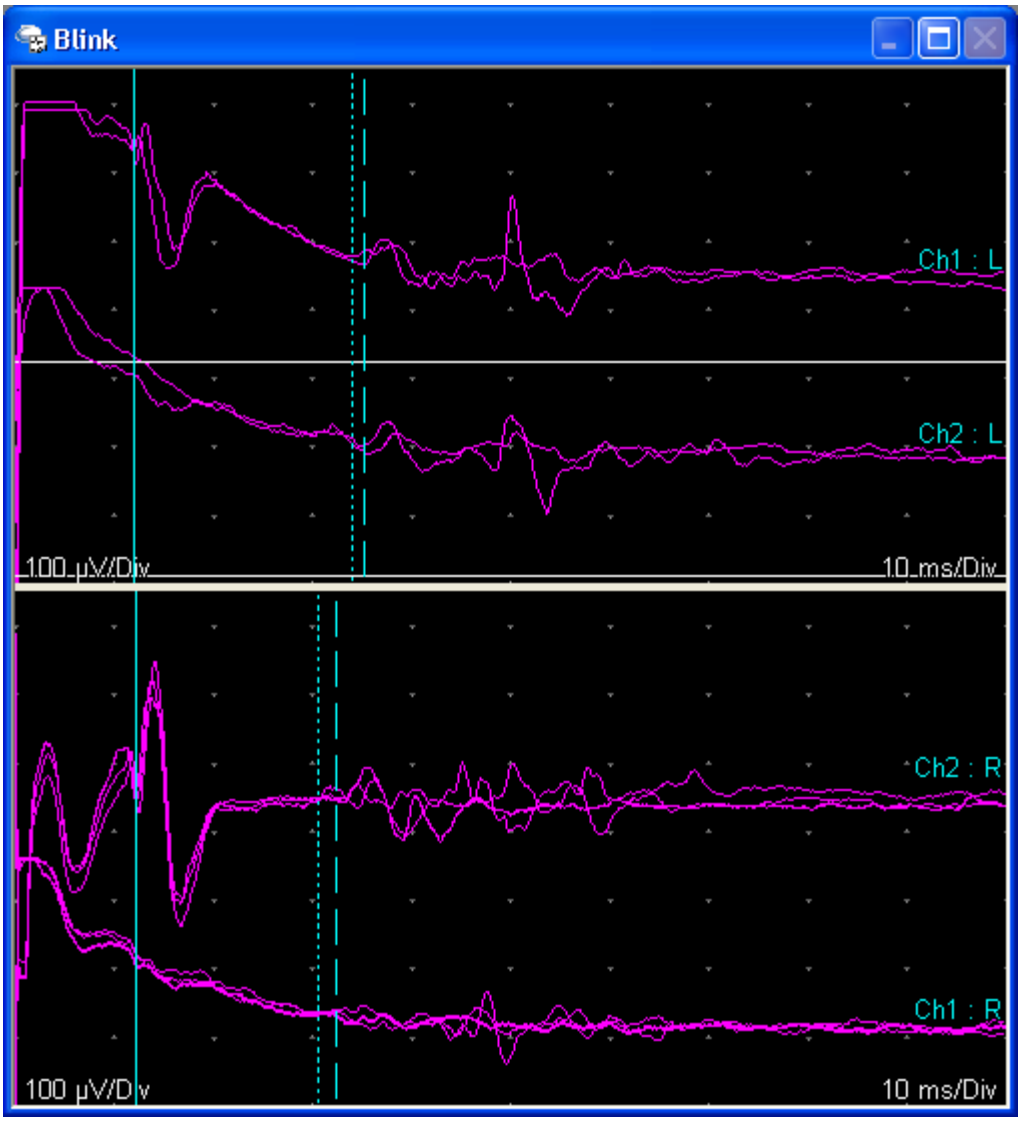
Each of the three markers has a different line pattern.

To move the latency markers:

- Use **Knob #2 (R1)** to move the **R1** marker, use **Knob #3 (R2i /R2c)** to move the **R2i** and **R2c** markers.
- Use the **mouse** to click and drag the appropriate marker to the desired location.

9. Change the Side and Repeat steps 4 - 8.

Selecting a different side automatically stores the currently active (white) traces.



Blink Example.

The program will automatically calculate the R2i-R2c difference for each side. It will also calculate the Left minus Right differences for R1, R2i, R2c, and R2i-R2c.

Blink Table

Side	R1	R2i	R2c	R2i-R2c
L	11.96	34.95	34.13	0.82
R	12.10	33.28	32.37	0.90
Diff(L-R)	0.14	1.68	1.76	0.08

Blink Cursor Table

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

SEP - Basic Operation

Select the SEP Test:

- **If a Study has already been selected**, simply click on the SEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the SEP test protocol from the Study/Test menu.

Once the SEP test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. **Verify Amplifier Settings**

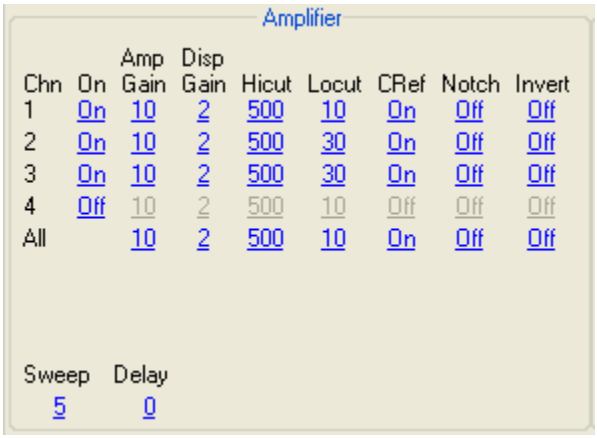
   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected SEP test.

Typical Settings

	Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
Upper Limb SEP	1 to 5	3k to 500	10	5.0
Lower Limb SEP	1 to 5	3k to 500	10	10.0

A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

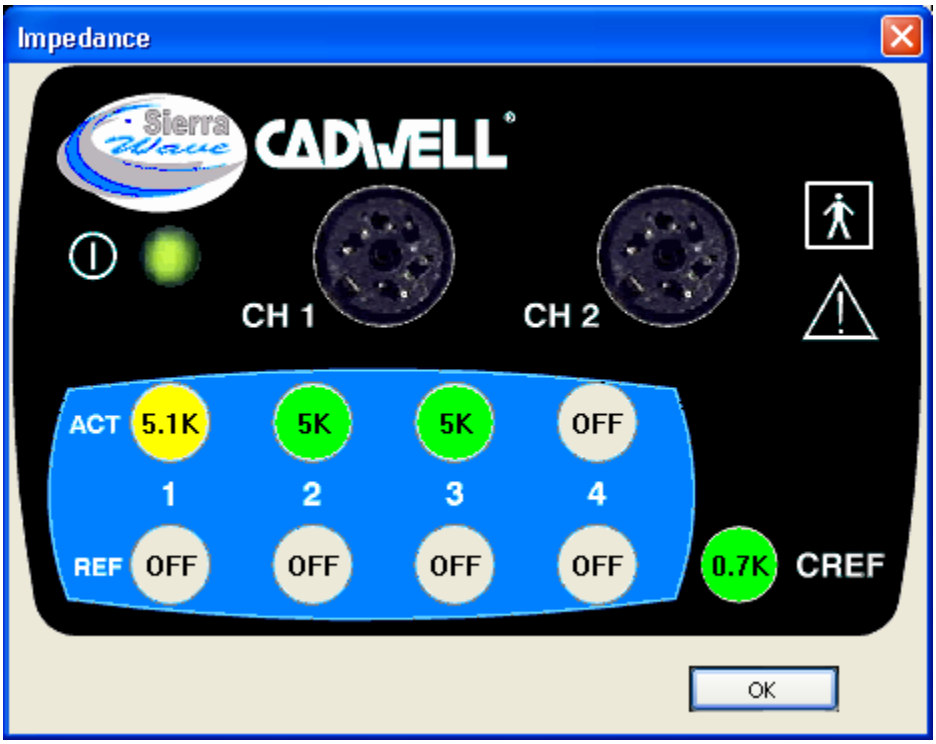
The **Notch** filter is typically not used during SEP recordings and should remain **OFF**.



Median SEP default Amplifier Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 1, 2 and 3 have the CREF input enabled, channel 4 is turned Off.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

 When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Select Side of Stimulation

Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings and Polarity

Apply the stimulating electrodes (bar electrode or individual electrodes) to the patient. Connect the stimulating electrodes to the end of the hand-held electrical stimulator (remove the probe tips from the end of the stimulator). The **proximal** stimulating electrode should be connected to the **Cathode (-)** and the **distal** stimulating electrode should be connected to the **Anode (+)**.

Intensity - start at zero milliamps and after data acquisition is started increase slowly until a visible muscle twitch is seen.

Pulse Width - typically set to 100 or 200 microseconds.

Rep Rate - typically between 2 to 5 Hz and not directly divisible into 60 (e.g., 2.11, 2.66, 4.77).

Polarity - set to **Normal (Nml)** mode. The green LED indicates the Cathode (-).

Controls Window. Controls Toolbar.

SEP Stimulator Controls

6. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

Example SEP Averager settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

 You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

7. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. **Slowly turn up the stimulus intensity level** until a visible muscle twitch is observed. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in a purple color.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

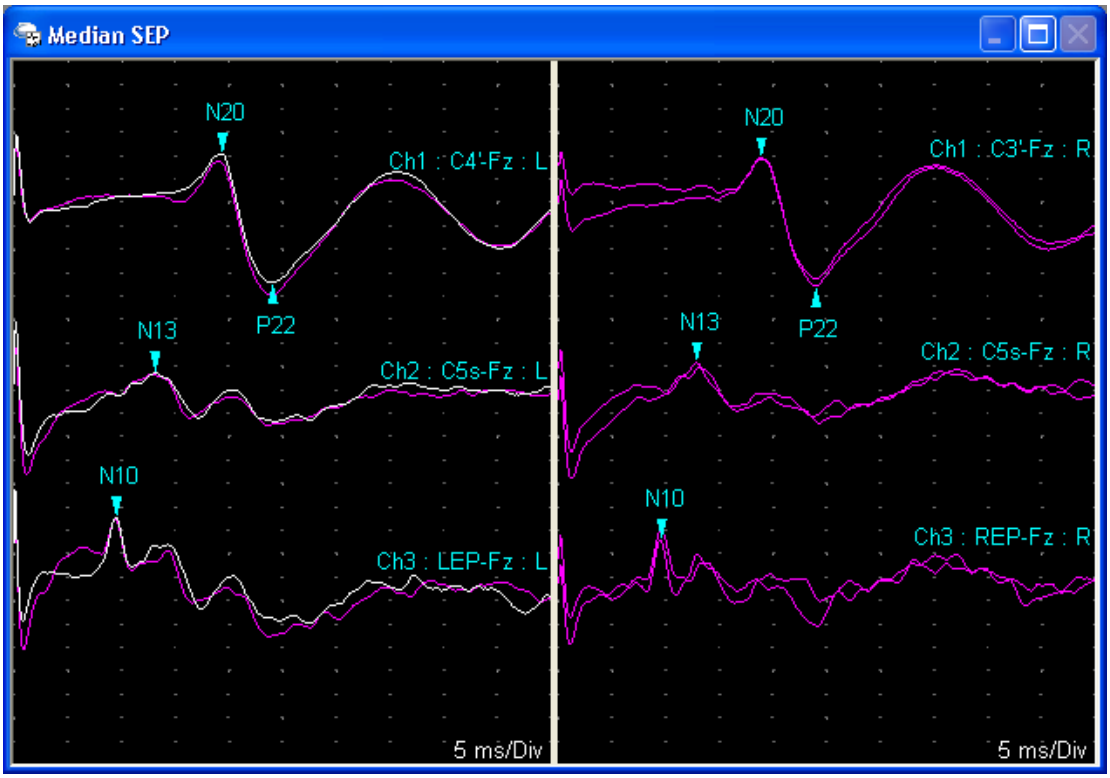
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example 3 Channel Median SEP, Left and Right.

8. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply click on the Trial you want to move with the left mouse button and drag the trial to its new location. If you want to move an individual Trace, not the entire Trial, first right-click the mouse over the Trace window and remove the check mark in front of "Trial Selection Mode".
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trial / Move)** to select and move trials. To move individual traces, first press the **F4 (Trial / Trace)** function key to change the selection mode.

When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

9. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trial to select it**, the trial will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trial to select it**, the trial will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial)** to select a trial, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trial. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

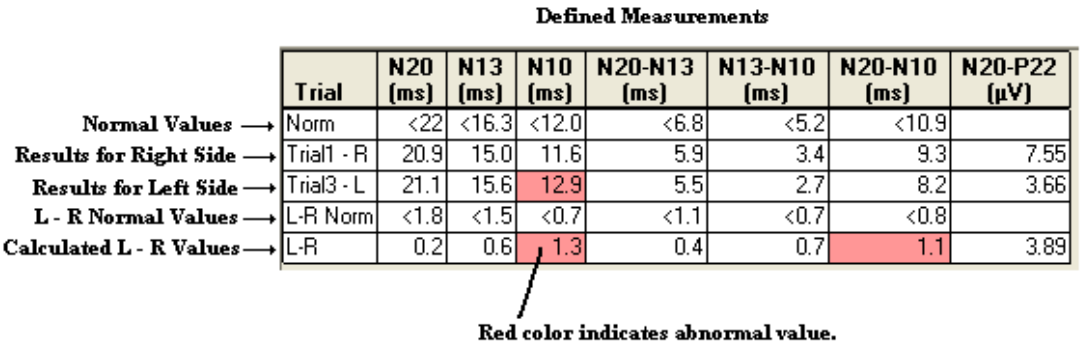
After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the SEP Test Protocol setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial)** to select the trial with the cursors you need to adjust, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



Trial	N20 (ms)	N13 (ms)	N10 (ms)	N20-N13 (ms)	N13-N10 (ms)	N20-N10 (ms)	N20-P22 (µV)
Norm	<22	<16.3	<12.0	<6.8	<5.2	<10.9	
Trial1 - R	20.9	15.0	11.6	5.9	3.4	9.3	7.55
Trial3 - L	21.1	15.6	12.9	5.5	2.7	8.2	3.66
L-R Norm	<1.8	<1.5	<0.7	<1.1	<0.7	<0.8	
L-R	0.2	0.6	1.3	0.4	0.7	1.1	3.89

Example Median SEP Cursor Table.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trial.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

AEP - Basic Operation

Select the AEP Test:

- **If a Study has already been selected**, simply click on the AEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the AEP test protocol from the Study/Test menu.

Once the AEP test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected AEP test.

   Typical AEP Settings

   Gain = 0.2 to 0.5 uV/Div

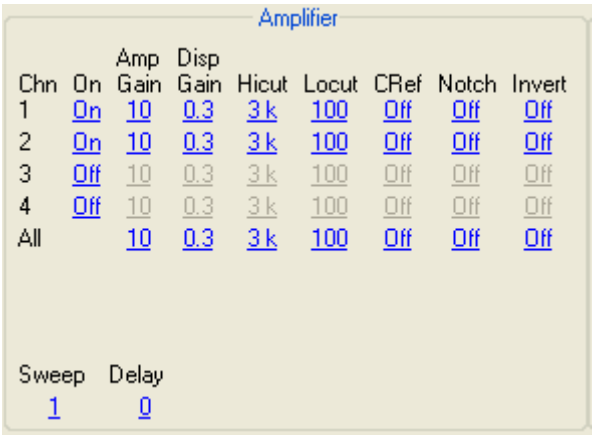
   Hicut = 3k Hz

   Locut = 100 Hz

   Sweep Speed = 1.0 ms/Div

   A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

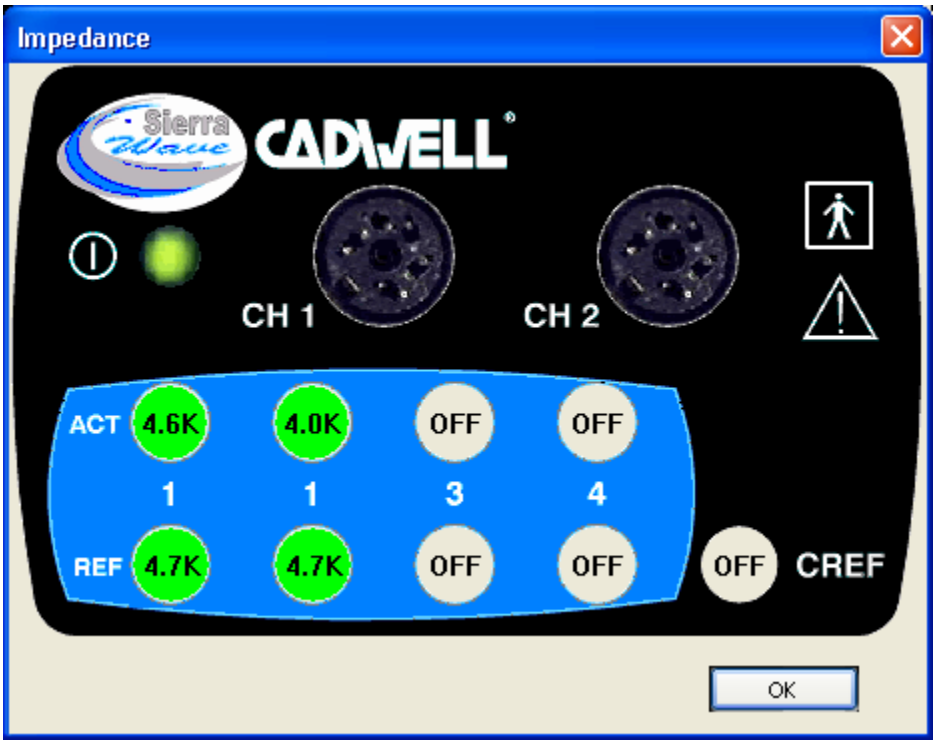
   The **Notch** filter is typically not used during AEP recordings and should remain **OFF**.



2Ch. AEP Default Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 3 & 4 are turned Off. CREF is turned OFF.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

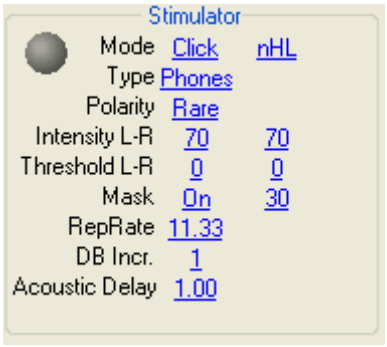
When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Select Side of Stimulation

Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings

Apply the stimulator (headphones or inserts) to the patient, the red headphone/insert should be placed on the patient's right side, the blue headphone/insert should be placed on the left. Connect the stimulator to the back of the Sierra Wave base unit.



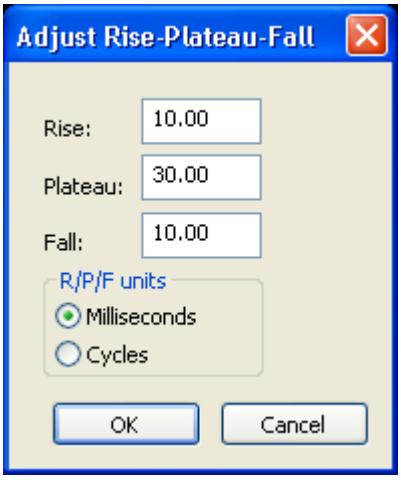
AEP Stimulator Settings - Controls Window

AEP Stimulator Settings - Controls Toolbar

Mode: Click here to select the auditory stimulus type, choose either **Click**, **Tone**, **Pip202**, or **Pip212**.

- **Click** - this is a 100 microsecond click stimulus.
- **Tone** - by default this is a 10-30-10 tone burst stimulus. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time. This stimulus is typically used for long latency auditory evoked potentials.

- **Pip 202** or **Pip 212** - these are also tone stimuli but their rise, plateau, and fall times are measured in cycles rather than milliseconds. The 2-0-2 Pip has a 2 cycle rise, 0 cycle plateau, and 2 cycle fall. The 2-1-2 Pip has a 2 cycle rise, 1 cycle plateau, and a 2 cycle fall.
- **Frequency** - when Tone, Pip202, or Pip212 are selected a Frequency setting will be displayed. Click here to select the frequency of the tone/pip. The choices are 250, 500, 750, 1000, 2000, 3000, 4000, 6000, and 8000 Hz.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

- **Envelope** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.

Type: Click here to select the type of stimulus delivery hardware, choose either **Phones** or **Inserts**.

When **Inserts** are selected the program will **automatically subtract 1.0 milliseconds** from all latency calculations to compensate for the delay produced by the plastic tubing. This delay value can be modified by clicking on the **Acoustic Delay** value. This value does not shift the displayed trace.

Polarity: Click here to set the stimulus polarity, the choices vary depending on the stimulus type.

- **For Click** - choose either **Rarefaction**, **Condensation**, or **Alternating** polarity.
- **For Tone or Pip** - choose either **Negative**, **Positive**, or **Alternating** polarity.

Intensity L-R: Click here to set the starting stimulus intensity value. The first column is for the left side, the second column is for the right side.

 To avoid excessive auditory stimulation, ensure that the stimulus intensity never exceeds 75 dB above the hearing threshold.

Threshold L-R: Indicates the behavioral threshold value. The first column is for the left side, the second column is for the right side. During data acquisition the Threshold values are added to the Intensity values to produce the stimulus at the headphones/inserts. See step #6 for instructions on determining thresholds.

Intensity Units: Choose either **nHL** (normalized hearing level) or **SPL** (sound pressure level). When SPL is selected the Threshold settings are disabled.

dB Incr: Click here to change the intensity value scale. The default setting is 1 dB increments, choices are 1, 2, 5 and 10.

Mask: Click here to set the "white" noise masking as either **On** or **Off** and to set the level for the non-stimulated ear. The amount selected is the number of dB's below the Intensity value. This is known as differential masking and allows the intensity of the masking noise to decrease automatically as the intensity of the stimulus is decreased.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz).

6. Determine Behavioral Threshold Levels (optional)

There are two specially designated knobs for setting the behavioral threshold levels. **Knob #2 (L Thresh/Off)** and **Knob #3 (R Thresh/Off)**. To determine the threshold levels follow these steps.

I. **Turn** Knob #2. Stimuli will be automatically delivered to the left ear and the threshold value for the left ear will turn "yellow".

II. **Continue to turn** Knob #2 until the patient can definitely hear the stimulus.

III. Slowly turn Knob #2 in the reverse direction to **decrease** the threshold level. Keep decreasing the level until the patient signals that they can no longer hear, or can just barely hear, the stimulus.

IV. **Press Knob #2** to stop stimulus delivery and set the threshold value for the left ear.

V. **Repeat** the above steps for the right ear using **Knob #3**.

The threshold value is automatically added to the intensity value to obtain the output level for the stimulator. For example, if the left intensity was set to 70 dB and the left threshold was determined to be 12 dB, the actual output intensity from the stimulator would be 82 (70 + 12).

7. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

AEP Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

8. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in a purple color.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

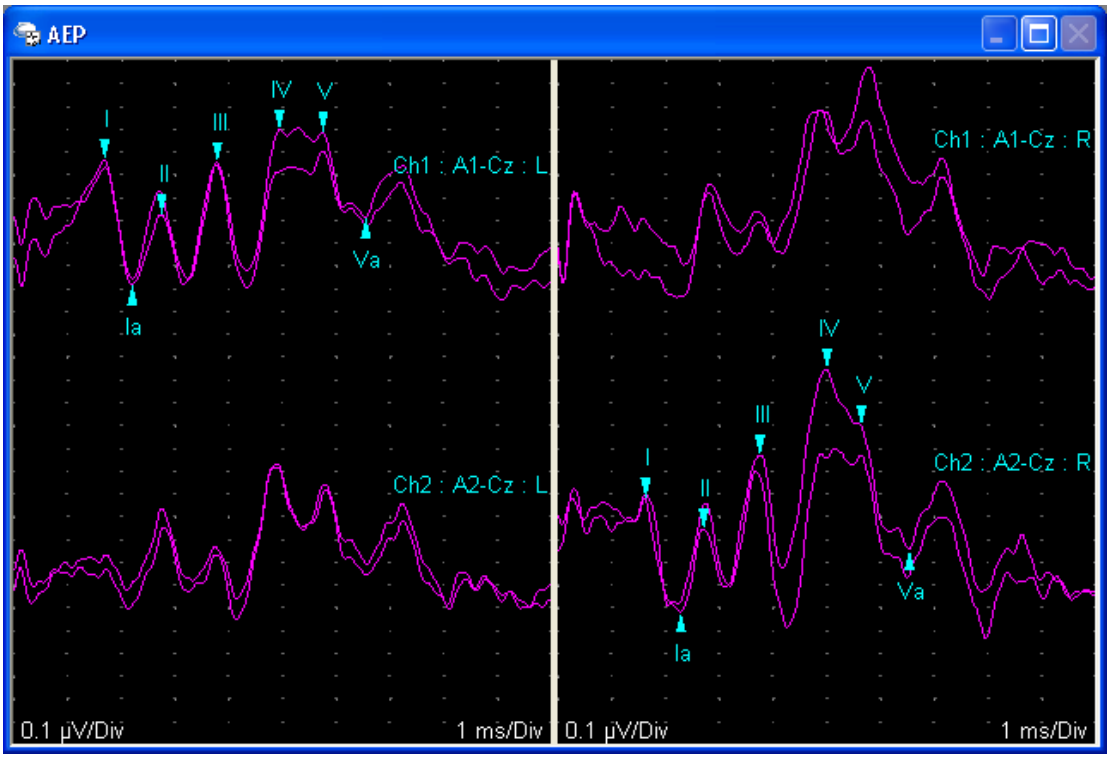
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example 2 Channel AEP, Left and Right.

9. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply **click on the Trace you want to move with the left mouse button** and drag the trace to its new location.
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

  When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

10. Place Auto Cursors

To place Cursors on the important trace features, follow one of these 3 procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

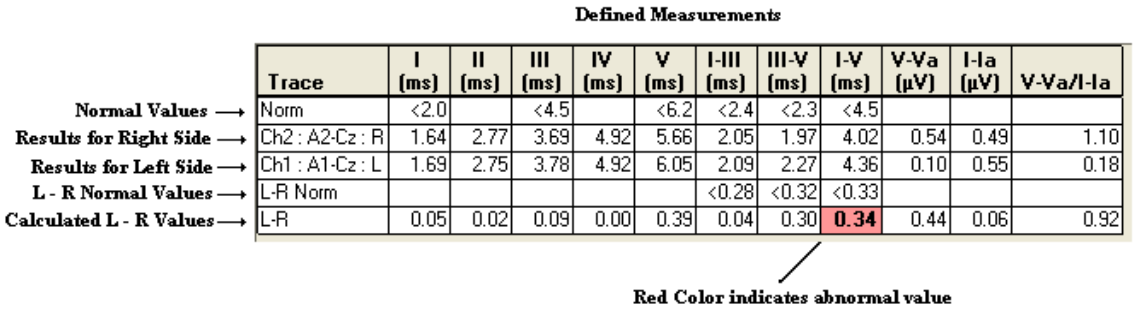
After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the AEP Test Setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



Trace	I (ms)	II (ms)	III (ms)	IV (ms)	V (ms)	I-III (ms)	III-V (ms)	I-V (ms)	V-Va (µV)	I-Ia (µV)	V-Va/I-Ia
Norm	<2.0		<4.5		<6.2	<2.4	<2.3	<4.5			
Ch2 : A2-Cz : R	1.64	2.77	3.69	4.92	5.66	2.05	1.97	4.02	0.54	0.49	1.10
Ch1 : A1-Cz : L	1.69	2.75	3.78	4.92	6.05	2.09	2.27	4.36	0.10	0.55	0.18
L-R Norm						<0.28	<0.32	<0.33			
L-R	0.05	0.02	0.09	0.00	0.39	0.04	0.30	**0.34**	0.44	0.06	0.92

AEP cursor table example.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trace.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

11. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

12. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

VEP - Basic Operation

Select the VEP Test:

- **If a Study has already been selected**, simply click on the VEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the VEP test protocol from the Study/Test menu.

Once the VEP test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected VEP test.

   Typical VEP Settings

   Gain = 5 uV/Div

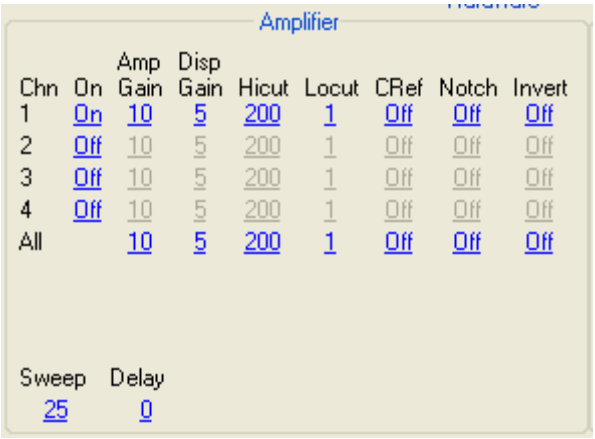
   Hicut = 200 Hz

   Locut = 1 Hz

   Sweep Speed = 25 ms/Div

   A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

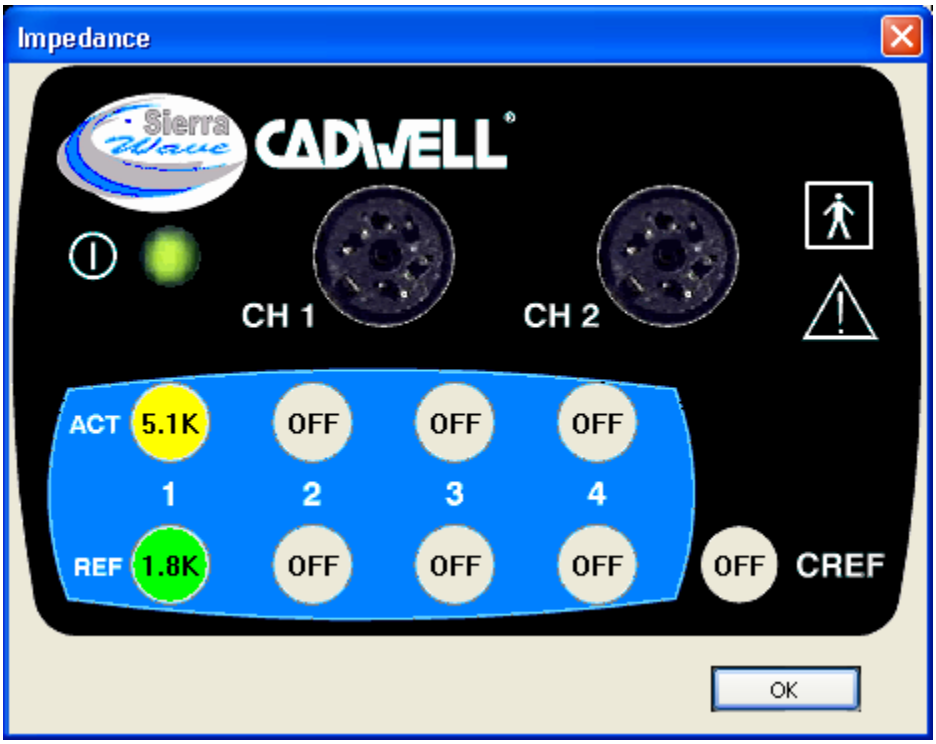
   The **Notch** filter is typically not used during VEP recordings and should remain **OFF**.



Default VEP Amplifier Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 2, 3, & 4 are turned Off. CREF is turned Off for Channel 1.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

When performing evoked potential studies all impedances should be **less than 5k Ohms**.

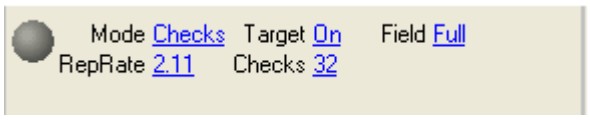
4. Select Side of Stimulation

Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings

Connect the VEP stimulator to the appropriate connector on the back of the Sierra Wave base unit. Position the stimulator at the required distance from the patient. Cover the non-stimulated eye.

VEP Default Stimulator Settings - Controls Window



VEP Stimulator Settings - Controls Toolbar

Mode: Click here to select the type of visual stimulus. Choices are **Checks**, **Goggles**, **LED**, and **Flash**.

- **Checks** - selects a reversing black & white checkerboard pattern. When checks are selected as the stimulus type the following additional parameters are available.
    - **Target** - select either On or Off. When turned On a small target is positioned in the center of the black & white monitor, the patient should focus on this target during data acquisition.
    - **Checks** - click here to select the number of checks displayed across a horizontal row. The choices are 1, 2, 4, 8, 16, 32, 64, and 128 (default is 32 checks with monitor positioned about 1 meter from patient).
    - **Field** - click in this area to select the field of stimulation. The choices are Full Field, Upper Half, Right Half, Lower Half, Left Half, Left Upper Quarter, Right Upper Quarter, Right Lower Quarter, and Left Lower Quarter (default is Full Field).
- **Goggles** - selects the LEG Goggles.
- **LED** - selects the 3 inch hand held LED checkerboard stimulator.
- **Flash** - selects the strobe flash stimulator.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz).

 If you are using a **LCD Television Monitor**, rather than a **CRT Monitor**, please refer to the document **"291218-933 - Setup Instructions for LCD Checkerboard Monitor.pdf"**. LCD monitors have different screen drawing characteristics than CRT monitors, and as such a compensatory delay (or offset) has to be determined and entered into the Sierra Wave program before an LCD monitor can be used. Without this delay value entered into the program the latency of the visual evoked potentials will be greatly prolonged.

6. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

VEP Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

7. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in a purple color.

The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

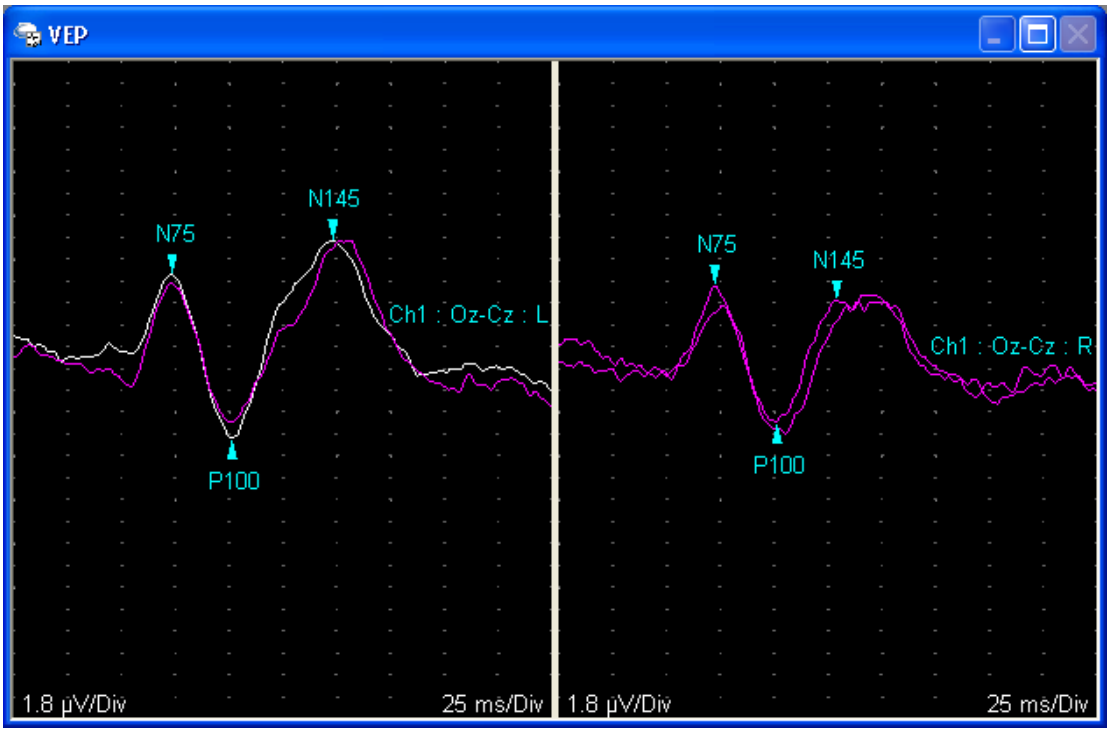
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example VEP, single channel recording, Left & Right.

8. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply click on the Trace you want to move with the left mouse button and drag the trace to its new location.
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

  When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.
- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

9. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

For information on configuring the Auto Cursors, see the VEP Test Setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

  After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

Defined Measurements

	Trace	N75 (ms)	P100 (ms)	N145 (ms)	N75-P100 (µV)
Results for Right Side →	Ch1 : Oz-Cz : R	72.3	101.2	128.9	11.18
Results for Left Side →	Ch1 : Oz-Cz : L	73.4	101.2	148.0	13.39
Calculated L - R Values →	L-R	1.2	0.0	19.1	2.21

VEP cursor table example.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trace.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

P300 - Basic Operation

Select the P300 Test:

- **If a Study has already been selected**, simply click on the P300 test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the P300 test protocol from the Study/Test menu.

Once the P300 test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected P300 test.

   Typical P300 Settings

   Gain = 2.0 uV/Div

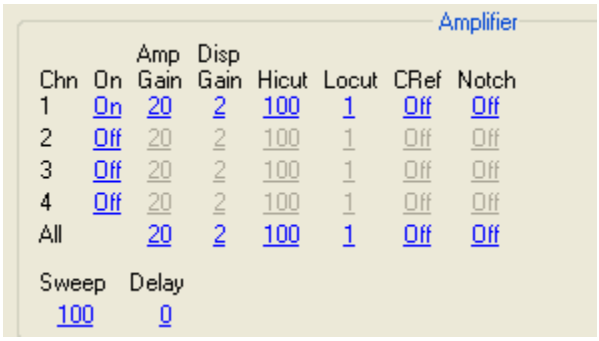
   Hicut = 30-100 Hz

   Locut = 1 Hz

   Sweep Speed = 75 - 100 ms/Div

   A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

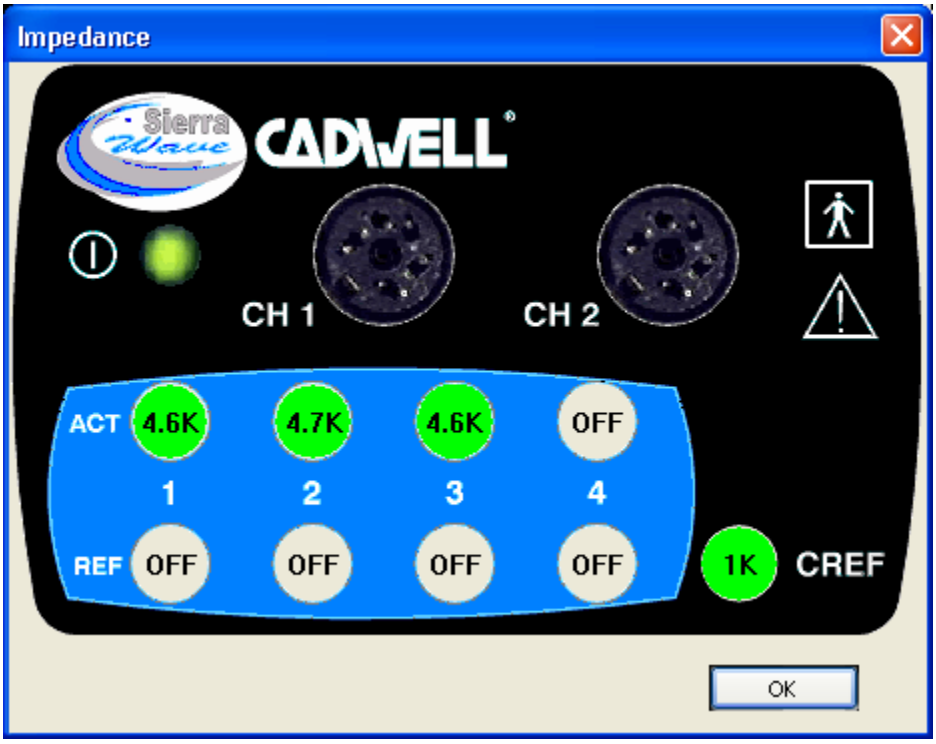
   The **Notch** filter is typically not used during P300 recordings and should remain **OFF**.



3 Ch. P300 Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channel 4 is turned Off. CREF is turned ON for Channels 1 & 2 & 3.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off"

over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Check Stimulator Settings

Clinical recordings of the P300 are generally performed using a binaural auditory tone stimulus, commonly referred to as the auditory odd-ball paradigm. Typically, two easily discriminable tones of different pitches are presented in random order. One of the two tones occurs more often than the other and is designated the Common tone. The other tone is designated the Rare tone. This outline will assume that an auditory stimulus will be used for both the Common and Rare stimuli.

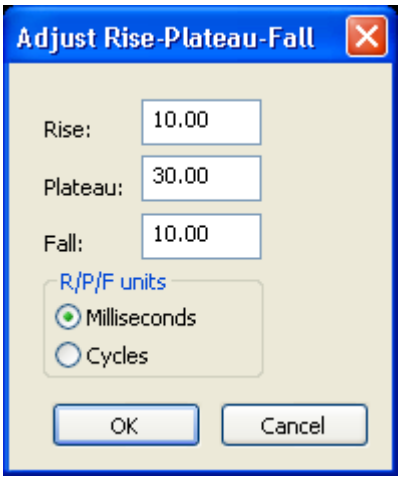
Apply the stimulator (headphones or inserts) to the patient, the red headphone/insert should be placed on the patient's right side, the blue headphone/insert should be placed on the left. Connect the stimulator to the back of the Sierra Wave base unit.

P300 Stimulator Controls Toolbar

Common Stim: These settings are used to configure the Common stimulus.

- **Type** - can be set to Audio, Visual, Electrical, or '.Wav' file. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.

- **Frequency** - click here to select the frequency of the tone. The default setting is **1000** Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.
- **Env.** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

Rare Stim: These settings are used to configure the Rare stimulus.

- **Type** - can be set to Audio, Visual, Electrical, or '.Wav' file. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.
- **Frequency** - click here to select the frequency of the tone. The default setting is **3000** Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.

- **Env.** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.

RepRate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). The default setting is 0.97.

Rare %: Click here to set the percentage of Rare stimuli that will be delivered. The default setting is 20 %.

To avoid excessive auditory stimulation, ensure that the stimulus intensity never exceeds 75 dB above the hearing threshold.

5. Verify Averager Settings

AvgCnt - The second number displayed here is the total number of stimuli (Common + Rare) that will be delivered. When this number is reached stimulation will automatically be stopped. The default is 200 (160 Common, 40 Rare).

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the number of stimuli/sweeps that have been rejected for both the Common and Rare stimuli will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

P300 Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data

can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

 You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

6. Acquire Responses

A. Start Data Acquisition.

It is important that the patient attend to the stimuli. This is facilitated by having the patient keep a mental record of the number of Rare tones (i.e., higher pitched tones) that are presented during the test. Drowsiness should be avoided, as well as distracting noises.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

The P300 program has dual averager banks. The Common stimuli are averaged in the first averager bank and the corresponding traces are displayed in the left half of the trace window. The Rare stimuli are averaged in the second averager bank and the corresponding traces are displayed in the right half of the trace window.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls window** or **Toolbar**.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in a purple color.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

Ask the patient how many Rare stimuli they counted. Compare this with the number shown in the AvgCnt column.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

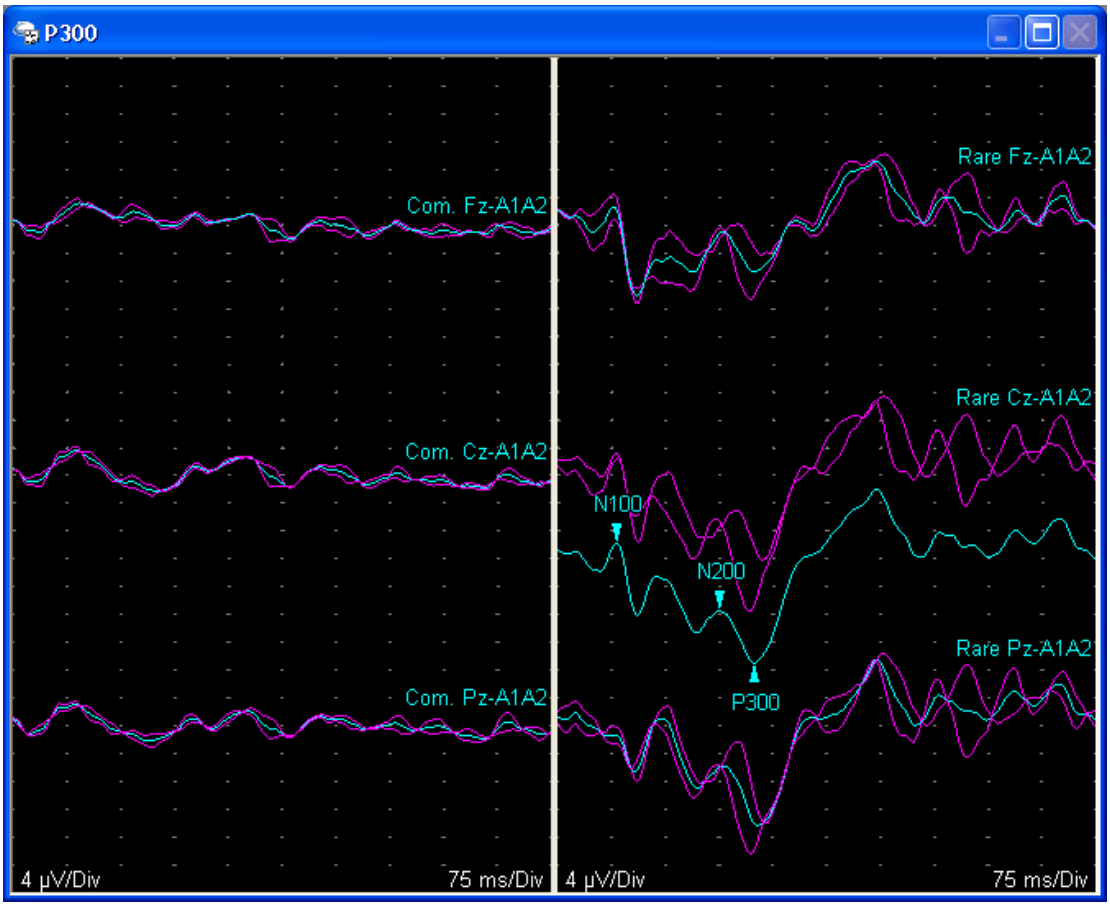
Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces. Again, ask the patient to count the Rare stimuli.

E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Perform a Grand Average (Optional)

Press the **F7 (Grand Avg)** function key. Performing a Grand Average can enhance the principle peaks. A 'blue' trace, representing the grand average of all traces acquired from that channel, will be shown for each channel in the montage.



Example 3 Channel P300. Cursors have been placed on the Grand Average trace for the Cz-A1A2 channel.

7. Trace Positioning (optional)

<u>If the position of the traces needs to be adjusted, follow one of these procedures.</u>

- **Using the Mouse** - simply **click on the Trace you want to move with the left mouse button** and drag the trace to its new location.
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

8. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

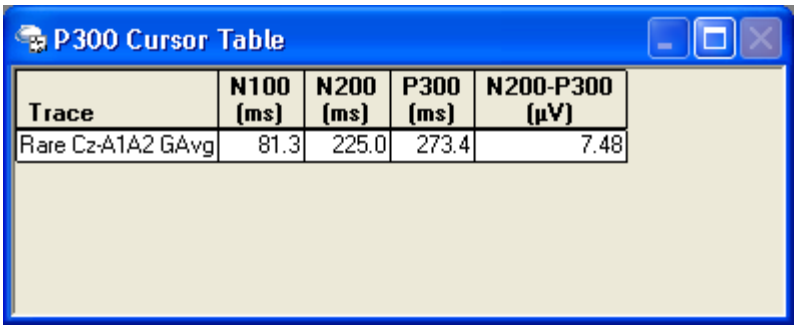
After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the P300 Test Setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



P300 cursor table example.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

9. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

10. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.

- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

The TabData Window

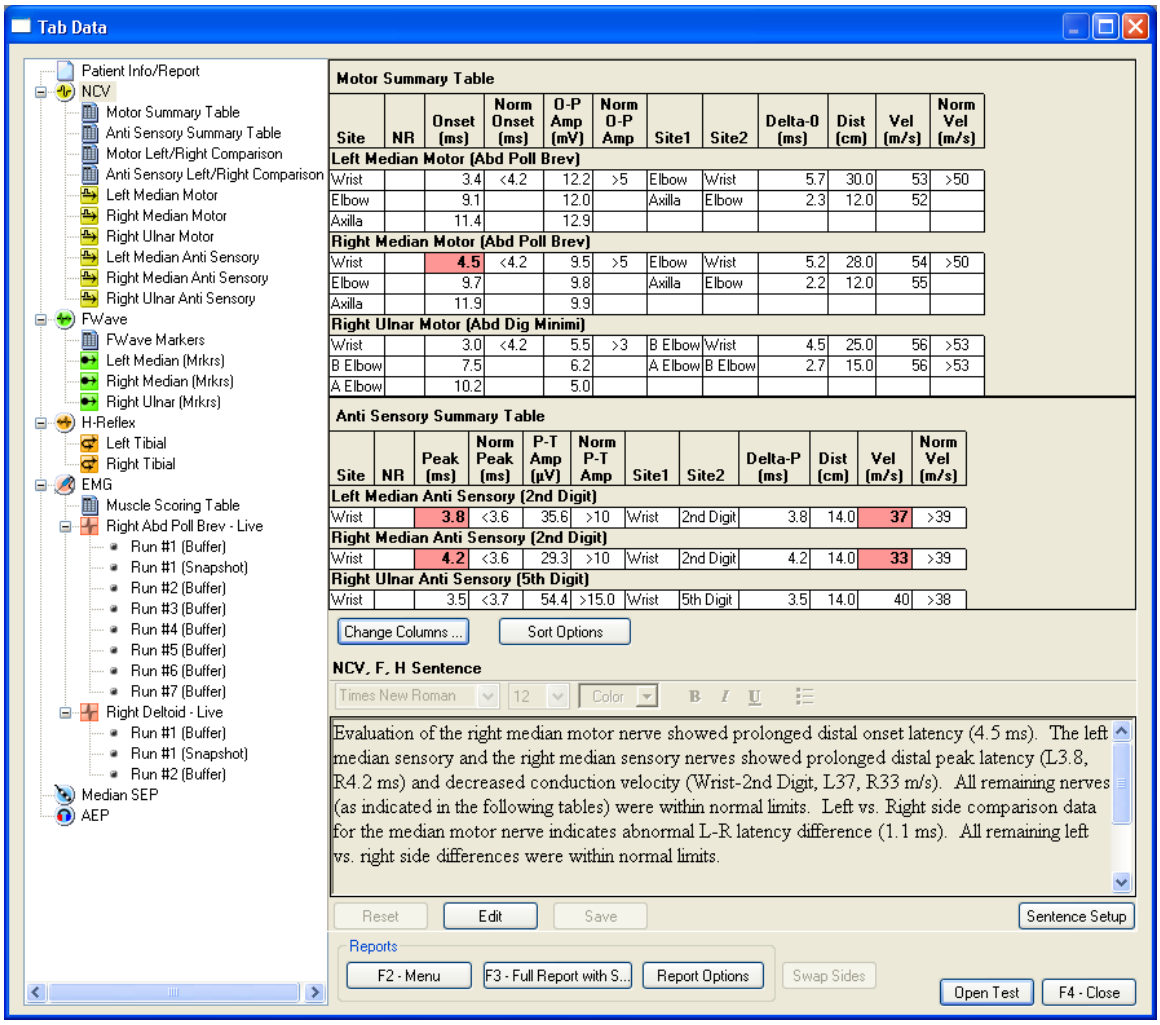
The **TabData** window provides an overview of all tests completed on the patient as well as summary tables for test protocols such as NCV, F/H, and EMG. An optional Sentence Generator is available to create sentences describing the EMG and NCV results.

To open the TabData window press the **F4 (TabData)** function key from within any test protocol or select TabData from the **View** menu.

Completed test protocols are listed down the left-hand side of the window. To select a test protocol or summary table perform one of the following actions.

- Turn **Knob #1 (Select / Open)** to move the blue highlight to the desired test protocol or table.
- **Click the left mouse** button on the test protocol or table.

The highlighted entry's results are displayed on the right-hand side of the TabData window.



TabData window with All NCV summary tables selected.

Actions that can be performed in the TabData window:

Adjusting Auto Cursor Positions

Begin by highlighting an individual test protocol, such as Right Median Motor. The test's traces and cursor table will be displayed on the right-hand side of the window.

Click on a cursor using the left mouse button and drag it along the trace to its new location. The information in the cursor table will be updated to reflect the new position.

Trace Context (pop-up) Menu

Whenever traces are displayed in the right-hand side of the TabData window you can right-click the mouse over the trace area to display the same context menu that is available during data acquisition.

Use this context menu to delete traces, smooth traces, etc.

Change Muscle Scoring

If an EMG Muscle Scoring Table is selected you can change the muscle scoring selections for a muscle simply by clicking with the left mouse button within the table.

Sorting Muscle Scoring Table

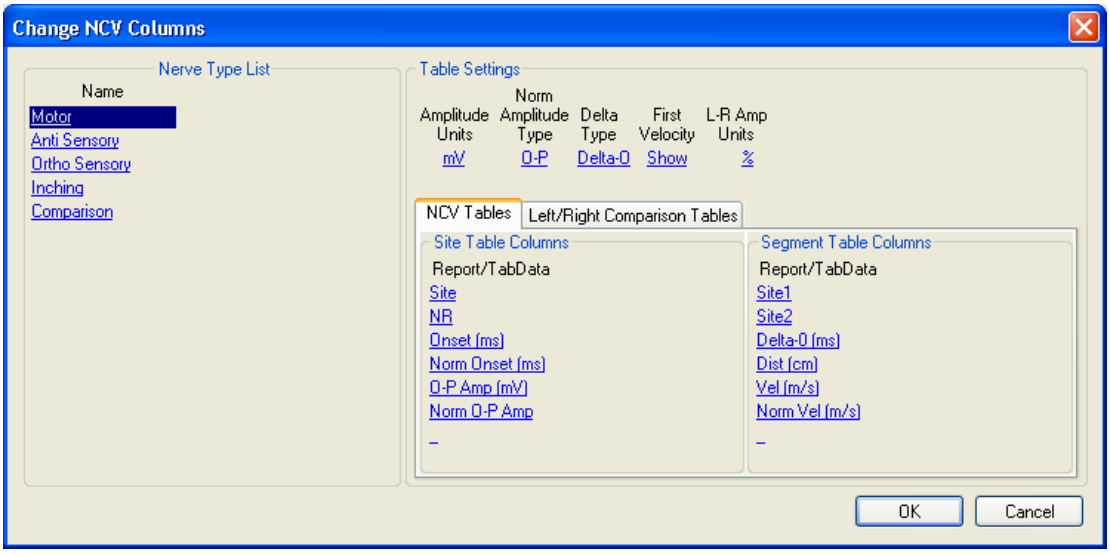
If an EMG Muscle Scoring Table is selected you can click the mouse at the top of any of the table's columns to sort the table according to that column's information. To reverse the sorting, right-click the mouse over the muscle scoring table and select "Original Sort Order" from the pop-up menu.

NCV Column Setup

When a NCV Summary table or individual nerve test protocol is selected the **Change Columns** button is available.

Clicking on **Change Columns** allows you to specify how the NCV results will be shown in your reports. *This does not change how the results are displayed during data acquisition.*

Click on the **Nerve Type** you want to change. To include information in reports, click at the bottom of the displayed column, or within the column, and then select **Insert** from the pop-up menu. Select the value you want to include in the report from the displayed list of choices. To remove information in reports, click on the value displayed in the column, then select **Delete** from the pop-up menu.

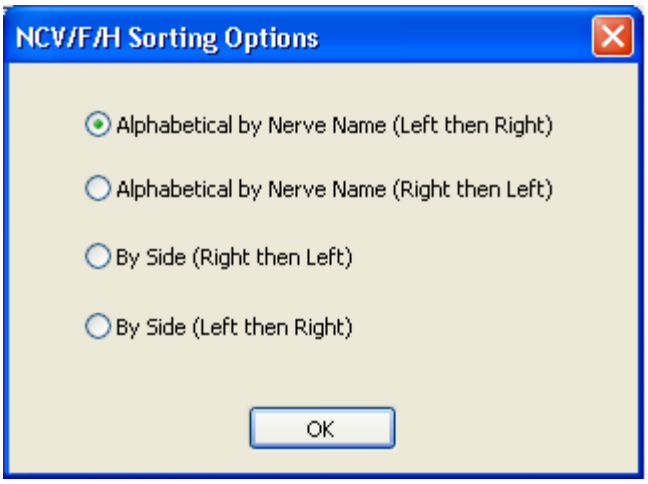


NCV - Change Columns window.

Sorting within the NCV, F Wave, and H Reflex Summary Tables

When a NCV Summary table or individual nerve test protocol is selected the **Sort Options button** is available.

Clicking on this button allows you to specify how the NCV, F Wave, and H Reflex results will be sorted within the summary tables.



NCV/F/H Sorting Options

- **Alphbetical by Nerve Name (Left then Right)** - when this option is selected the nerves are sorted alphabetically by nerve name, Left side first and then Right side.
- **Alphbetical by Nerve Name (Right then Left)** - when this option is selected the nerves are sorted alphabetically by nerve name, Right side first and then Left side.
- **By Side (Right then Left)** - when this option is selected the nerves are sorted with Right side before Left side (all right-sided nerves and then all left-sided nerves).
- **By Side (Left then Right)** - when this option is selected the nerves are sorted with Left side before Right side (all left-sided nerves and then all right-sided nerves).

Swap Sides

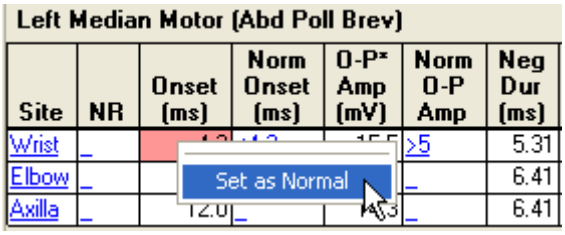
When an individual NCV, F Wave, or H Reflex test protocol is selected the **Swap Side** button can be used to swap the side parameter of the selected test.

If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

If the side you are swapping to already has stored traces, then a second run will be automatically added to that existing nerve.

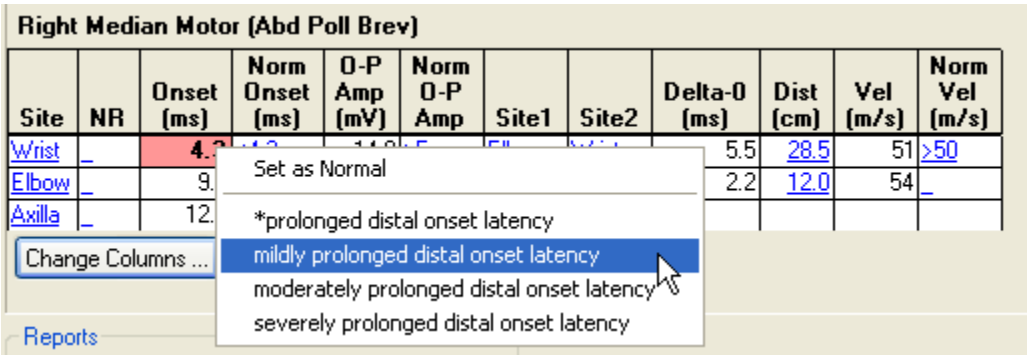
Override an Abnormal Value

When an individual test protocol is selected you can **right click** over an abnormal value and then select **Set As Normal** from the pop-up menu. The abnormal value flag will be removed from that value. To reset the abnormal value flag, right click over the value a second time and click on Set As Normal to remove the check mark.



Assign an Abnormal Severity Meaning

If you have the optional integrated sentence generator enabled, you can right click over an abnormal value to display a list of possible meanings. An asterisk indicates the sentence generator's currently assigned default meaning for the value. You can override the default meaning by selecting one of the additional meanings from the list.



Playback an EMG Buffer

When a stored EMG Buffer is selected, the compressed buffer trace will be shown in the right hand portion of the TabData window. Use the playback controls to replay the buffer without having to open the EMG test protocol.

View the Custom Fields from the Patient Information window

Clicking on the **Patient Info / Report** node will display the custom fields from the patient information window as well as the findings sentences (if enabled). If a QuickReport Item has been assigned to a custom field, it can be processed in this view. For more information on using custom fields, click here.

Print a Report

Two buttons, representing the **Print** and **Report** keys on the Sierra Wave base unit, are displayed at the bottom of the TabData window. The name of the report template that is currently assigned to these buttons is displayed as the button's label.

To initiate a report.

- **Click** on one of these two buttons with the mouse.
- Press the **F2** or **F3** function keys.
- Press the **Print** or **Report** keys on the Sierra Wave base unit.

Change Report Options

The **Report Options button** allows you to remove or add elements to generated reports without effecting the data acquisition screen or the TabData Summary view.

- **Flag Abnormals in Reports** - when this box is checked abnormal values will be indicated in reports, usually as red colored boxes or bolded numbers.
- **Show Comments (NCV, F, H)** - when this box is checked comments entered during NCV, F Wave, or H Reflex data acquisition will be displayed in the data tables of generated reports.
- **Show Norm Columns (NCV, F, H)** - when this box is checked the normal value columns for NCV, F Wave, and H Reflex tests will be included in the data tables of generated reports.
- **Show Column Header Shading** - when this box is checked the column headings at the top of each table are shaded gray.
- **Show Outside Table Lines** - when this box is checked a line is drawn between each nerve and a box is drawn around the entire table. If this box is unchecked, only the column heading row will remain underlined.
- **Show All Vertical Table Lines** - when this box is checked a vertical line is drawn between each table column.
- **Show All Horizontal Table Lines** - when this box is checked a horizontal line is drawn between each table row.
- **Convert Red Background to Grey (Best for Fax)** - when this box is checked the abnormal values, that are usually shown as red colored boxes in reports, will be changed to grey colored boxes. This is more suitable for reports that are being faxed to the referring physician.

Open a Test Protocol

To open a test protocol and display the acquisition screen (this would be necessary to re-stimulate or collect additional traces).

- Highlight the test protocol by turning **Knob #1 (Select / Open)** and then **press** to open.
- Highlight the test protocol and then click the **Open Test** button.
- **Double click** on the test protocol with the mouse.

Close the TabData window

To close the TabData window and return to the previous test protocol screen.

- Click on the **F4 (Close) button**.
- Press the **F4 (Close) function key** on the Sierra Wave base unit.
- Click on the TabData window's **red X** .

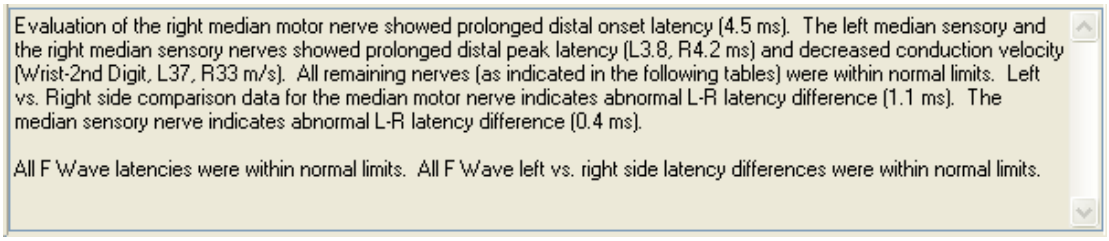
Integrated Sentence Generator for Findings:

The TabData window features an optional Sentence Generator which can build findings sentences to describe NCV, F Wave, H-Reflex, EMG, and EP data.

To Enable the Sentence Generator:

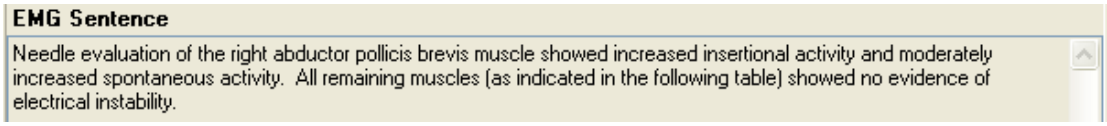
- Start the Sierra Wave program.
- Select **System Setup** from the **Edit** menu.
- Place a check mark in the box labeled **"Show Sentence Generator in TabData"**.
- Click **OK**.

When an NCV, F Wave, or H-Reflex table node is highlighted in the TabData window, the findings sentences for those test protocols will be displayed below the summary tables.



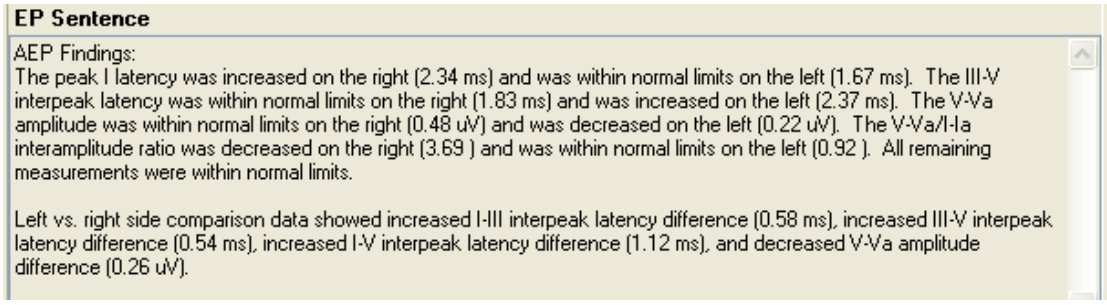
NCV, F, H findings sentences.

When the EMG Scoring Table is highlighted in the TabData window, the findings sentences for the muscle scoring will be displayed below the scoring table.



EMG findings sentences.

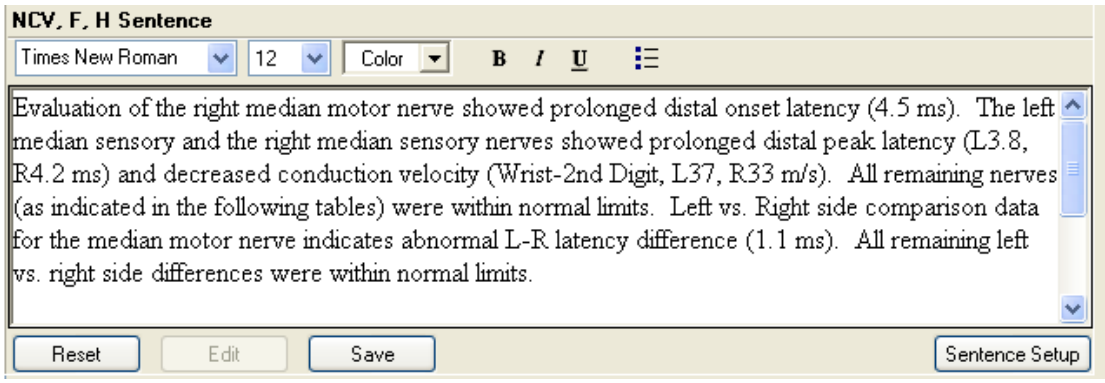
When an EP node is highlighted in the TabData window, the findings sentences for that evoked potential protocol will be displayed below the summary tables.



AEP findings sentences.

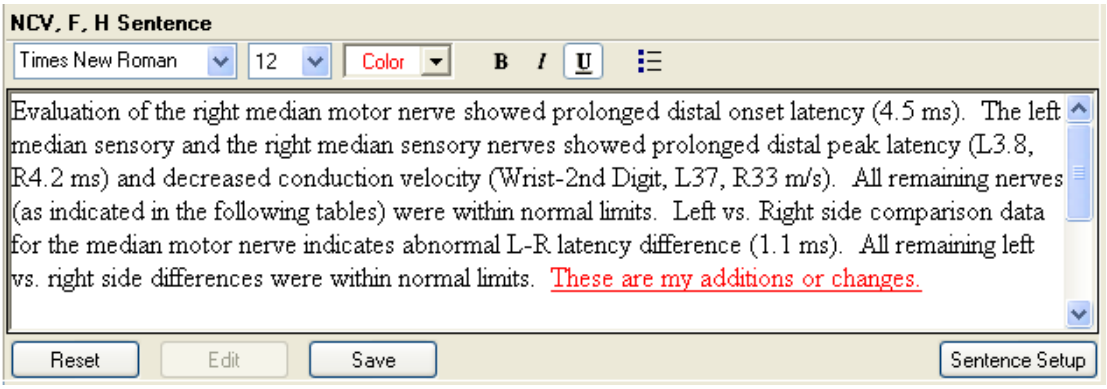
Editing the Findings Sentences:

Below each sentence is a **Reset**, **Edit**, and **Save** button. Click the **Edit button** if you want to make changes or additions to the generated sentences. The background of the sentence area will change to white color, signifying that you are in the Edit mode. The formatting controls above the sentence area will also be activated.



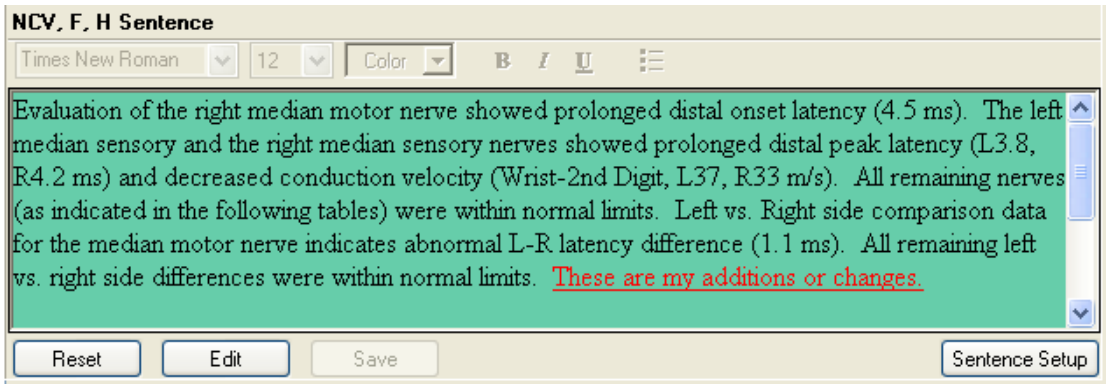
Edit mode.

Click within the sentence area and make your changes/additions.



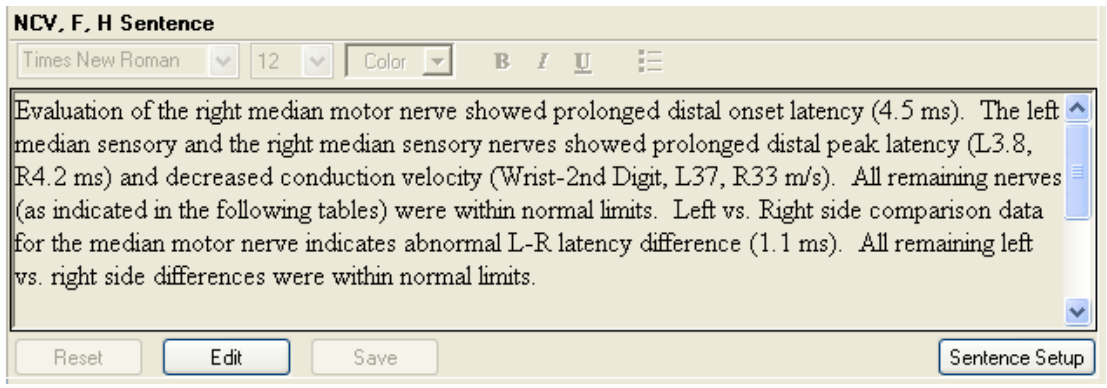
Edit mode with changes.

To save your changes, click the **Save button**. The background will turn green, this signifies that editing has been performed and those changes/additions have been saved.



Changes to the sentences have been saved.

To cancel your changes or additions, click the **Reset button**. The sentence is returned to its default state and the background color changes back to the non-edit mode color.



Sentence has been reset to default state.

Generating A Report

The Sierra Wave uses a separate program for report generation, this program is called **QuickReport**.

To initiate a report you must select a template from within the Sierra Wave program. Once a template is selected the QuickReport program will start automatically.

 QuickReport is a Microsoft Word™ based application and includes such Word features as spell check, grammar check, table formatting, and graphics support.

 QuickReport can be run stand-alone to edit and create the report templates used by the program.

To Select a Report Template

From within the TabData window:

- **Click** on **one of the two report buttons** shown within the TabData window. The buttons are labeled with the name of the template currently assigned to them.
- **Press** either the **Print** or **Report** key on the Sierra Wave base unit.

From within a Test Protocol screen:

- **Press** either the **Print** or **Report** key on the Sierra Wave base unit.
- Use the program's **File Menu** to select one of the following.

  Launch QuickReport & Select Template - this will start the QuickReport program and allow you to select any report template available on the system.

  Print *"Template Name"* for Print key - the template name currently assigned to the Print key on the Sierra Wave base unit is displayed here. Clicking this entry will select this template and start QuickReport.

  Print *"Template Name"* for Report key - the template name currently assigned to the Report key on the Sierra Wave base unit is displayed here. Clicking this entry will select this template and start QuickReport.

Description of the Factory Default Report Templates

Current Test - use this template to print the results for the individual Test Protocol that is currently displayed on the screen. For example, use this to print the results for a single NCV nerve test or a single Evoked Potential test. It also includes the Chief Complaints, Medications, Physical Exam / History, and Impression custom fields from the Patient Information window.

Full Report (manual Findings) - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window as well as an interactive Findings item for manual creation of findings sentences.

Full Report with DataLAB - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator feature of the TabData window. The results of the DataLAB feature are also included in this report.

Full Report with Sentence Gen - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator feature of the TabData window.

Full Report with SG and AV - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator feature of the TabData window. The AnatomyVIEW graphic is also included in this report.

Injection Report - this template to print the injection log table from the EMG Guidance protocol. It also includes an injection diagnosis and procedure code table.

MMUA Report - this template includes the summary tables and MUP waveforms from Multi-Motor Unit Analysis. It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

TabData w/ Traces - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints,

Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

TabData w/o Traces - this template includes all the test protocols within the TabData window (tables only). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

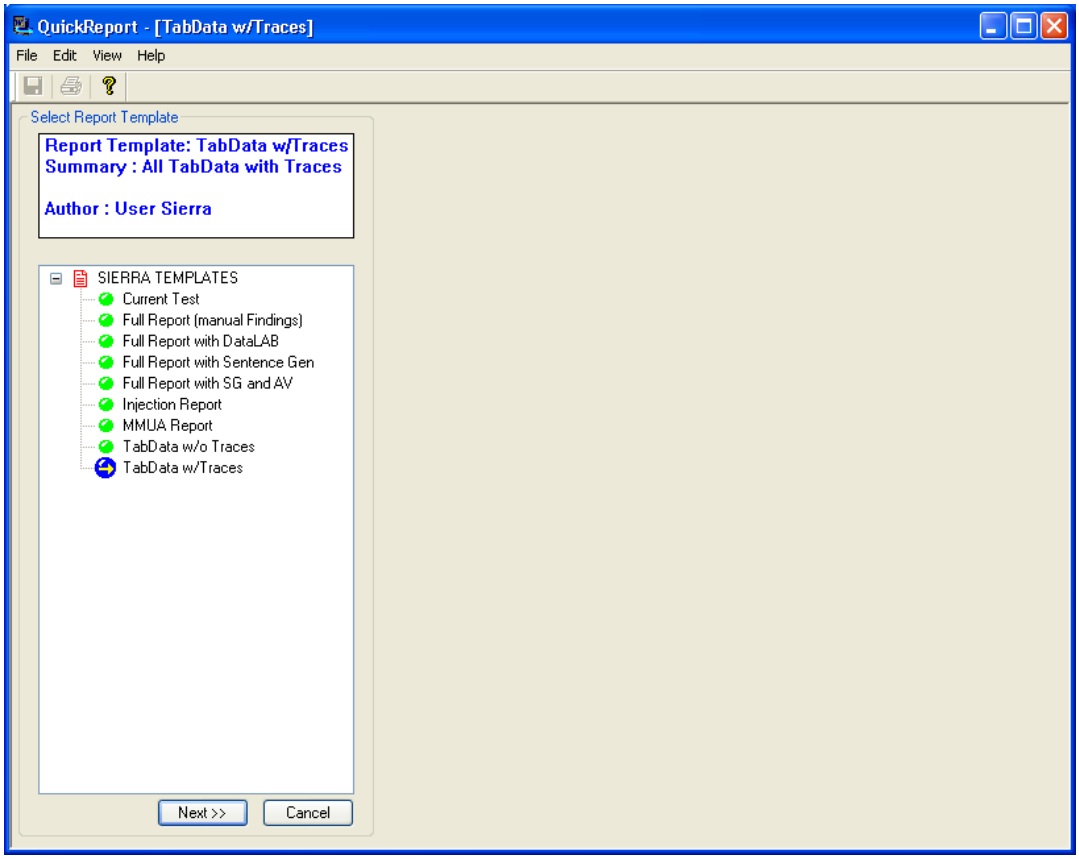
Overview of QuickReport

QuickReport has **three main views**.

Select Report - the program will go to this view if you select "Launch QuickReport & Select Template" from the Sierra Wave's file menu. This view allows you to choose any template on the system. This view is initially displayed if you start QuickReport outside of the Sierra Wave program. To select a template, either double click on it or single click on it and then click the Next button.

Fill In Report - the program will go to this view if you select a report template that requires user input. For example, the "Full Report (manual Findings)" template will go directly to this view so that the user can make manual selections for the Findings section of the report.

Document - this view shows the generated report in Word format. The program will automatically go to this view if you select a report template that does not require any user input, the "Current Test", "TabData w/ Traces", and "TabData w/o Traces" templates are examples. The program will also switch to this view when all selections are complete on the Fill In Report view.



QuickReport - Select Report view.

To Print the Report

From the **Document** view,

- click on the **Printer icon**  at the top of the screen. The report will be sent to your default printer.
- select **Print** from the **File menu**.

To Save the Report

From the **Document** view,

- click the **Finish** button, you will be prompted to save the report.
- click on the **Diskette icon**  .
- select **Save** from the **File menu**.

The report is saved to the user's Data directory with the filename of *"lastname, firstname, date, time~template name.doc".*

To Close QuickReport

From the **Document** view,

- select **Exit** from the **File menu**.
- click the **Finish** button at the bottom left of the screen.
- click the **Red X**  in the top right-hand corner.

If the report has not been saved the program will ask you if you would like to save the report before exiting.

 To get a simple printout of the current test screen, select **Print Screen** from the Sierra Wave **File** menu.

 For more detailed information on QuickReport and report templates, see the Help Topics from within the QuickReport program.

Closing the Patient Exam

To close the patient's exam, click on the **File menu** and select **Close Exam**.

- The program will automatically display the **Patient Information** window if you did not enter a **Last Name** for the patient prior to starting the exam. Enter the Last Name in the Patient Information window and click **F3-OK** to close the exam.

 You can also click on the **red X**  in the upper right hand corner. This will close the patient's exam first, then the Sierra Wave program will be exited.

Closing the Sierra Wave Program

To close the Sierra Wave program.

- Click on the **File menu** and select **Exit**.

OR,

- Click on the **red X**  in the upper right hand corner of the screen.

 The program will automatically display the **Patient Information** window if you did not enter a **Last Name** for the patient prior to starting the exam. Enter the Last Name in the Patient Information window and click **F3-OK** to close the exam. The Sierra Wave program will then close immediately after this.

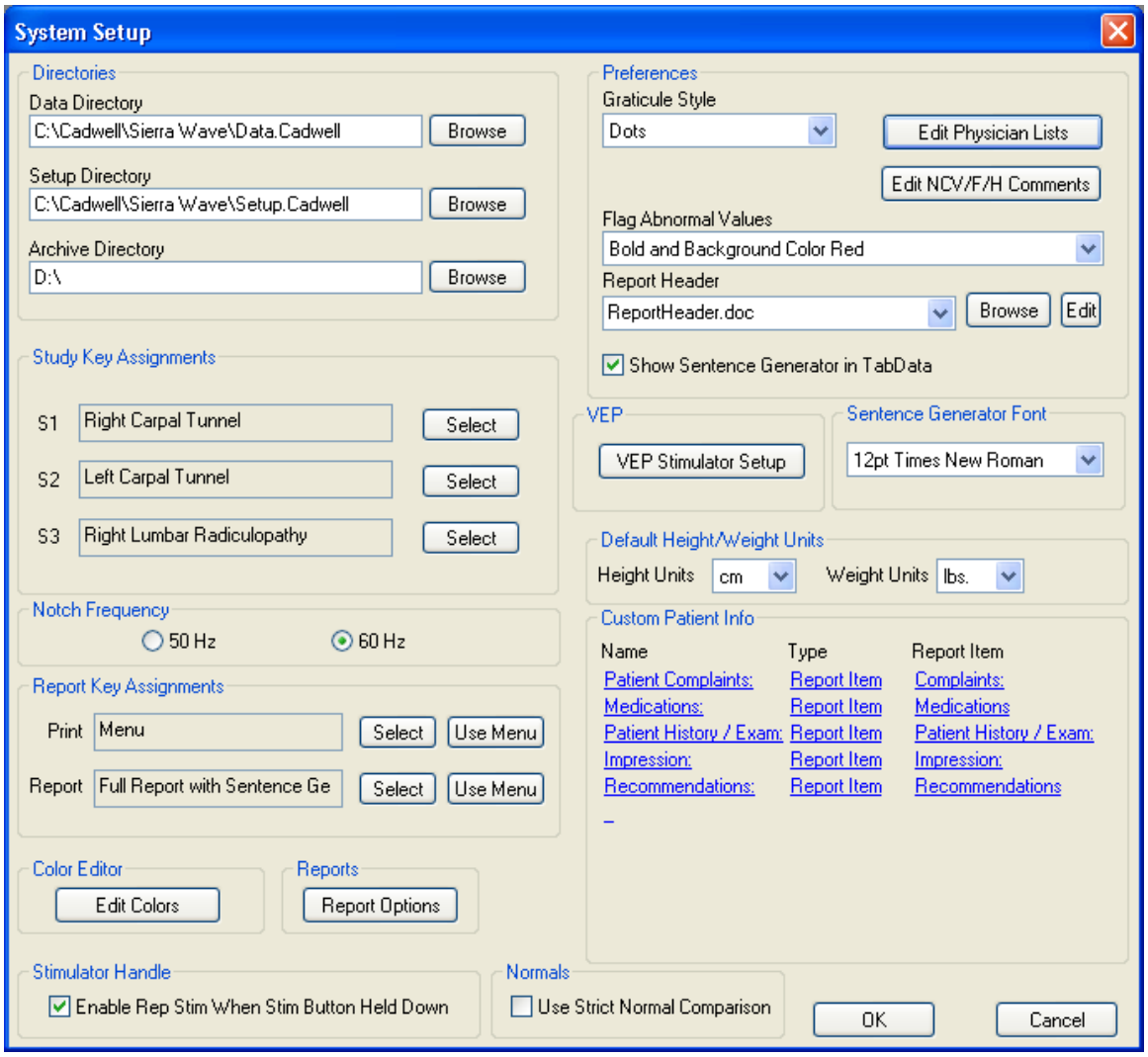
System Setup Options

System Setup Window

This window is used to setup program Directories, Study & Report Key Assignments, Screen Colors, Preferences and Custom Patient Info.

- Click on **Edit**.
- Select **System Setup**.

The **System Setup** window will be displayed.



There are 13 sections in the System Setup window.

Directories

- Data Directory - specifies where user's Patient Data will be stored.
- Setup Directory - specifies where user's Parameter Settings will be stored.
- Archive Directory - sets the default location for archiving patient data and stored reports.

Study Key Assignments

- Program Study Keys on Wave base unit.

Notch Frequency

- Set the frequency of the notch filter.

Report Key Assignments

- Program Report Keys on Wave base unit.

Color Editor

- Program colors for screen elements.

Reports

- Remove or add elements to the generated report.

Stimulator Handle

- Enable or disable repetitive stimulation mode.

Normals

- Check this box to remove the 'equal to' requirement when comparing the patient's values to normals.

Preferences

- Graticule Style – Dashes or Dots on Trace window.
- Flag Abnormal Values - None, Bold, Bold with Asterisk, Background Color Red, Bold & Background Color Red.
- Edit Physician Lists - Used to add or remove names from the Physician, Referring Physician, and Technician fields.
- Edit NCV/F/H Comments - Used to edit the list of comments available in the NCV, F Wave, and H-Reflex test protocols.

- Report Header - Used to select and edit the header to be used in reports.
- Sentence Generator - Enables the automatic generation of findings sentences in the TabData window for EMG, NCV, F Wave, H-Reflex, and EP test protocols.

VEP Stimulator Setup

- Specify the VEP monitor delay value and select the flash duration for VEP Goggles.

Sentence Generator Font

- Specify the default font size and font style that will be used to display the findings sentences within the TabData window.

Default Height / Weight Units

- Select the default units for Height (ft., cm, txt) and Weight (lbs., kg, txt) in the Patient Information window.

Custom Patient Info

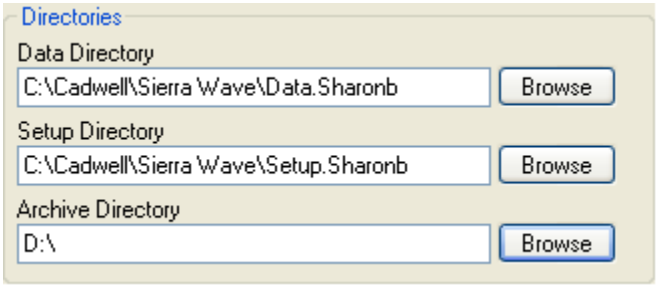
- Setup the Custom Fields in the Patient Information Window.

After making changes to any of these settings, Click **OK** and the changes will be saved.

Directory Paths

When the Wave Program is first installed it creates a **Data** folder and a **Setup** folder. Factory default test parameters and study lists are placed the Setup folder.

Once you start the Wave Program it will create a unique Data folder and Setup folder using your **Windows user name**. This allows each user, that logs into the computer, to have their own data and setup locations. The Windows user name is added to the end of the folder name separated with a period. For example; **Data.Sharonb** and **Setup.Sharonb**.



Data Directory:

The Data folder is where patient data files and stored reports are stored.

Setup Directory:

The Setup folder is where the user's test parameters, study lists and preserve files are stored.

Archive Directory:

This is normally set to your CD-R/CD-RW drive letter. It can be set to a local folder, a network folder or other write-able media.

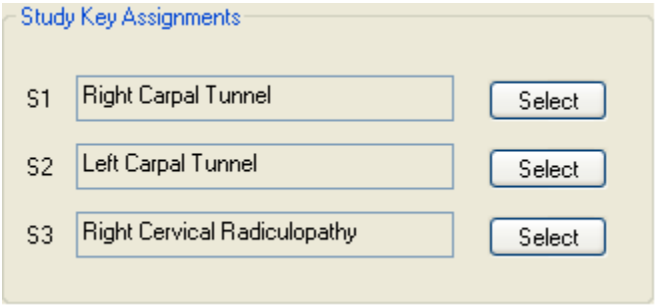
Browse buttons:

Click the appropriate Browse button to select a different directory path.

If desired, you can set every user's Data and Setup folder paths to the same locations. This would ensure that everyone uses the same parameter settings and saves patient data to a central location.

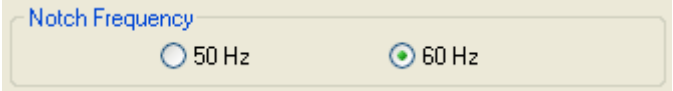
Study Key Assignments

The Study Key Assignment allows you assign your most common studies/tests to the **S1**, **S2** and **S3** Study Keys on Wave base unit. Click on the **Select** button and then select the study/test to change the Study Key Assignment.



Notch Frequency

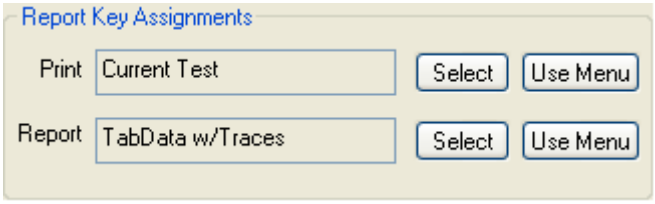
This section allows the user to choose the frequency of the notch filter. The choices are **50** or **60** Hz.



Simply click on the frequency that is appropriate for your location.

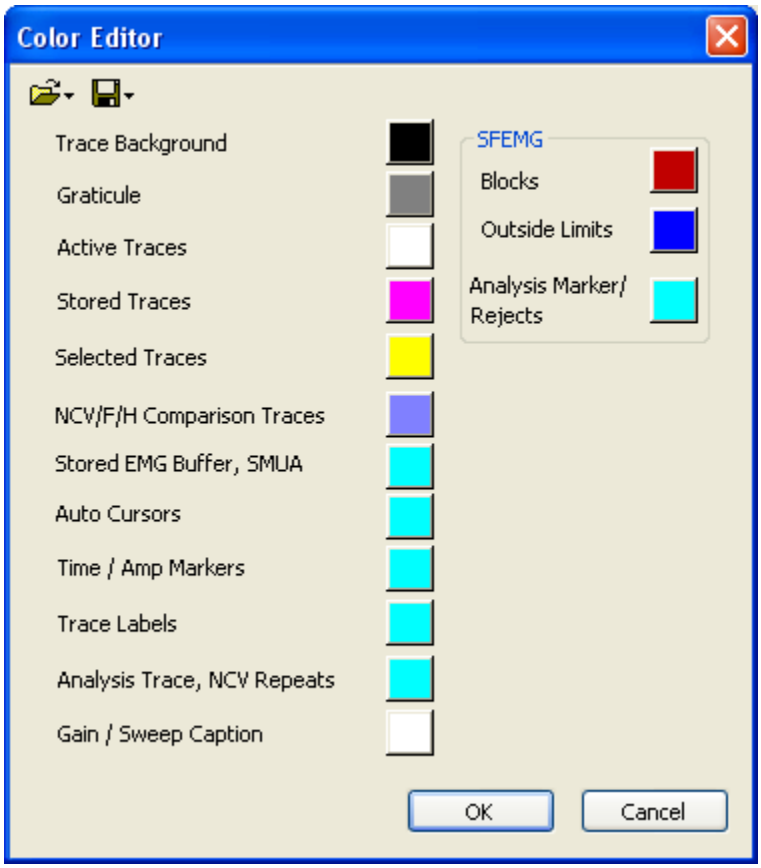
Report Key Assignments

The Report Key Assignment allows you to assign specific report templates to **Print** & **Report** Keys on Wave base unit. Click on the **Select** button; click **(+)** next to report category; highlight the report template and click **OK** to change the Report Key Assignment. You can also assign "Use Menu" to bring up the complete report template list when the appropriate key is pushed.



Edit Colors

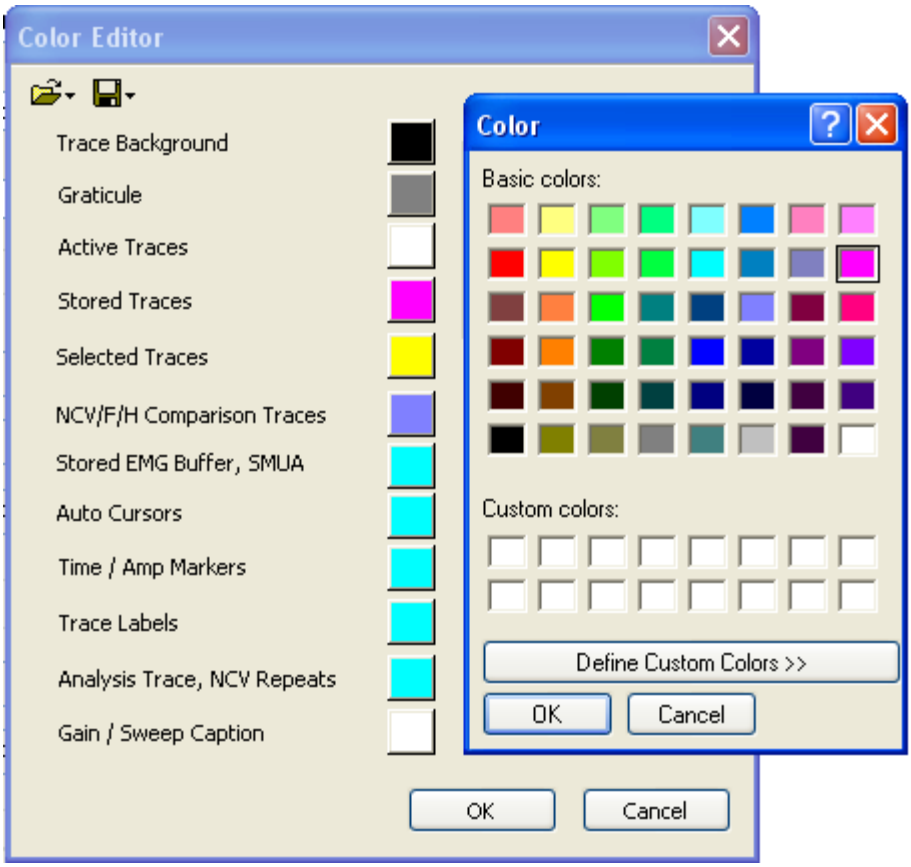
Click the **Edit Colors button** to display the **Color Editor** window.



Color Editor window.

To Change the color of an Item:

Click on the box corresponding to the item you want to change, then select a new color from the color palette. Color changes will take effect when the next new study is started.



To Load a Factory Default Color Scheme:

Click on the **folder icon** and select **Default 1** or **Default 2** from the list. The Sierra Wave ships from the factory with Default 1 selected as the color scheme.

To Save the current color scheme as a Custom Scheme:

After making changes to the appropriate items in the color editor; click the **diskette icon** and then select either **Custom 1** or **Custom 2** from the list. Your selections will be saved to that scheme.

You cannot save changes to the Default color schemes.

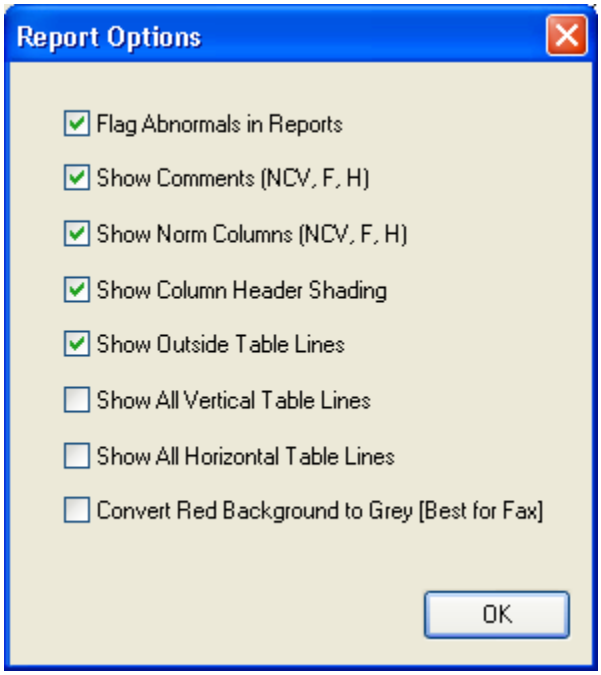
To Load a Custom Color Scheme:

Click on the **folder icon** and select either **Custom 1** or **Custom 2**. Click the **OK** button to apply the selected color scheme.

Report Options

This section allows you to remove some elements from generated reports without removing them from the data acquisition screen or the TabData Summary view.

Click on the **Report Options** button to display the following window:



- **Flag Abnormals in Reports** - when this box is checked abnormal values will be indicated in reports, usually as red colored boxes or bolded numbers.
- **Show Comments (NCV, F, H)** - when this box is checked comments entered during NCV, F Wave, or H Reflex data acquisition will be displayed in the data tables of generated reports.
- **Show Norm Columns (NCV, F, H)** - when this box is checked the normal value columns for NCV, F Wave, and H Reflex tests will be included in the data tables of generated reports.
- **Show Column Header Shading** - when this box is checked the column headings at the top of each table are shaded gray.

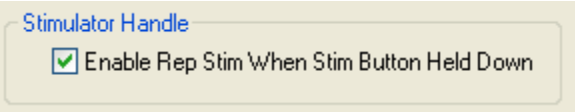
- **Show Outside Table Lines** - when this box is checked a line is drawn between each nerve and a box is drawn around the entire table. If this box is unchecked, only the column heading row will remain underlined.
- **Show All Vertical Table Lines** - when this box is checked a vertical line is drawn between each table column.
- **Show All Horizontal Table Lines** - when this box is checked a horizontal line is drawn between each table row.
- **Convert Red Background to Grey (Best for Fax)** - when this box is checked the abnormal values, that are usually shown as red colored boxes in reports, will be changed to grey colored boxes. This is more suitable for reports that are being faxed to the referring physician.

The Report Options button can also be accessed in the **TabData Summary** view.

Stimulator Handle

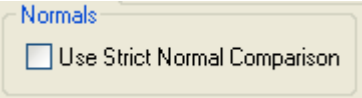
This section allows you to change the function of the Stim button on the electrical stimulator.

Checking this box will enable the repetitive stimulation function when the Stim button is held down for 2 seconds.



Normals

Check this box to remove the 'equal to' requirement when comparing the patient's values to normals.



When this option is checked **cursor values that are equal to the normal value will be flagged as abnormal**. For example, if the normal onset value is entered as (<4.2), a recorded value from the patient of 4.2 will be flagged as abnormal. The program considers a value equal to the norm as abnormal.

Site	NR	Onset (ms)	Norm Onset (ms)
Wrist	_	4.2	<4.2
Elbow	_	9.1	_
Axilla	_	11.4	_

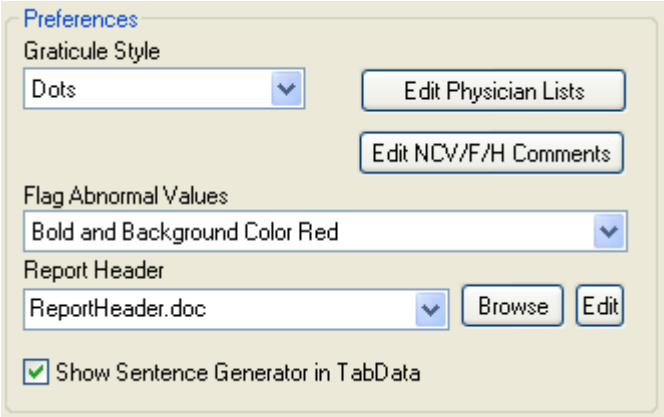
Value of 4.2 is normal.

Site	NR	Onset (ms)	Norm Onset (ms)
Wrist	_	4.2	<4.2
Elbow	_	9.1	_
Axilla	_	11.4	_

Value of 4.2 is abnormal.

Preferences

This section allows user to customize trace window graticule style, to flag abnormal values, to create and choose different report headers, and to enable the automatic sentence generator.

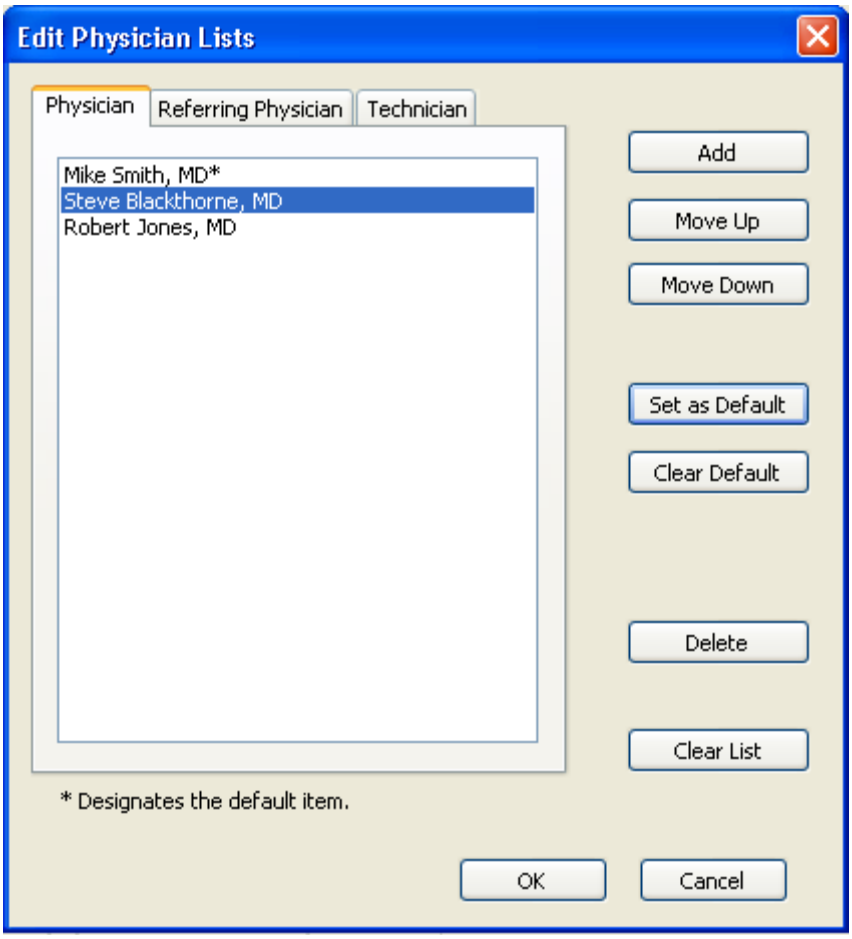


Graticule Style:

Use the drop down arrow to select **Dashes** or **Dots** for trace window.

Edit Physician Lists:

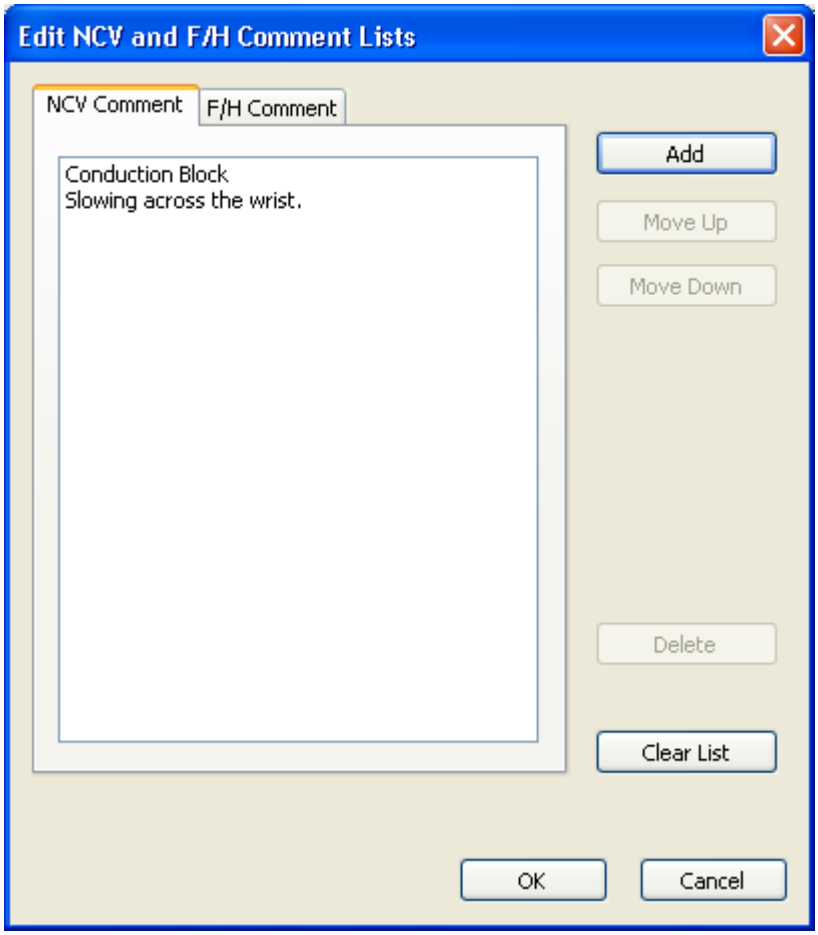
Clicking on this button opens the **Edit Physician List** window. This window can be used to Add or Delete entries from the Physician, Referring Physician, and Technician lists. The order of the names can be changed using the Move Up and Move Down buttons. Use the Set as Default button to indicate which name should automatically appear when a new patient exam is started. These lists are available when entering the Patient Information.



Edit Physician Lists

Edit NCV/F/H Comments:

Clicking on this button opens the **Edit NCV and F/H Comments** window. This window can be used to Add or Delete entries from the comment lists used in the NCV, F Wave, and H-Reflex test protocols. The order of the comments can be changed using the Move Up and Move Down buttons.



Edit NCV and F/H Comments

Flag Abnormal Values:

Use the drop down arrow to select **None**, **Bold, Bold with Asterisk, Background Color Red,** or **Bold Text and Background Color Red**. Abnormal values will be flagged in the test window, TabData, and the Report.

Report Header:

Multiple report headers can be saved for different locations, doctors, etc...

Click the **Edit** button to open the currently selected Report Header using Microsoft Word and make changes to it.

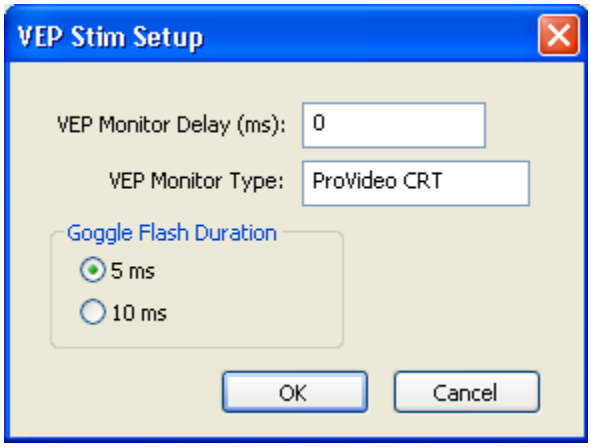
Click the **Browse** button to locate a different report header or click the **drop-down arrow** to select from a list of the most recently used report headers.

Sentence Generator:

Placing a check mark in this box enables the automatic generation of findings sentences in the TabData window for EMG, NCV, F Wave, H-Reflex, and EP protocols.

VEP Stimulator Setup

Clicking on the VEP Stimulator Setup button opens the following window.



VEP Monitor Delay (ms):

This setting has been added to support the use of selected LCD monitors for use as checkerboard pattern stimulators. LCD monitors have different screen drawing characteristics than CRT monitors, and as such a compensatory delay (or offset) has to be determined and input before an LCD monitor can be used. Without this delay value entered into the program the latency of the visual evoked potentials will be greatly prolonged.

LCD checkerboard monitors purchased from Cadwell have been calibrated and the delay has been carefully determined. Use the delay value indicated on the back of the LCD monitor. For the ViewSonic N1630W this value is 52 milliseconds.

If you do not purchase an LCD monitor from Cadwell the appropriate delay value will not be known and the latency of your visual evoked potentials could be adversely affected.

The Composite Video (yellow) connector is used on the LCD checkerboard monitors. This requires that a RCA-to-BNC adapter be used with the standard CRT monitor cable.

The delay value should be set to zero milliseconds for all old-style CRT monitors.

VEP Monitor Type:

This is a text field that allows a descriptive label to be entered for the VEP monitor.

VEP Goggles Flash Duration:

This setting allows the duration of the goggle LED flash to be set at 5 or 10 milliseconds. If you are using normative data from other competitor systems it is suggested that you use a setting of 5 milliseconds.

Sentence Generator Font

Select the default font size and font style that will be used to display the findings sentences within the TabData window.

Choices are:

- 12 pt Times New Roman
- 10 pt Times New Roman
- 12pt Arial
- 10 pt Arial

Height & Weight Units

This section allows the user to choose the units that will be displayed for the patient's **Height** and **Weight**.

Height units:

- Feet and Inches (ft.)
- Centimeters (cm)
- Text (txt) - for backwards compatibility with older patient data or when using different measurement units.

Weight units:

- Pounds (lbs.)
- Kilograms (kg)
- Text (txt) - for backwards compatibility with older patient data or when using different measurement units.

Custom Patient Information Fields

This section allows you to create custom information fields in the **Patient Information Window**. This information will be transferred to your report (you will need to enter items in the report template to include this information). Up to 20 fields can be created and there are 5 types (length) to choose from.

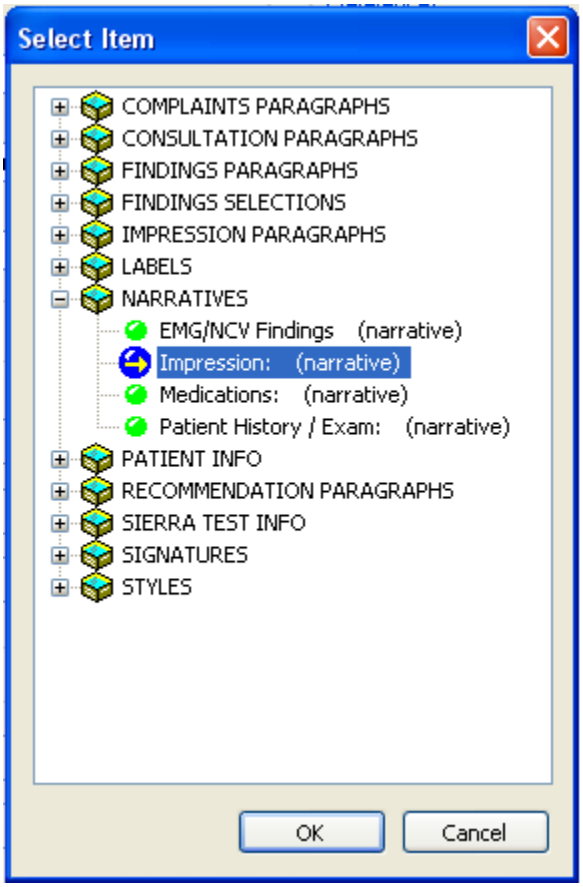
Name:

Enter the name of the Custom Field. To change an existing field name, click on it with the mouse. To enter a new field, click on the blank blue line at the bottom of the list.

Type:

Click here to specify the length of each Custom Field. Choices are **Short** (15 characters max), **Medium** (40 characters max), **Long** (110 characters max), **Paragraph** (unlimited characters), and **Report Item**. A selection of Short, Medium, Long, or Paragraph for a custom field will setup a simple text box in the patient information window.

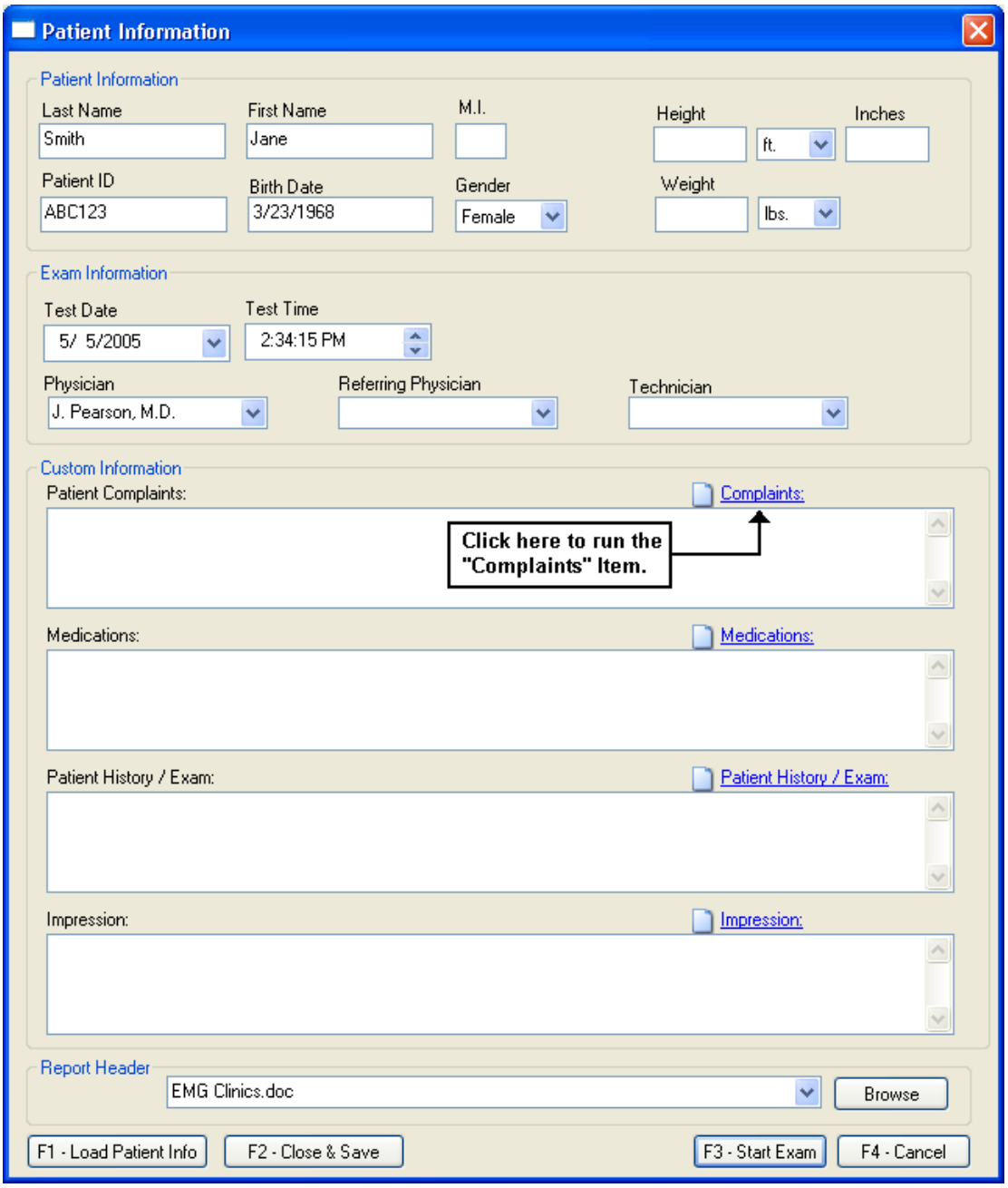
If **Report Item** is selected an additional column will be displayed. This additional column, titled Report Item, allows you to assign a QuickReport Item to this custom field. Simply click within the Report Item column and the **Select Item** window will be displayed. This window displays all the available Narrative, Paragraph, and Select items that are stored within QuickReport's database. Only one report item can be assigned to each custom field.



Select Item window.

Using a Report Item with a Custom Field

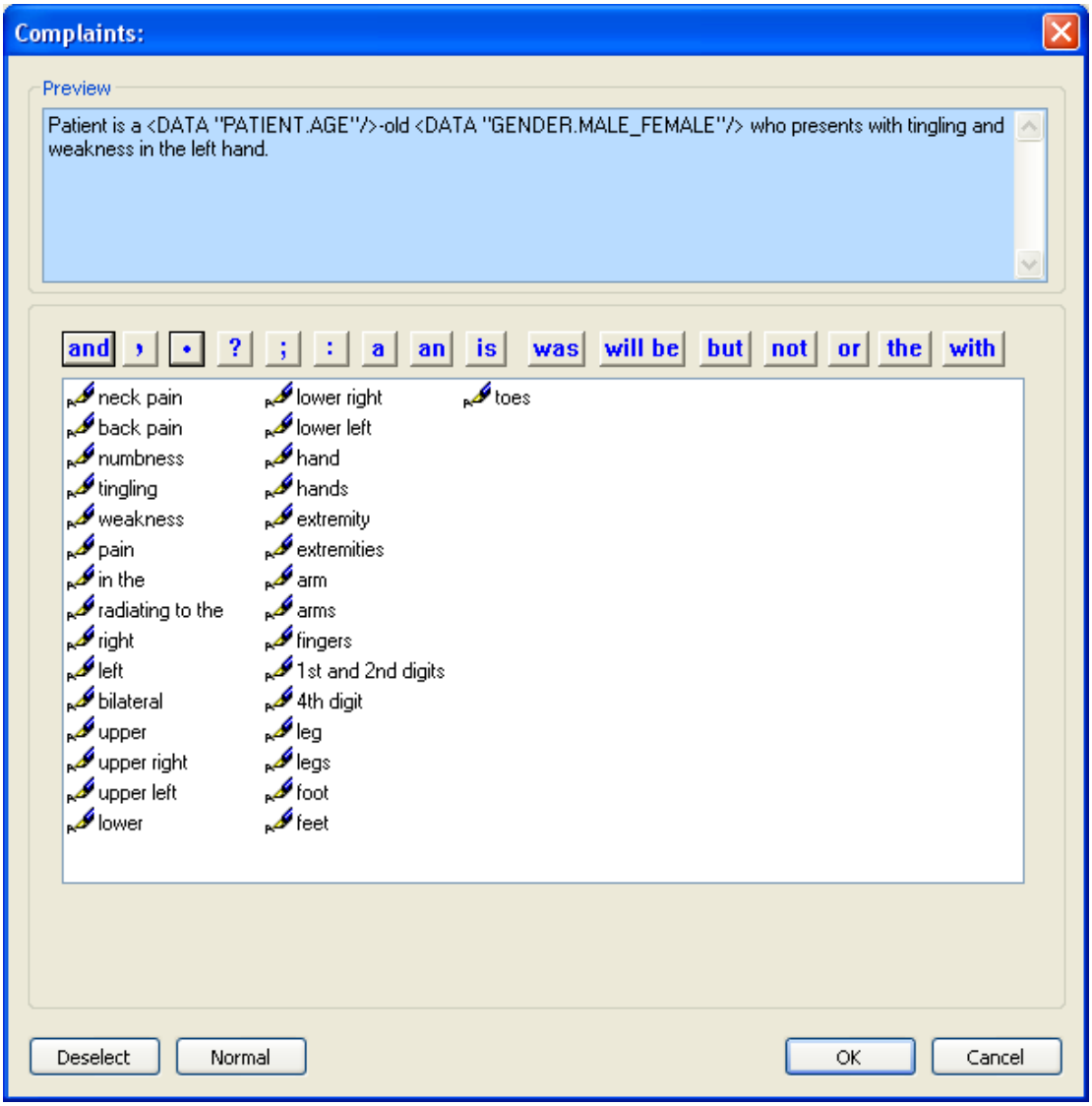
When a report item has been assigned to a custom field, the label of that report item and a small document icon will be displayed above and to the left of the custom field in the patient information window. The user still has the option of simply typing into the custom field, or they can click on the report item's name and process that item. This gives the user the ability to 'pre-process' the report item before starting the report generator.



Patient Information window.

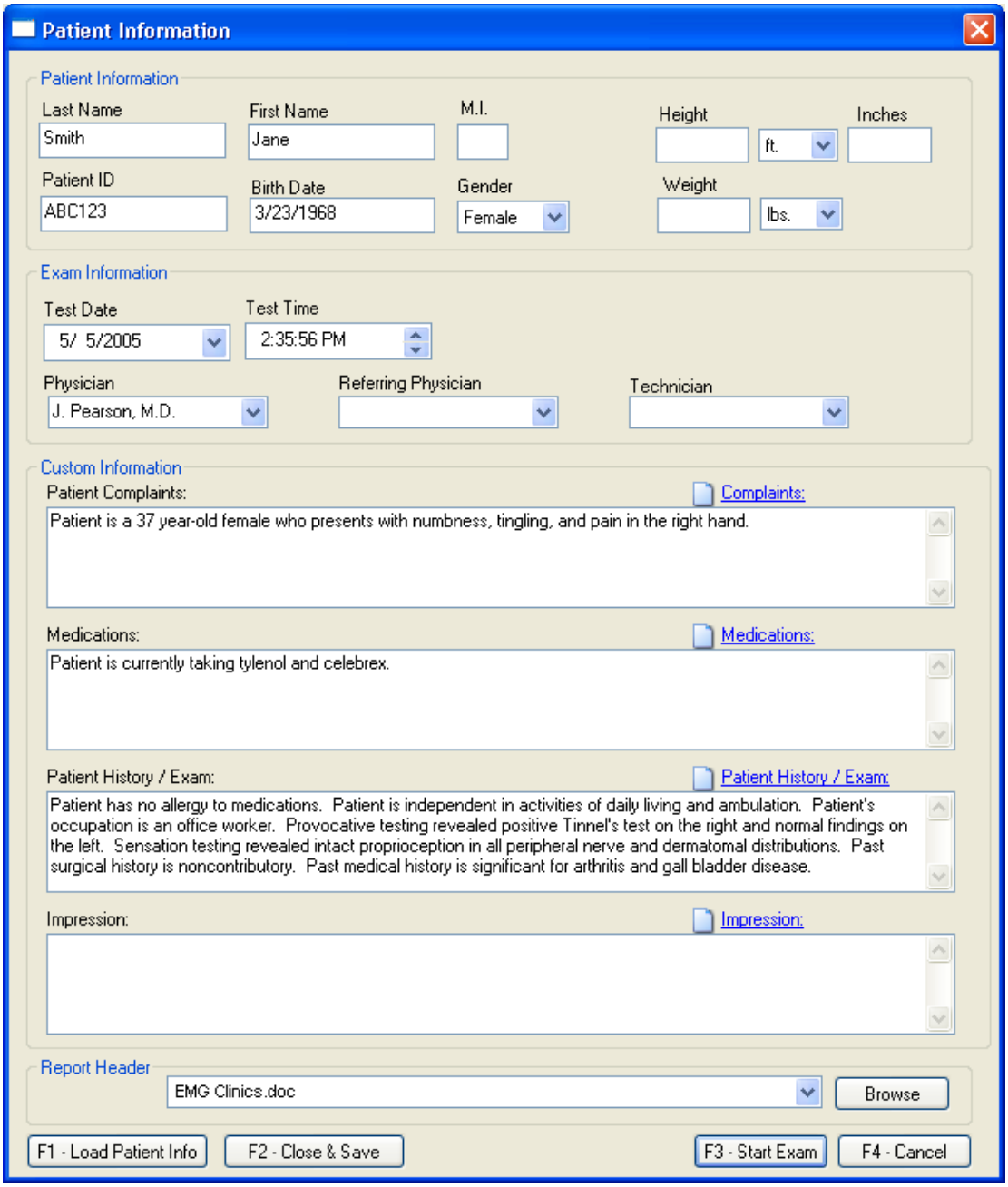
Clicking on the Complaints item 

, in the above example, will pop-up the typical QuickReport window for that item which is shown below.



Chief Complaints report item.

You can complete the report item in the normal fashion and when the OK button is clicked the output of the report item (i.e., the data in the blue preview box) is inserted into the custom field in the patient information window.



Patient Information window with the Patient Complaints, Medications, and Patient History/Exam custom fields completed.

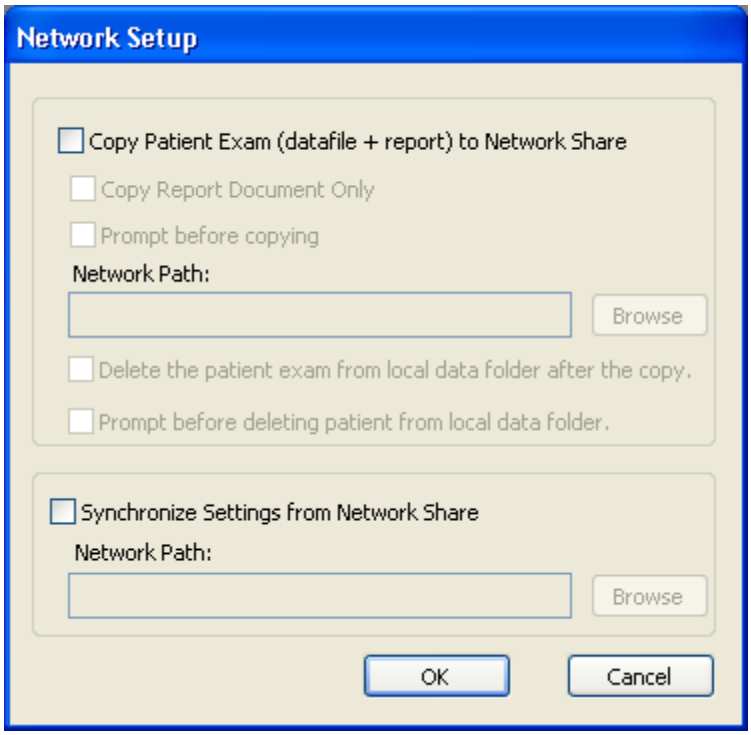
Network Setup Options

Network Setup Window

This window is used to setup automatic copy of the patient's exam to a specified network location and to enable automatic synchronization of test settings when the Sierra Wave program is launched.

- Click on **Edit**.
- Select **Network Setup**.

The **Network Setup** window will be displayed.



There are two sections in the Network Setup window.

Copy Patient Exam to Network Share

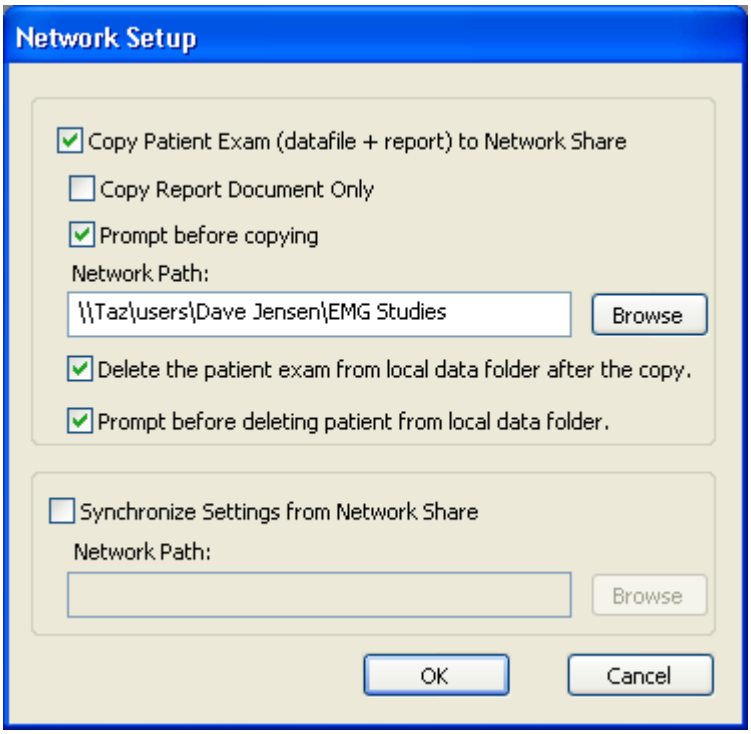
- Options related to copying the patient's exam and/or report document to a network location.

Synchronize Settings from Network Share

- Specify location of the Preserve file that will be loaded when the Sierra Wave program is launched.

Copy Patient Exam

The configuration options in this section allow for the automated copy of the patient's data file and/or report document to a specified location on the local area network at the conclusion of testing.



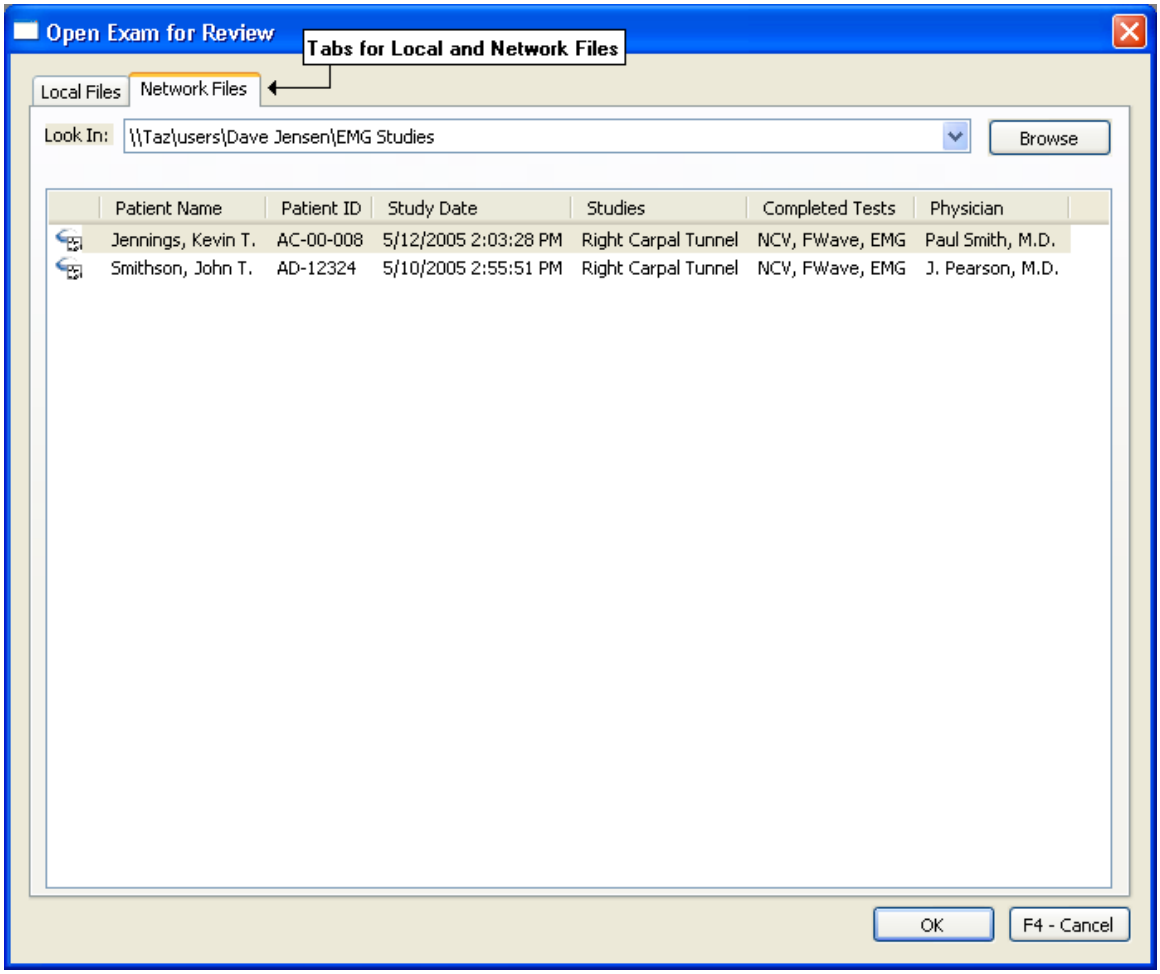
- **Copy Patient Exam (datafile + report) to Network Share** – enables the automatic copy feature. When the patient exam is concluded (e.g., File - Close Exam) the patient's datafile and report document will be copied to the location specified under Network Path.
    - **Copy Patient Report Document Only** – if enabled, only the report document will be copied to the specified location.
    - **Prompt before copying** – enables a message to the user that the program is ready to copy the patient's exam/report to the specified location. Clicking OK will confirm that the exam/report should be copied.
    - **Network Path** – specifies the location on the network where the patient's exam/report will be copied. The user should have "read/write" permissions for this location.
    - **Delete the patient exam from local data folder after the copy** – enabling this option will delete the patient's file from the users local

data folder once it has successfully been copied to the specified location.

- **Prompt before deleting patient from local data folder** – if the previous Delete option is enabled, this option will enable a message to the user that the program is ready to delete the patient from the local hard drive. Clicking OK will confirm that the exam/report should be deleted.

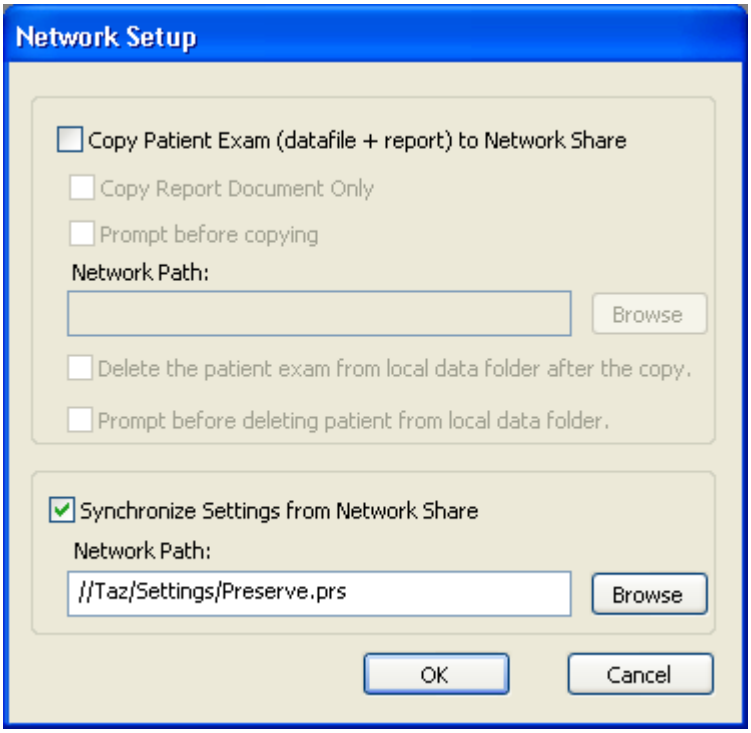
If your Sierra Wave is configured for multiple user accounts, each user can specify a unique network path.

When the **Copy to Network** feature is enabled the **Review/Resume Exam** windows will contain two tabs; **one tab for local files and another for files on the network**.



Synchronize Settings

The configuration options in this section allow for the automatic restore of settings from a specified preserve file when the Sierra Wave program is launched.



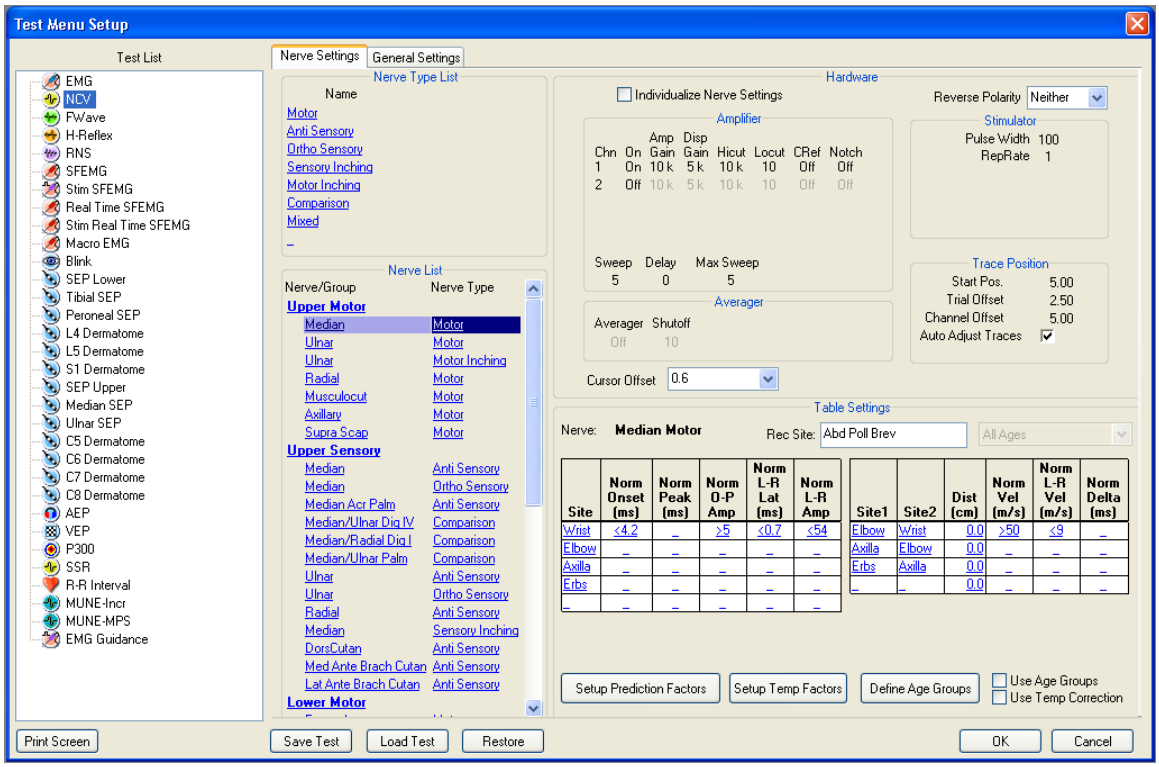
- **Synchronize Settings from Network Share** – enables the automatic synchronization feature. When the Sierra Wave program is launched the preserve file specified in the Network Path will automatically be loaded. If the network path is not available, then the program will utilize the settings that were loaded the last time the network path was available.
    - **Network Path** – specifies the location on the network where the preserve file is located. The user should have "read" permission for this location.

If your Sierra Wave is configured for multiple user accounts, this is a good way to ensure that all users are utilizing the same test settings and report templates.

Test Protocol Setup

Test Menu Setup Window - Overview

From the **Edit** menu, select **Test Menu** to display the **Test Menu Setup** window. From this window you can program all the default parameter settings for every test protocol on the instrument.



The **Test Menu Setup** window is generally divided into two sections, the **Test List** section on the left and the **Settings** section on the right.

Test List Section:

This area lists the currently available test protocols. Color coded icons represent the various test types.

Test Icons:		
Test Type:	Icon:	Description:
EMG		Pink color with blue needle hub.
NCV		Yellow color with CMAP trace.
F Wave		Green color with F Wave trace.

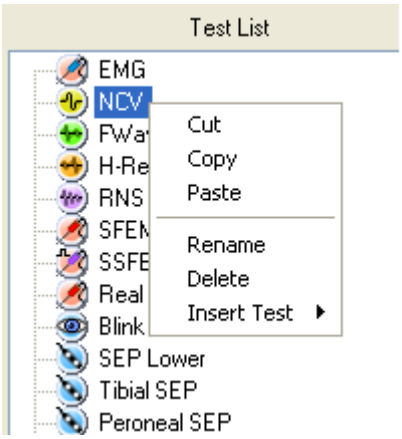
H Reflex		Orange color with H Reflex trace.
RNS		Violet color with RNS decrementing trace.
Blink		Blue colored eye.
SFEMG		Pink color with red needle hub.
SSFEMG (Stim-SFEMG)		Pink color with violet needle hub.
Real Time SFEMG (SFEMG2)		Pink color with red needle hub.
Macro EMG		Pink color with red needle hub.
SEP		Blue with bar electrode.
VEP		Blue with checkerboard pattern.
AEP		Blue with headphones.
P300		Blue with target.
RR Interval		Red Heart.
MUNE (MPS and Incremental)		Blue color with CMAP trace.
EMG Guidance		Pink color with blue needle hub.

To Select a Test Protocol:

Left click on the test with the mouse. The test protocol will be highlighted in blue and that test's parameter settings will be displayed.

The Test List's Right-click menu.

By right-clicking the mouse over a test you can display the right-click menu.



Test List's right-click menu.

Cut, Copy, & Paste.

Select **Cut** to remove the highlighted test protocol from the list. Select **Paste** to place the recently cut or copied test protocol above the currently highlighted test protocol. Select **Copy** to make a copy of the highlighted test protocol.

When Copying & Pasting test protocols the program will automatically change the name of the pasted protocol by placing a "2" after its name. Two test protocols cannot have the same name.

Renaming a test.

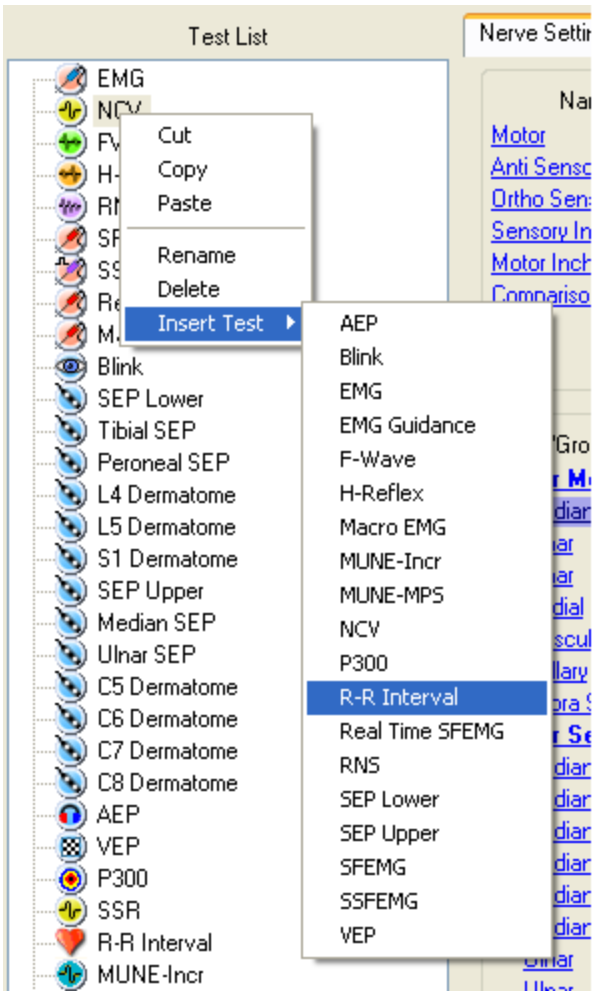
To rename a test protocol, right-click on the test and select **Rename**. Now, type the new name for the protocol and press enter.

Deleting a test.

To remove a test from the test list, right-click on the test and select **Delete**.

Inserting Test.

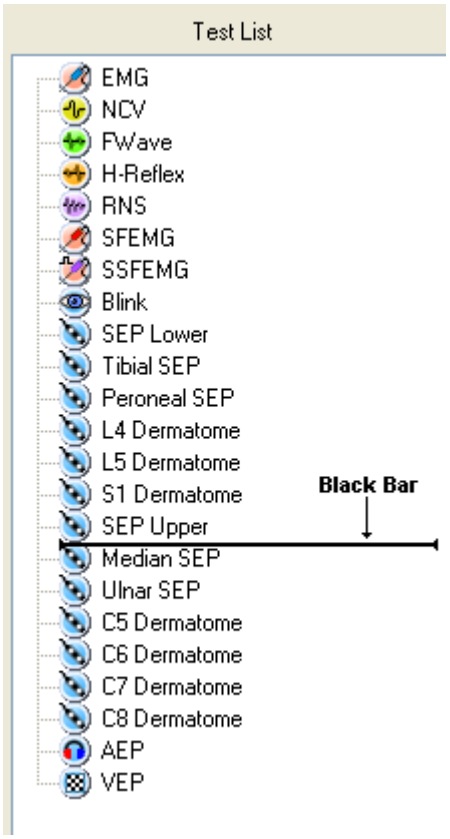
To insert a test protocol into the test list, right click on one of the existing test protocols and select **Insert**. A second menu will be displayed showing the type of tests you can insert. Click on the type of test that you want and it will be inserted above the originally highlighted test protocol.



Insert Test menu.

To Move a test in the list to change the order:

Click on the test you wish to move with the left mouse button. Keep the button pressed down while you move the mouse up or down through the list. You will see a **black bar** moving with the mouse as you move it up or down in the list. When you let go of the left mouse button the test will be moved to the location of the black bar.



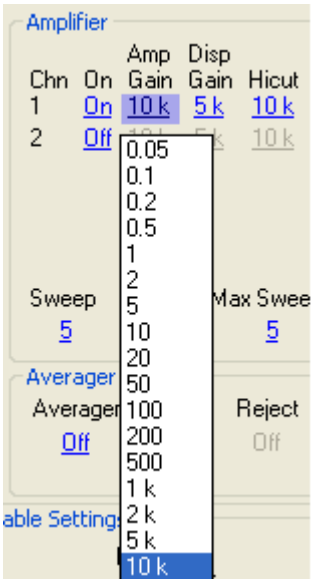
Settings Section:

Blue colored and underlined items can be changed or edited by clicking on them with the left mouse button. Drop down lists can also be changed by clicking on the drop down arrow .

- Clicking on a nerve name, site name, etc., will open a text box. Simply type in the box to change the name, then press Enter.

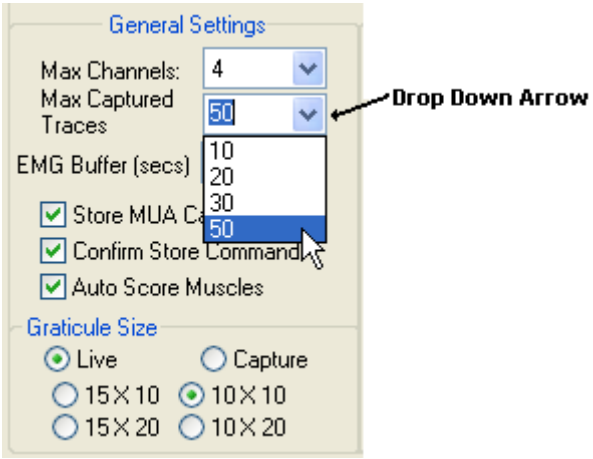
Clicking on the nerve name Median opens text box.

- Clicking on an amplifier setting, like Amp Gain, will display a list of selections. Simply click on the setting that you want.



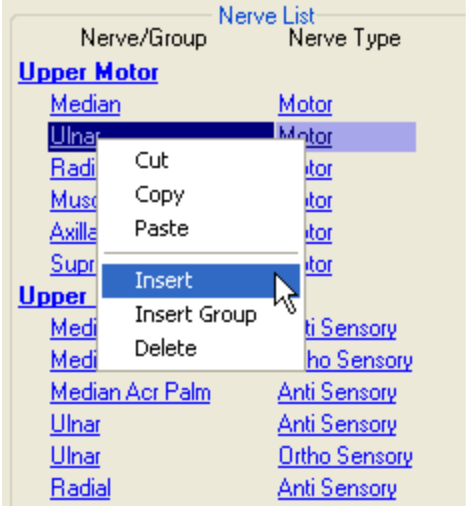
Clicking on Gain value of 5k opens list of values.

- Clicking on a drop down arrow, like Max Captured Traces in the EMG test protocol setup, will display a list of values. Simply click on the value that you want.



Clicking on  opens list of values.

By **right-clicking within a nerve or muscle list** you can Insert a Group Heading, Insert a new nerve or muscle, Delete, Cut, Copy, or Paste.



Right click over Ulnar nerve

The **NCV** test protocol has two tabbed sheets, **Nerve** & **General**. The Nerve tab has settings specific to the nerve type (motor, anti-sensory, etc.) and individual nerves, while the General tab has settings that are 'global' to all nerves.

If the test protocol, muscle, or nerve name is changed, you will need to update all the **Study Lists** that use this test protocol, muscle, or nerve. **Study Lists are not automatically updated.**

Test Setup Window Buttons:

Print Screen

Clicking the **Print Screen** button will send an image of the screen to your default printer.

Save Test

Clicking the **Save Test** button will open the Save Test window. This allows the currently selected test protocol to be saved to a file.

Load Test

Clicking the **Load Test** button will open the Load Test window. Use this feature to load the test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore from that file only the test settings for the currently highlighted test protocol.

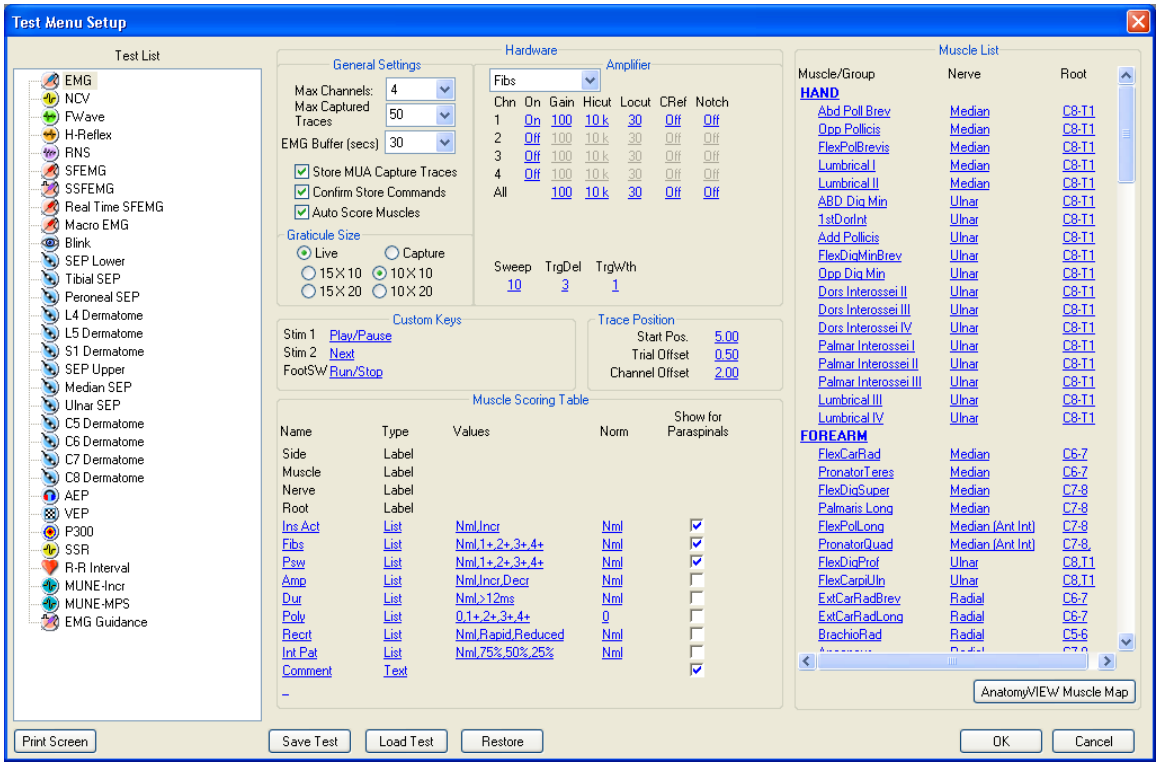
Clicking **OK** will close the Test Setup window and will save any changes that have been made to the test protocol settings.

Clicking **Cancel** will close the Test Setup window and will not save any changes that have been made to the test protocol settings.

EMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **EMG** test protocol in the test list. The EMG test protocol settings will be displayed on the right hand side of the screen.

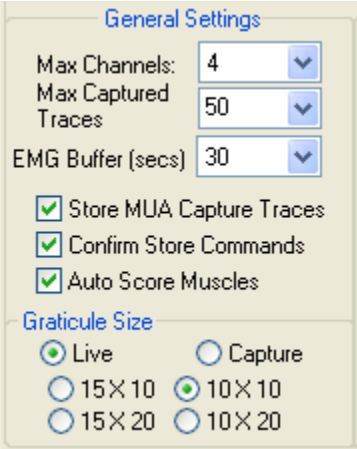
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Trace positioning, Custom Key settings, Muscle Scoring selections, and the Muscle List.



EMG Test Protocol Setup

Hardware Settings

General Settings



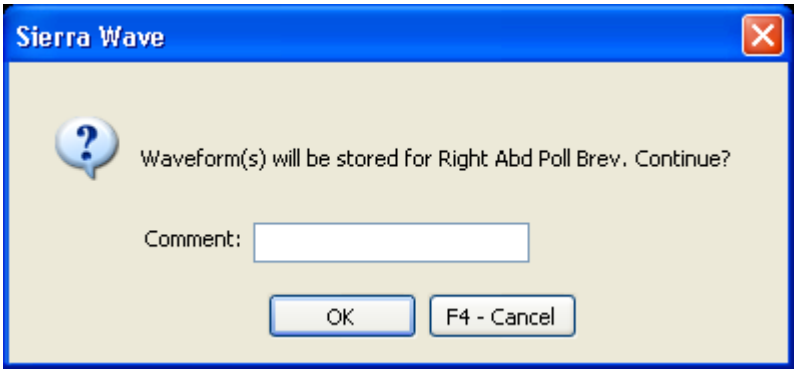
Max Channels: Sets the maximum number of channels that can be turned ON in the test. Choices are 1, 2, 3, or 4.

Max Captured Traces: Sets the maximum number of traces that can be held in the captured trace buffer. Only applies to Capture EMG mode. Choices are 10, 20, 30, or 50.

EMG Buffer (secs): Sets the maximum length of the Live EMG Buffer. Choices are 30, 60, 120, 240, 360, and 600 seconds.

Store MUA Capture Traces: When this box is checked the program will automatically store the individual captured traces as well as the averaged MUP trace when the Store key is pressed. This only applies to SMUA mode.

Confirm Store Commands: When this box is checked the program will display a confirmation window whenever an EMG Snapshot, Live Buffer, or Captured traces are stored. This ensures that the data is stored with the correct muscle name and side.

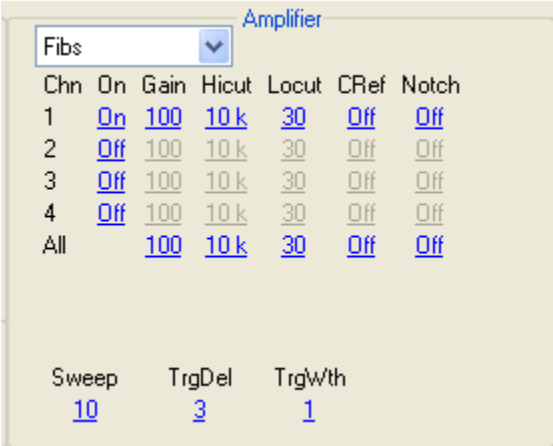


Auto Score Muscles: When this box is checked the program will automatically add all muscles in the Study List to the score table as soon as the EMG protocol is loaded. The muscles will be initially scored as "Normal". If this box is not checked, you will need to manually score the muscles by using the **F2 (Muscle Sel/Score)** knob.

Graticule Size: These selections change the number of Vertical and Horizontal divisions that are displayed in the EMG Trace window. The first number is for the number of vertical divisions and the second number is for the number of

horizontal divisions. Live and Capture EMG modes can be programmed differently.

Amplifier Settings



Fibs: Click on this setting to program the amplifier settings for the Fibs, Recrt, Capture/SMUA, and IPA data acquisition modes. You can program a different Gain and Sweep Speed setting for each mode.

On: Click here to program a channel as either On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

All: Provides a quick method of changing the parameters for all the channels at one time.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

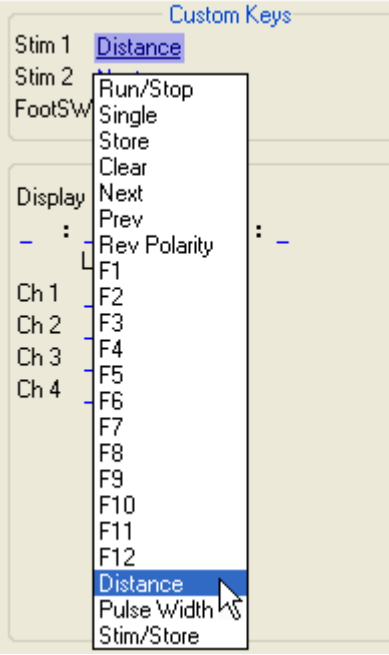
TrgDel: Click here to select the trigger delay point for Captured EMG/SMUA mode. The choices are 1 to 9 divisions in 0.1 increments.

TrgWth: Click here to specify the number of divisions between the dual trigger lines in Capture EMG/SMUA mode. The choices are 0.5, 1, 1.5, 2.0, 2.5, and 3.0 divisions.

Custom Keys

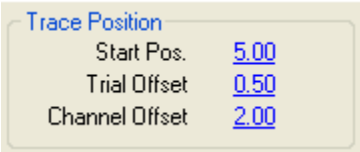
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position Settings



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the trace will be positioned 5 divisions below the top of the window.

Trial Offset: This setting determines where the first stored EMG snapshot is displayed within the trace window and also how much space will separate additional stored snapshots within the same trace window. In this example the setting is 0.5 divisions, therefore the first stored snapshot will be displayed 0.5 divisions below the Live trace. If another snapshot is stored within the same trace window it will be displayed 0.5 divisions below the first stored snapshot and so on.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Live channels.

These settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Muscle Scoring Table

This section is used to setup your muscle scoring column names (i.e., Fibs, Amp, Ins Act), the column type (List or Text), and if applicable the default values (i.e., choices) for the column.

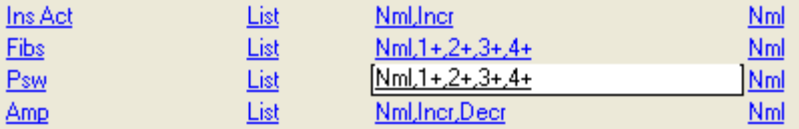
Name column: These entries will be displayed as the column headings across the top of your muscle scoring table. The first four entries **Side**, **Muscle**, **Nerve**, and **Root** are fixed and cannot be altered. The remaining entries are programmable. To change an existing name simply select it by clicking on it with the mouse, then type the new name and press Enter. To enter a new name, click on the blank entry at the bottom of the list, then type the name for the entry and press Enter.

It is a good idea to keep the Name entries as short as possible. This will allow more column headings to be entered and displayed across the report table.

Type column: After entering the name for the scoring column you can specify the column type. Simply click on the type setting and select Label, List, or Text.

- **Label** - simply inserts the column name into the muscle scoring table.

- **Text** - allows free form typing to be entered for that scoring column.
- **List** - allows you to program a list of value choices for that scoring column. Once the List type is selected the Values section will be enabled and you can enter your choices. Simply click on the Values area and type your choices, the choices must be separated by a comma.



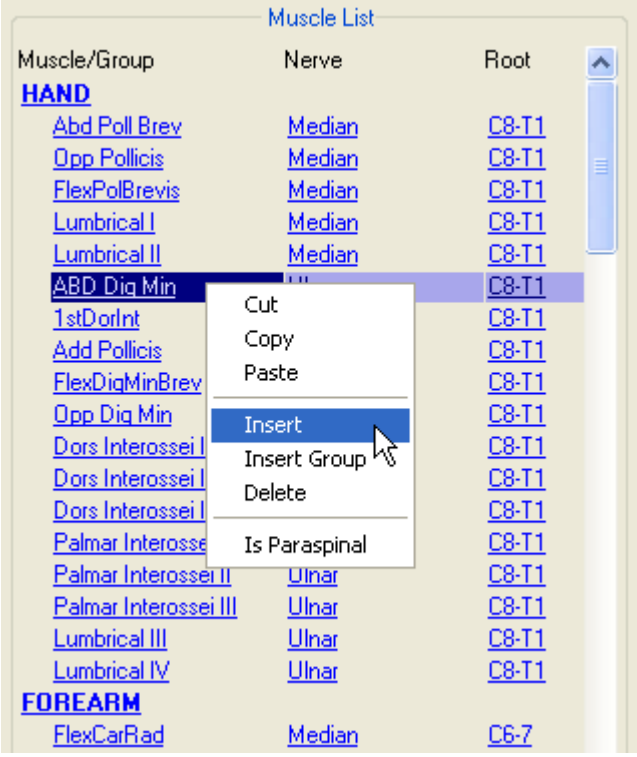
Value choices separated by commas.

Norm column: If the scoring entry is a List, you can preset the value that should be scored when the muscle is normal.

Show for Paraspinals: These check boxes allow you to choose which scoring columns will be enabled for paraspinal muscles.

Muscle List

This section is used to setup your EMG muscle list. The list can contain group headings (i.e., Hand, Forearm), muscle names, nerve names, and root levels.



To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, and root level.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name and root level.

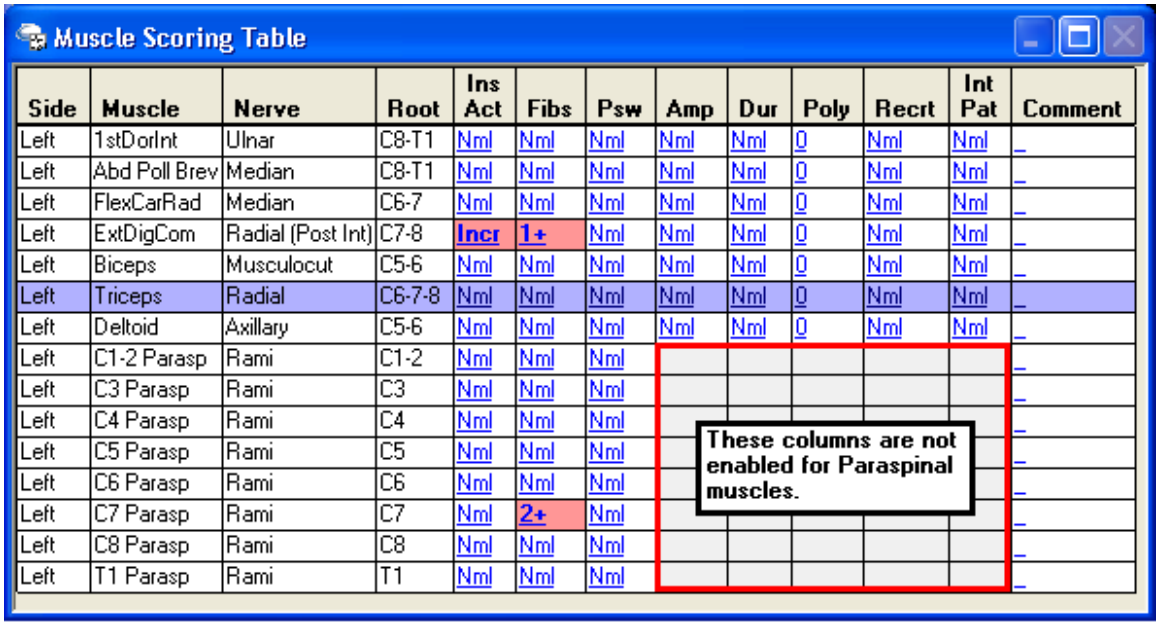
To insert a Group Heading into the list: Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Type the heading name in the muscle/group name field, leave the nerve and root fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle: Click on the muscle name you want to change. Type the new name and press **Enter**.

To change the order of the muscles in the list: Changing the order of the muscle list requires the use of the **Cut & Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list: Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

To designate a muscle as a Paraspinal: Right click on the muscle and select **Is Paraspinal**. Muscles with this designation will appear with an **asterisk** in front of their name. Use the check boxes in the muscle scoring table setup to specify which of the scoring columns will be utilized for these muscle types.



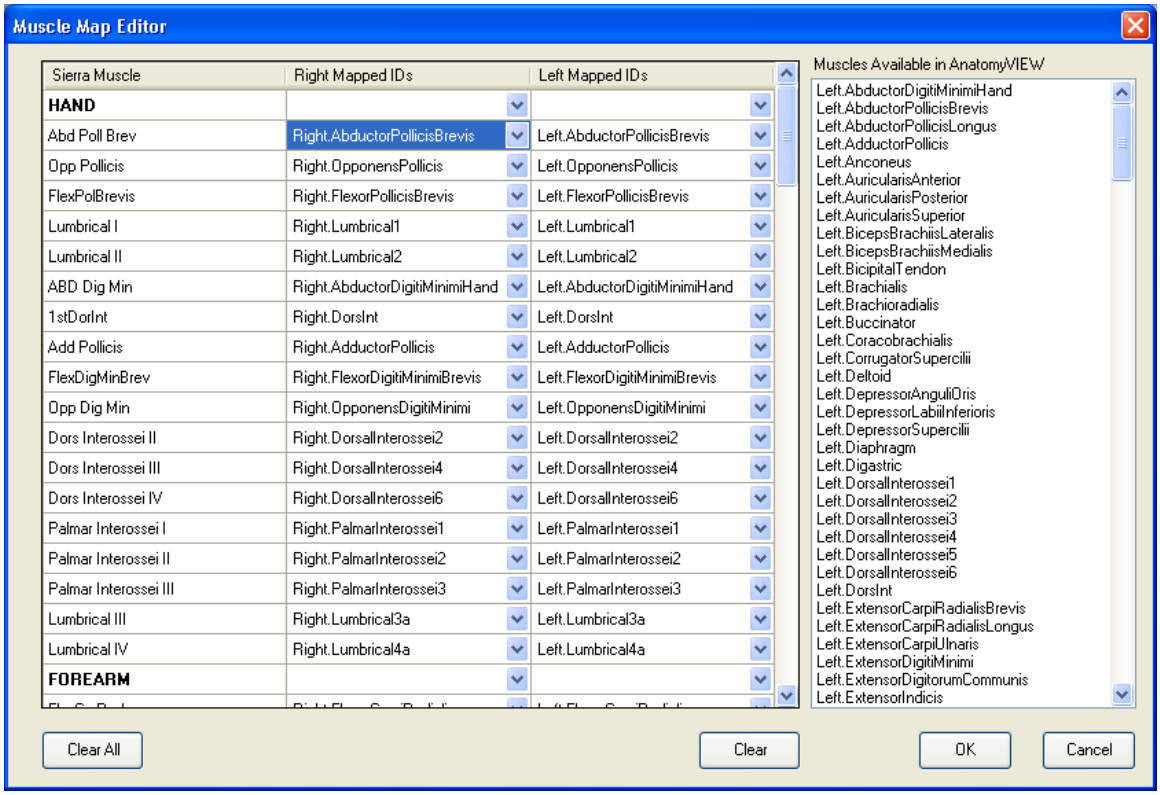
Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Left	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	Abd Poll Brev	Median	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	ExtDigCom	Radial (Post Int)	C7-8	Incr	1+	Nml	Nml	Nml	0	Nml	Nml	
Left	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	
Left	C1-2 Parasp	Rami	C1-2	Nml	Nml	Nml						
Left	C3 Parasp	Rami	C3	Nml	Nml	Nml						
Left	C4 Parasp	Rami	C4	Nml	Nml	Nml						
Left	C5 Parasp	Rami	C5	Nml	Nml	Nml						
Left	C6 Parasp	Rami	C6	Nml	Nml	Nml						
Left	C7 Parasp	Rami	C7	Nml	2+	Nml						
Left	C8 Parasp	Rami	C8	Nml	Nml	Nml						
Left	T1 Parasp	Rami	T1	Nml	Nml	Nml						

AnatomyVIEW Muscle Map

The AnatomyVIEW feature allows the EMG muscle scoring data to be displayed on a 3D color-coded anatomical model.

The Sierra Wave is very flexible in that each user can create and name their own muscles and change the name of factory default muscles. Therefore, the program must be able to match each users name for a muscle to the muscle ID that is recognized by the AnatomyVIEW window. This is done using the **Muscle Map Editor**.

Click on the **AnatomyVIEW Muscle Map button** to open the **Muscle Map Editor** window.



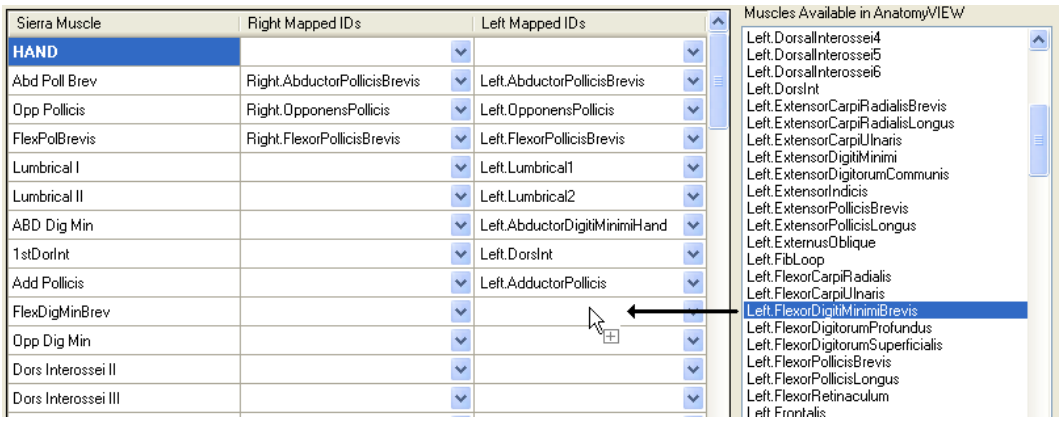
Muscle Map Editor window.

Column Descriptions:

- **Sierra Muscle** - this column shows the user's muscle list, as read from the EMG test protocol setup window.
- **Right Mapped IDs** - this column shows the muscle ID's from the Viewer that have been assigned to this muscle for the Right side.
- **Left Mapped IDs** - this column shows the muscle ID's from the Viewer that have been assigned to this muscle for the Left side.
- **Muscles Available in AnatomyVIEW** - this column lists all the muscle IDs that the Viewer is able to display.

To Map a Viewer Muscle ID to a Muscle:

1. Find the appropriate **muscle ID** in the **Viewer List**.
2. **Left click** on the **muscle ID** and **drag it over** to the appropriate **Right** or **Left Mapped ID** cell.
3. **Release** the mouse button **to drop** the muscle ID into the cell.

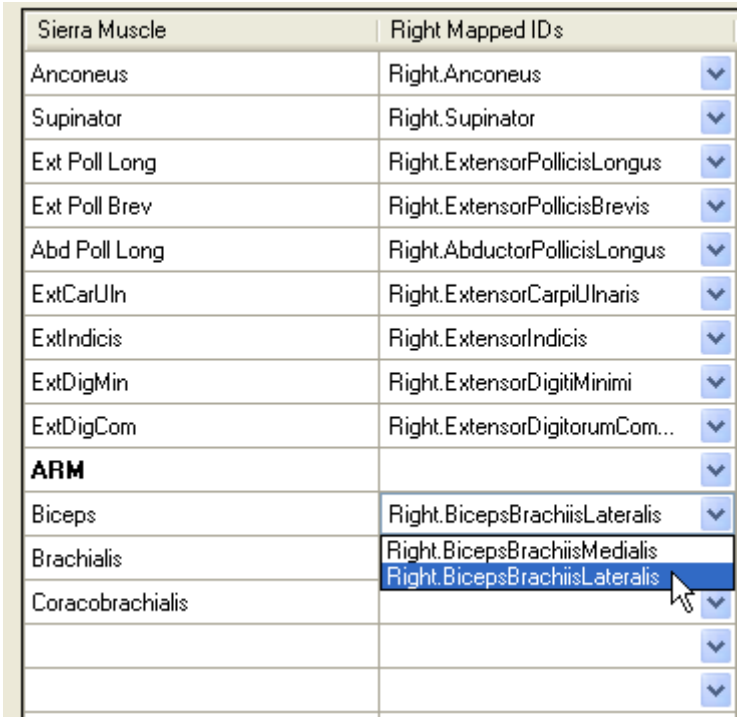


Click and Drag muscle available in Viewer and drop into appropriate user muscle.

To Map Multiple Viewer Muscle IDs to a Muscle:

You may want to map more than one Viewer muscle to a muscle in your muscle list. For example, when you score the Biceps muscle, you may want both the Lateral Biceps and the Medial Biceps to be highlighted in the AnatomyVIEW window. This can be done by mapping multiple viewer muscles to the muscle in your list.

Simply click and drag multiple muscle IDs from the viewer list and drop them onto the muscle. You can click on the drop-down arrow to view all the muscles that have been mapped to your muscle.



The Viewer's Lateral & Medial Biceps have both been mapped to the user's Biceps muscle.

To Clear an Assignment:

1. **Highlight** the appropriate cell by clicking on it with the mouse.
2. Click on the **Clear** button.

To Clear All Assignments:

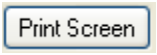
1. Click on the **Clear All** button.

To Save the Assignments:

1. Click on the **OK** button.

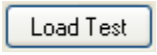
 The muscle mapping data is saved to a file in the user's setup folder. This file is named "MuscleMap.xml" and it is automatically included in the Preserve & Restore functions.

Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

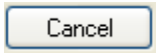
Clicking the **Save Test** button will open the Save Test window. This allows the EMG test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the EMG test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the EMG settings from that file.

Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the EMG test protocol settings.

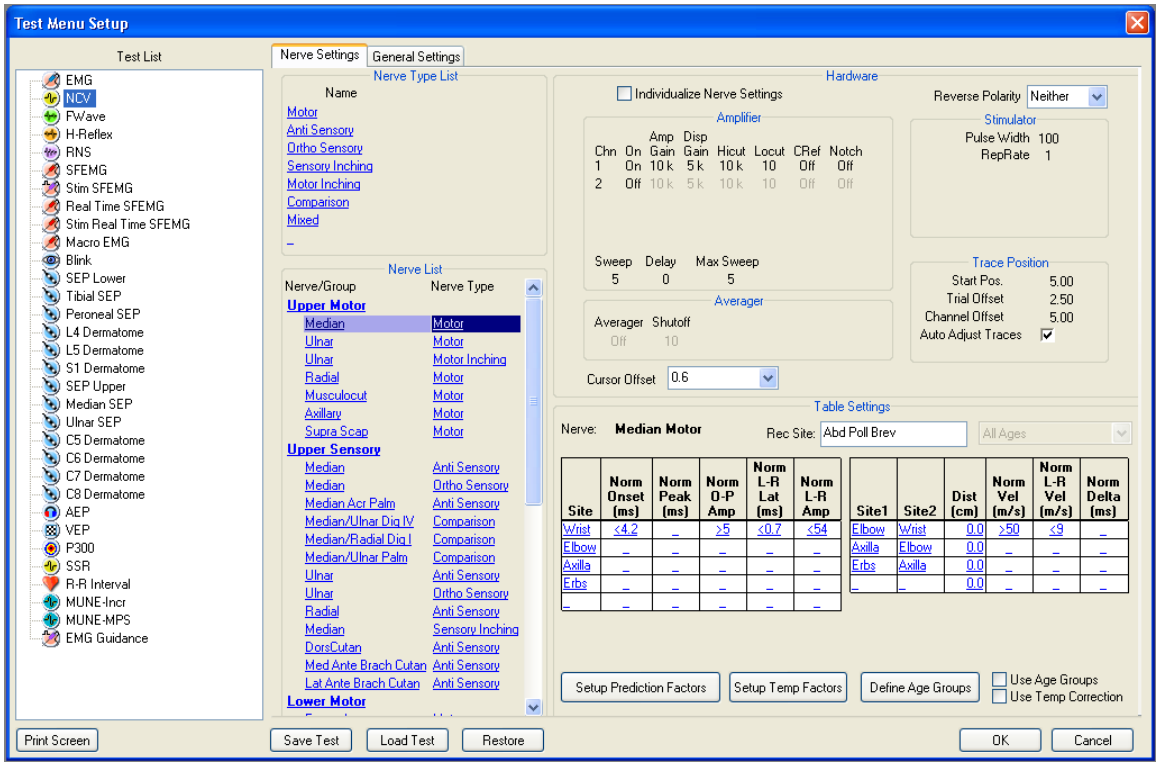


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the EMG test protocol settings.

NCV Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **NCV** test protocol in the test list. The NCV test protocol settings will be displayed on the right hand side of the screen.

NCV settings are divided into two tabbed sheets, the **Nerve Settings** and the **General Settings**.



NCV Test Setup window

Nerve Settings Tab

Nerve Type List

This section is used to specify the types of nerve conduction tests that will be performed. For each nerve type that is defined, you can program the default amplifier, stimulator, averager, trace position, and table settings. Common nerve types are Motor, Anti-Sensory, Ortho-Sensory, and Inching.

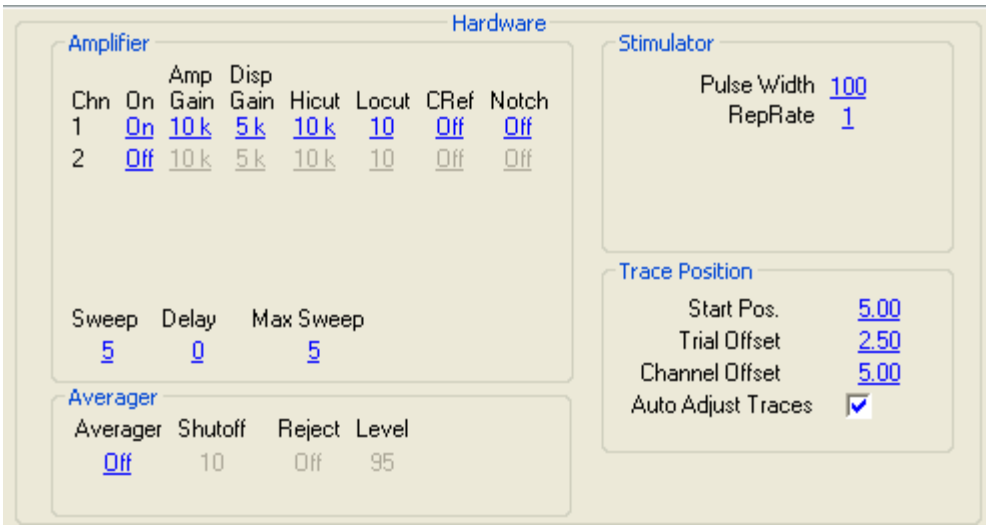
Each nerve type has its own table in the TabData summary window and in printed reports.

To edit the settings of a nerve type, click on the nerve type name. The right side of the window will change to display the settings for that nerve type.

Motor Nerve Type Settings

Nerve Type Hardware Settings (with Motor Nerve Type selected)

This section is used to program the default amplifier, stimulator, averager, and trace position settings for all the nerves of the type that is selected.



Amplifier:

On: Click here to program a channel as either On or Off. NCV supports two or four channel recording mode. To enable four channel recording, go to the General Settings tab.

Amp Gain: Click here to select the default Amplifier Gain setting in microvolts per division (uV/Div).

Disp Gain: Click here to select the default Display Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter. (Not recommended for motor nerves)

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Max Sweep: Click here to select the maximum sweep speed that can be used for the test in milliseconds per division (ms/Div).

Stimulator:

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Averager:

Off/On : Click here to enable or disable the averager. Occasionally sensory nerves require averaging of several responses. This parameter is usually set to OFF and is turned ON as needed during the patient examination.

When turned **ON**, you can then select the following;

Shutoff Count (total number of responses to average).

Reject Status (artifact rejection Off or On).

Reject Level (35 to 100% of amplifier bandwidth).

Trace Position:

Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In the above example, the first trace will be positioned 4 divisions below the top of the window.

Trial Offset: This setting determines how much space will separate each stored NCV trace. In the above example the setting is 2.5 divisions, therefore the second NCV trace will be displayed 2.5 divisions below the first trace. If a third NCV trace is acquired it will be displayed 2.5 divisions below the second NCV trace and so on.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the two Live channels.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the Trace window.

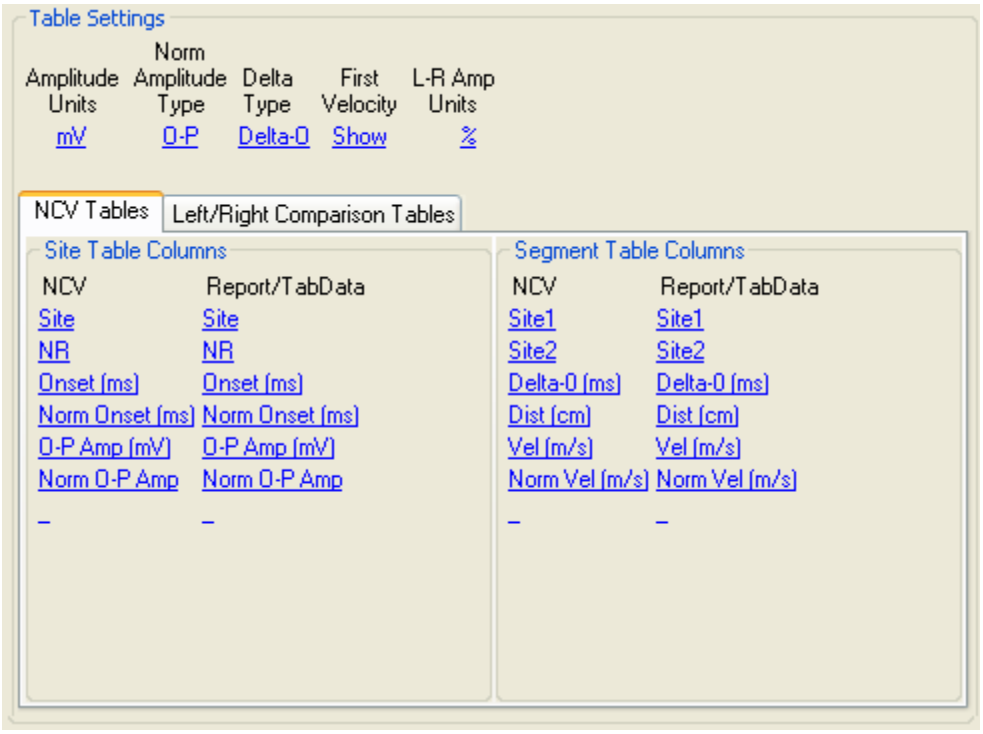
 Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Nerve Type Table Settings

This section is used to program how the measurements for the selected Nerve Type will be displayed.

Selections can be made for both the **NCV Tables** and the **Left/Right Comparison Tables**.

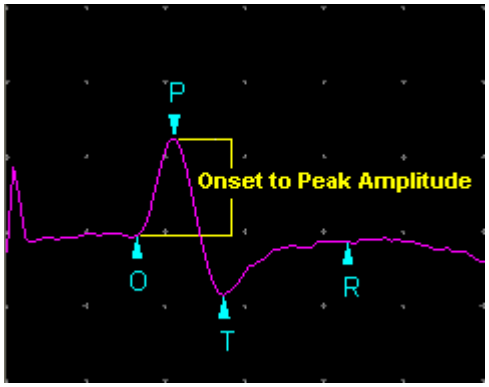
You can program what is displayed during data acquisition (NCV) and what is displayed in the Report/TabData summary window independently. For example, some users like to have normal values displayed during data acquisition but not in reports.

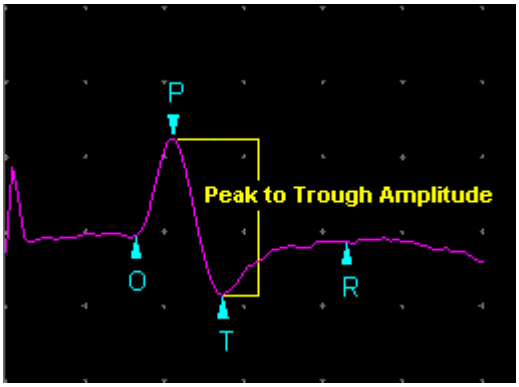


Motor Type - Table Settings

Amplitude Units: Click here to select the amplitude measurement units, either millivolts **(mV)** or microvolts **(uV)**. Motor nerves are generally displayed in millivolts, sensory nerves in microvolts.

Norm Amplitude Type: Click here to select how the normal amplitude value is displayed, either **Onset to Peak** or **Peak to Trough**.





Delta Type: Click here to select how the nerve conduction velocity calculations are determined.

- **Delta-O**, velocity is calculated based on the difference between the onset latencies of the two responses, and when distal onset latency is used for the terminal conduction velocity.
- **Delta-P**, velocity is calculated based on the difference between the peak latencies of the two responses, and when distal peak latency is used for the terminal conduction velocity.

First Velocity: Click here to select whether the first velocity segment should have it's velocity displayed or hidden. Generally this setting is always set to Show, but in some instances users like to put in a distal segment for motor nerves, such as Wrist to APB. This allows them to record the distal distance but hide the conduction velocity.

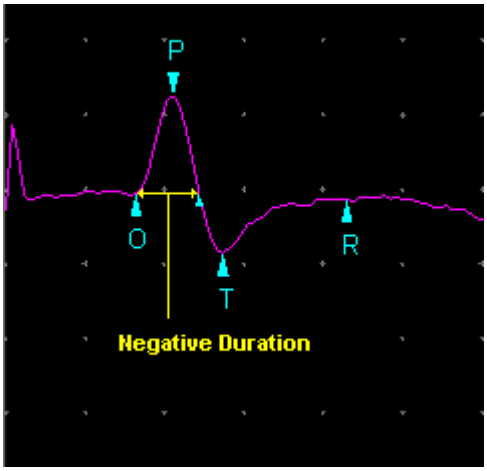
L-R Amp Units: Click here to specify whether the left minus right side amplitude differences are displayed as percentages (%) or absolute amplitude values (uV or mV).

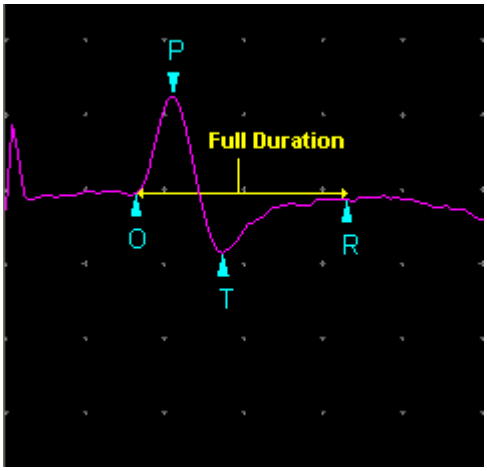
Site Table Columns: Select the site measurement columns that you would like to display on the data acquisition screen (NCV) and in the report (Report/TabData). To include a measurement, click at the bottom of the displayed column list, or within the column list, and then select **Insert** from the pop-up menu. Select the measurement you want to include from the displayed list of choices. To remove a measurement, click on the measurement column in the column list, then select **Delete** from the pop-up menu.

Site Table measurement choices.

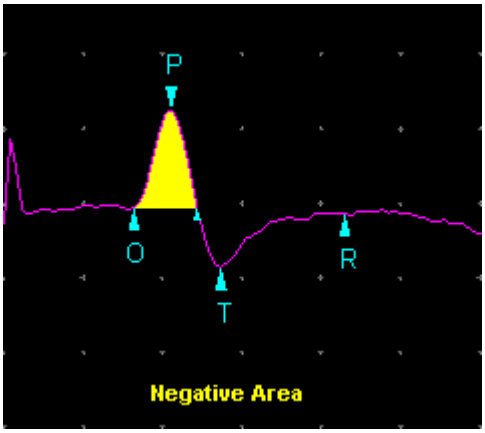
- **Site** - this column displays the stimulus site names, (e.g., Wrist, Elbow, Axilla).
- **NR** - this column is used to indicate a "no response".
- **Onset (ms)** - this column reports the onset latency of the response in milliseconds.
- **Norm Onset (ms)** - this column displays the normal value for the site if one has been entered for the nerve being tested.
- **Peak (ms)** - this column displays the peak latency of the response in milliseconds.
- **Norm Peak (ms)** - this column displays the normal value for the site if one has been entered for the nerve being tested.

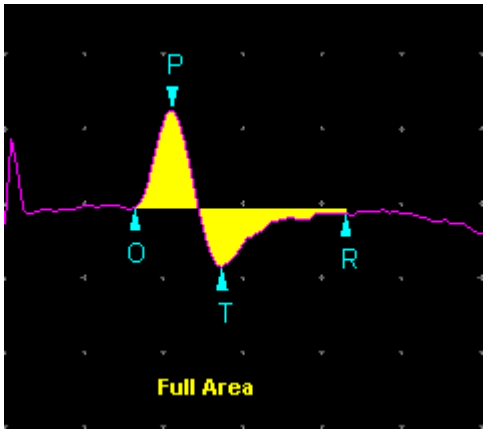
- **O-P or P-T Amp** - this column displays the amplitude of the response as either onset to peak or peak to trough. The type of measurement, **mV** or **uV**, is determined by selecting the **Amplitude Units**.
- **Norm Amp** - this column displays the normal amplitude for the site if one has been entered for the nerve being tested. The label of **O-P** or **P-T** is determined by the **Amplitude Type** setting.
- **Neg Dur (ms)** - this column displays the negative duration of the response in milliseconds.
- **Full Dur (ms)** - this column displays the full duration of the response in milliseconds.





- **Neg Area** - this column displays the negative area of the response in either **mV-ms** or **uV-ms** depending on the setting of the **Amplitude Units**.
- **Full Area** - this column displays the full area of the response in either **mV-ms** or **uV-ms** depending on the setting of the **Amplitude Units**.



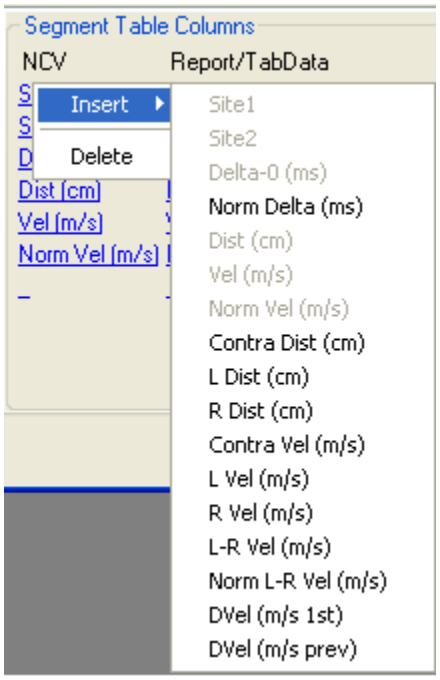


- **Amp% (1st)** - this column shows a site's percent change in amplitude compared to the amplitude of site #1. (Site #1 compared to itself is always 100%)
- **Amp% (Prev)** - this column shows a site's percent change in amplitude compared to the amplitude of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Neg Area% (1st)** - this column shows a site's percent change in negative area compared to the negative area of site #1. (Site#1 compared to itself is always 100%).
- **Neg Area% (Prev)** - this column shows a site's percent change in negative area compared to the negative area of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Full Area% (1st)** - this column shows a site's percent change in full area compared to the full area of site #1. (Site#1 compared to itself is always 100%).
- **Full Area% (Prev)** - this column shows a site's percent change in full area compared to the full area of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Contra Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the contralateral side.
- **L Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the left side of the nerve.
- **R Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the right side of the nerve.
- **L-R Lat (ms)** - this column shows the Left minus Right side difference in the latency values.
- **Norm L-R Lat (ms)** - this column displays the L-R normal latency difference value for the site if one has been entered for the nerve being tested.
- **Contra Amp (uV or mV)** - this column displays the corresponding amplitude values (as either onset to peak or peak to trough) for the contralateral side. The type of measurement, mV or uV, is determined by selecting the Amplitude Units.
- **L Amp (uV or mV)** - this column shows the correspond amplitude values (as either onset to peak or peak to trough) for the left side.

The type of measurement, mV or uV, is determined by selecting the Amplitude Units.

- **R Amp (uV or mV)** - this column shows the correspond amplitude values (as either onset to peak or peak to trough) for the right side. The type of measurement, mV or uV, is determined by selecting the Amplitude Units.
- **L-R Amp (%, uV, or mV)** - this column displays the Left minus Right side difference in amplitude values. The values can be shown as a percentage or as an absolute value.
- **Norm L-R Amp** - this column displays the L-R normal amplitude difference value for the site if one has been entered for the nerve being tested.

Segment Table Columns: Select the segment measurement columns that you would like to display on the data acquisition screen (NCV) and in the report (Report/TabData). To include a measurement, click at the bottom of the displayed column list, or within the column list, and then select **Insert** from the pop-up menu. Select the measurement you want to include from the displayed list of choices. To remove a measurement, click on the measurement column in the column list, then select **Delete** from the pop-up menu.

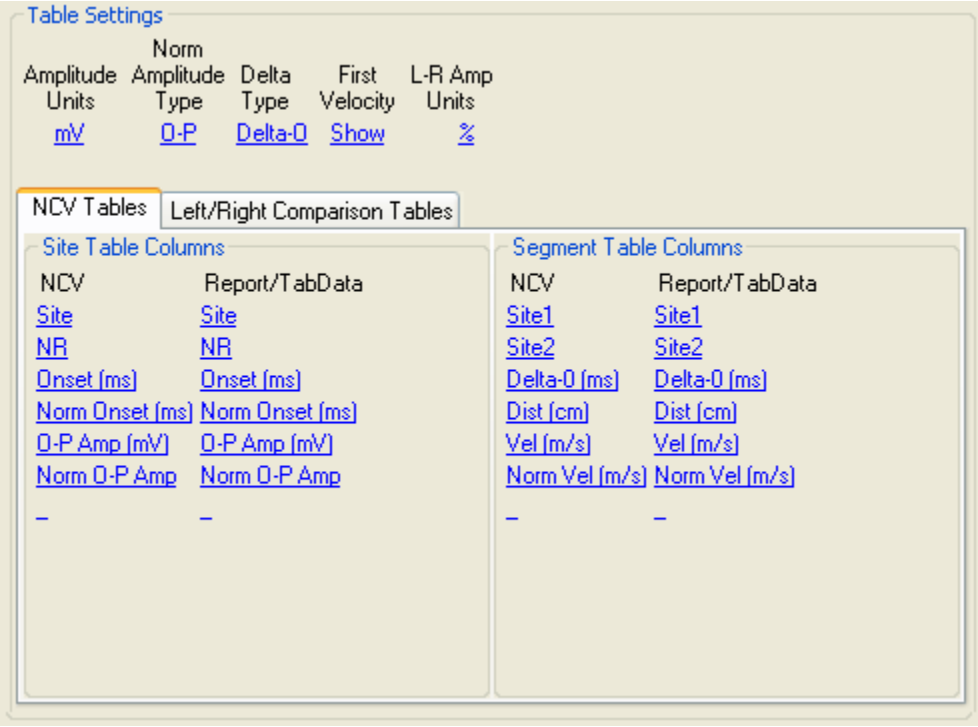


Segment Table measurement choices.

- **Site 1 and Site 2** - this column shows the names of the stimulus sites that make up the segment.
- **Delta-O or Delta-P** - this column shows the difference (in milliseconds) between the response latencies of the two sites composing the segment. The type of measurement is determined by selecting the **Delta Type** (onset or peak).
- **Norm Delta (ms)** - this column displays the segment's normal value for the Delta measurement if one has been entered for the nerve being tested.
- **Distance (cm)** - this column provides a place to enter the distance (in centimeters) between the two stimulus sites, or in some cases the distance between the distal stimulation site and the recording site.
- **Vel (m/s)** - this column displays the calculated conduction velocity in meters per second.
- **Norm Vel (m/s)** - this column displays the normal velocity for the segment if one has been entered for the nerve being tested.
- **Contra Dist (cm)** - the column displays the corresponding distance values for the contralateral side.
- **L Dist (cm)** - this column displays the distance values for segments on the left side.
- **R Dist (cm)** - this column displays the distance values for segments on the right side
- **Contra Vel (m/s)** - this column displays the corresponding velocity values for the contralateral side.
- **L Vel (m/s)** - this column displays the velocity values for segments on the left side.
- **R Vel (m/s)** - this column displays the velocity values for segments on the right side.
- **L-R Vel (m/s)** - this column displays the Left minus Right side difference in velocity values.
- **Norm L-R Vel (m/s)** - this column displays the L-R normal velocity difference value for the segment if one has been entered for the nerve being tested.
- **DVel (m/s 1st)** - this column shows a segment's change in velocity compared to the velocity of the 1st segment. (e.g., Segment 2 compared to Segment 1, Segment 3 compared to Segment 1).

- **DVel (m/s prev)** - this column shows a segment's change in velocity compared to the velocity of the previous segment. (e.g., Segment 2 compared to Segment 1, Segment 3 compared to Segment 2).

Default Selections for the NCV Tables:



Default selections for the NCV Tables.

Default Selections for the Left/Right Comparison Tables:

Default selections for the Left/Right Comparison Tables.

Nerve List

This section is used to setup your NCV nerve list. The list can contain group headings (i.e., Upper Motor, Upper Sensory) and individual nerve names. The Nerve Type column allows the nerve type settings programmed above to be assigned to the nerve.

Nerve List

To Select a Nerve: To select a nerve in the list, click on the nerve name with the left mouse button. Once the nerve is selected its parameter settings, site table, and segment table will be displayed on the right hand side of the screen. See the section below titled **Nerve Table Settings** for information on how to change these settings.

To Insert a new Nerve into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the nerve name, then click in the nerve type field and select the nerve type from the pop-up list.

Within the list - right click the mouse over an existing nerve name. From the pop-up menu select **Insert**. A new row will appear above the nerve you right clicked on. Enter the nerve name, then click in the nerve type field and select the nerve type from the pop-up list.

To insert a Group Heading name into the list: Right click the mouse over an existing nerve name. From the pop-up menu select **Insert Group**. A new row will appear above the nerve that you right clicked on. Enter the heading name in the Nerve/Group name field. Group Headings are automatically shown in bold text:

To change the name of a Nerve: Click on the nerve name you want to change. Type the new name and press **Enter**.

To change the order of the nerve list: Changing the order of the nerve list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the nerve or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the nerve or group heading to go and select **Paste** from the pop-up menu (the nerve

or group heading will be pasted above the row you right clicked upon). Repeat this process for all the nerves or group headings you want to move.

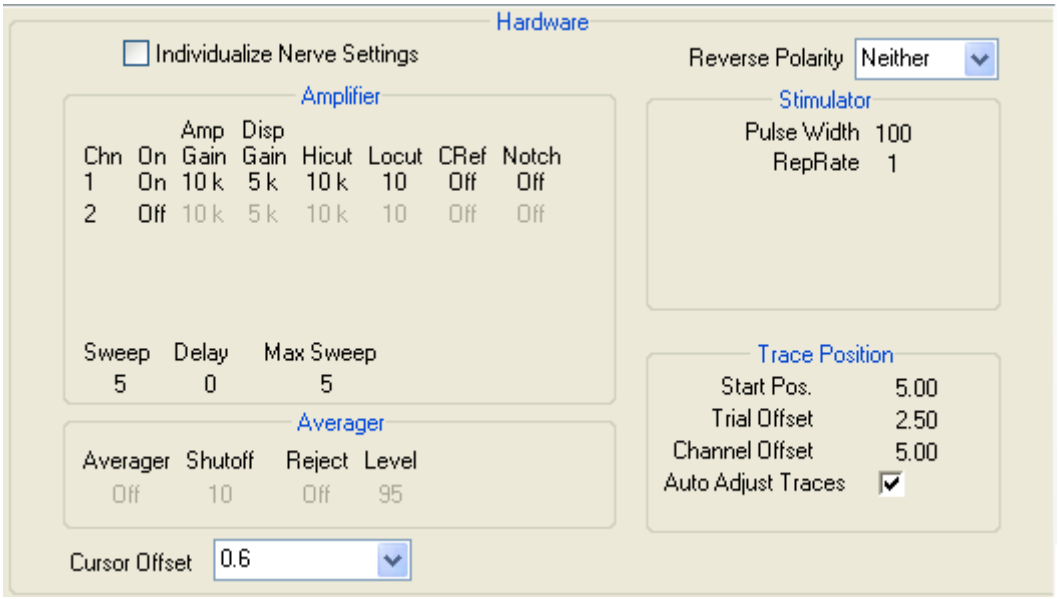
To delete a nerve or group heading from the list: Right click on the nerve or group heading you want to delete, then select **Delete** from the pop-up menu.

Nerve Table Settings

Once a nerve is selected in the nerve list, that nerve's parameter settings, recording and stimulus site names, and segment table will be displayed.

Hardware Parameter Settings:

The nerve's parameter settings will be initialized to the settings that were already programmed for the **Nerve Type** (i.e., motor settings, anti-sensory settings). Normally these will be the desired default settings and will not need to be changed. However, if necessary, the nerve's parameter settings can be programmed different than the nerve type settings. This is done by checking the box labeled **"Individualize Nerve Settings"** at the top of the parameter settings area. Once this box has been checked you can change the default amplifier, stimulator, averager, and trace position settings.



Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

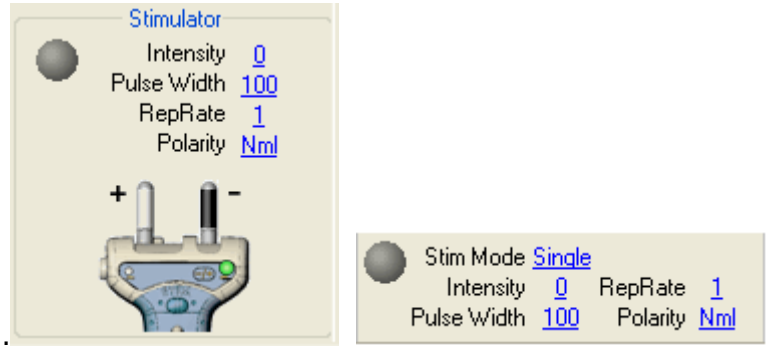
- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested.

In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.

- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For NCV Studies, the **Cathode (-) should be positioned closest to the recording electrodes.**

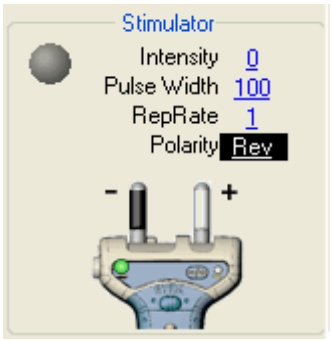
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

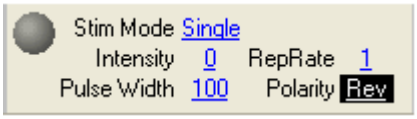


Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.





Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Site and Segment Table Settings:

This section is used to program the recording site name, stimulus site names, normal values, and segments for velocity calculations. The two tables in this section are commonly referred to as the **Site** and **Segment** tables.

Nerve: **Median Motor** Rec Site: Abd Poll Brev

Site	Norm Onset (ms)	Norm Peak (ms)	Norm O-P Amp	Norm L-R Lat (ms)	Norm L-R Amp
Wrist	<4.2	_	>5	<0.7	<54
Elbow	_	_	_	_	_
Axilla	_	_	_	_	_
Erbs	_	_	_	_	_
_	_	_	_	_	_

Site Table

Site1	Site2	Dist (cm)	Norm Vel (m/s)	Norm L-R Vel (m/s)	Norm Delta (ms)
Elbow	Wrist	0.0	>50	<9	_
Axilla	Elbow	0.0	_	_	_
Erbs	Axilla	0.0	_	_	_
_	_	0.0	_	_	_

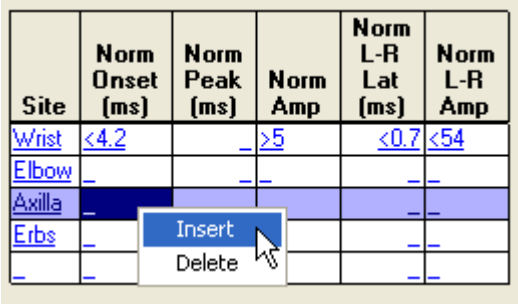
Segment Table

To enter the Recording Site name: Click in the **Rec Site** box, type the recording site name and press Enter.

To enter Stimulating Site names:

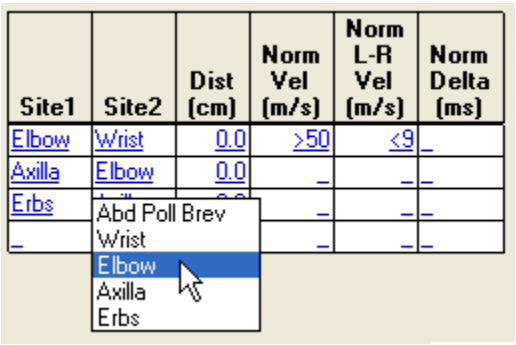
- **For a new nerve** - the first row of the Site Table will be blank, simply click in the Site box then type the stimulus site name and press Enter. A second row will automatically be displayed. Continue entering site names until complete.
- **For an existing nerve** - right click the mouse on an existing site name, a pop up menu will be displayed. Select Insert from this menu and a new row will be inserted above the site name that you originally right clicked

on. Now, click in the site name box and type the name for the stimulus site.



Right click on an existing site to insert a new row.

To build Segments for conduction velocities: After the stimulus site names have been entered you can build conduction velocity segments in the segment table. Click within the Site 1 box and select the site name from the pop-up menu. Then, click within the Site 2 box, on the same row, and select the other site name from the pop-up menu. For example, selecting Elbow for the first site and Wrist for the second site will allow a conduction velocity to be calculated for the Elbow to Wrist segment.



Building a conduction velocity segment.

To Enter Normal Values: There are three methods for entering normal values; **Simple Value Limit, Simple Value Limit by Age Group,** or **Prediction Equation**.

- **Method #1 - Simple Value Limit:**

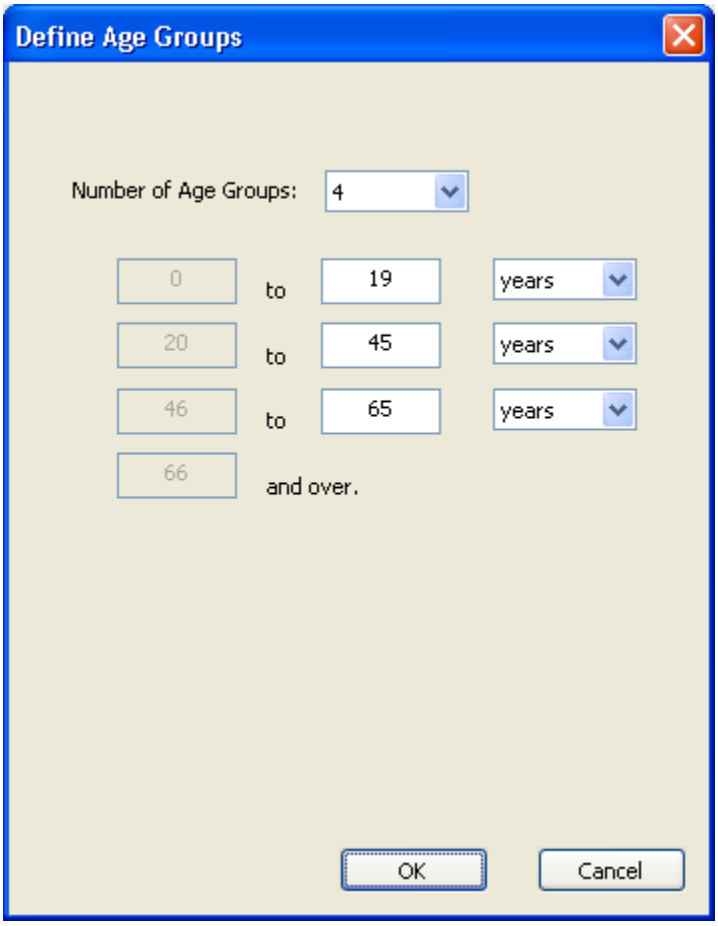
  Click in the normal value field and type the desired value for the upper or lower limit, then press Enter. You can use symbols such as > (greater than) or < (less than) if you like.

- **Method #2 - Simple Value Limit by Age Group:**

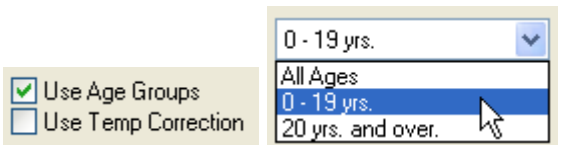
  Up to 8 Age Groups can be defined and normal values can be entered for each group. The Sierra Wave program will compute the patient's age based on their date-of-birth and then use the appropriate age group norms.

  To define the Age Groups:

  1. Click on the **Define Age Groups** button.



  2. Select the **number** of Age Groups, the maximum is 8.
  3. Fill in the **upper age limit** for each group, select **years** or **months**, and click **OK**.
  4. **Select a Nerve** from the nerve list.
  5. Check the **Use Age Groups** box. This will enable the **age groups drop-down list**.

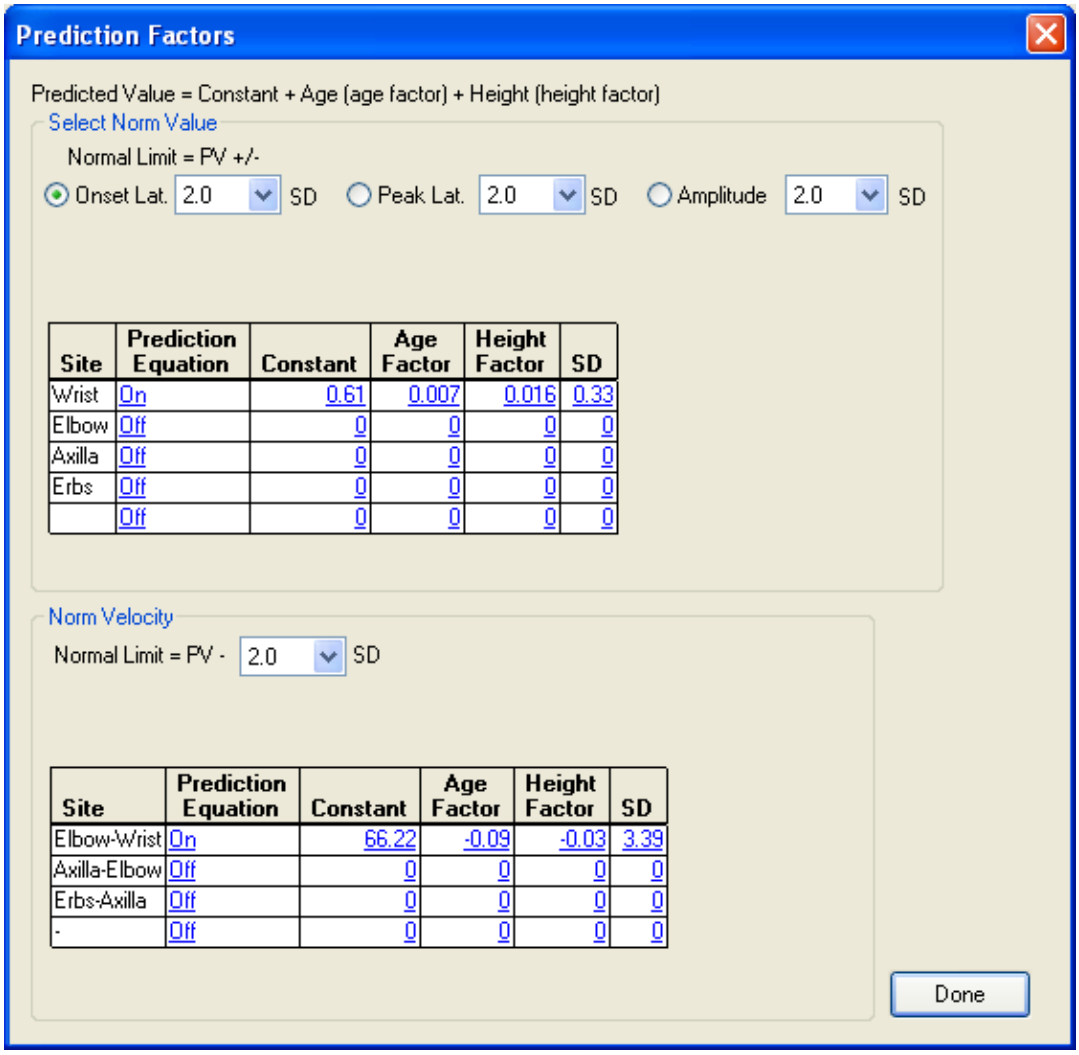


6. Enter the normal values for this age group into the **Site** and **Segment** tables. Repeat for each age group in the drop-down list.
7. Select another nerve in the nerve list, repeat steps 5 and 6.

If the patient's **date-of-birth is not entered** into the patient information window, the program will use the normal values entered for the **All Ages** group.

- **Method #3 - Prediction Equation:**

  Normal values can be predicted using the patient's **Age** and **Height**. Click on the **Prediction Equation button**, a window will be displayed which allows you to input the factors for Age, Height, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. The equation can be used to predict Onset latency, Peak latency, Amplitude, and Velocity. If the equation is enabled, the normal value in the Site or Segment table is replaced with the letters "**PV**", for predicted value. This signifies that the normal value is not a simple value limit but will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height** have been input in the Patient Information window.



Prediction Equation setup window.

The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

If the standard deviation is known then:

Normal Value = Predicted Value +/- 'x' Standard Deviations

Typically:

Latency Norm = Predicted Value + 2 SD

Amplitude Norm = Predicted Value – 2 SD

Velocity Norm = Predicted Value – 2 SD

To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0** or **>0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal values will be displayed.

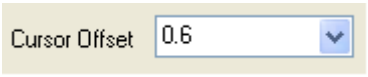
When the prediction equation is enabled you cannot input a simple value limit for the norm.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

To Enter a Distance: Sometimes a fixed distance is always used for a nerve segment. To program a distance simply click in the appropriate distance field and type the value. The Sierra Wave always uses distances in **Centimeters**. There is no need to type "cm" in the box.

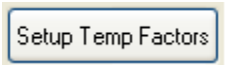
To Delete a Site or Segment: Right click the mouse over the row you want to delete and select Delete from the pop-up menu.

Cursor Offset: This parameter determines the starting point (in milliseconds) for the auto-cursor algorithm. Data prior to this setting is ignored by the algorithm.

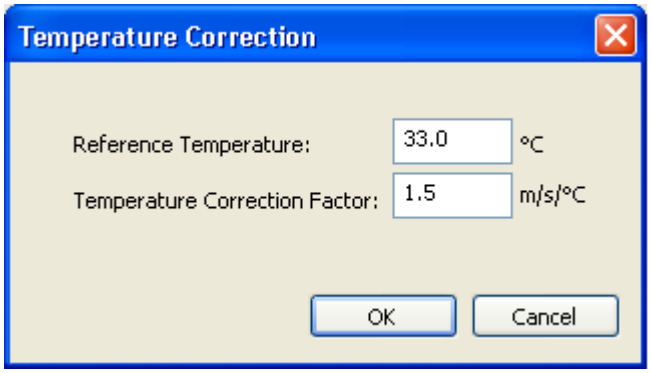


To use Temperature Corrected Velocity:

1. Click on the **Setup Temp Factors** button.



2. Enter the **Reference Temperature** (in °C), and the **Correction Factor** (meters/sec per °C) for the selected nerve.



3. Click **OK**.
4. Check the box **"Use Temp Correction"**.

If the patient's measured temperature is below the reference temperature -- for every degree that is below the reference temperature the program will add the correction factor to the displayed velocity value. This will be indicated by the letter "T" after the velocity value.

Using the above reference temperature and correction factor:

If the patient's temperature was measured at 30°C, the program would add 4.5 (1.5 x 3) to the velocity value.

5. Repeat steps 1 to 4 for other nerves in the nerve list.
6. Click **OK** to close the Test Menu window and save your changes to the Nerve's settings.

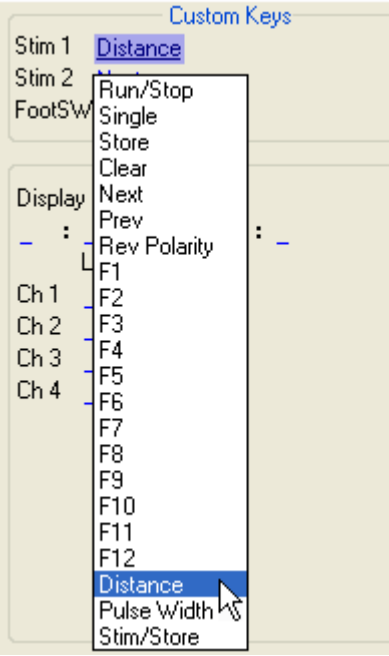
General Settings Tab

The parameter settings within this section are applied to all nerves within the nerve list.

Custom Keys:

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

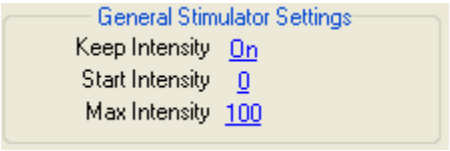
Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

General Stimulator Settings:

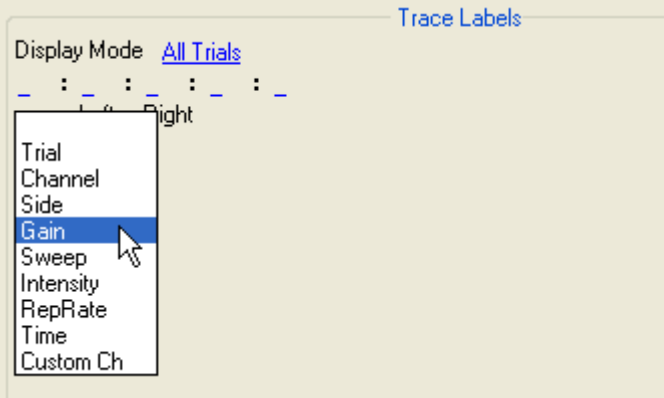
This section has settings that affect the electrical stimulator intensity.



- **Keep Intensity On/Off** - when set to **On**, the stimulus intensity will not be reset to zero milliamps when changing from one nerve to the next. The intensity will remain at what was used last. When this parameter is set to **Off**, the stimulus intensity will always be reset to zero milliamps when changing from one nerve to the next.
- **Start Intensity** - sets the initial starting stimulus intensity for the first nerve to be selected. Possible selections are 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.
- **Max Intensity** - sets the maximum intensity level in milliamps. Possible selections are 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.

Trace Labels:

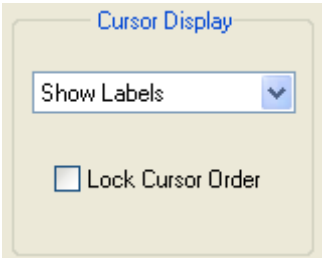
By default, all NCV traces are automatically displayed with the Site name for a trace label (e.g., Wrist, Elbow). These settings can be used to add other information to the trace label.



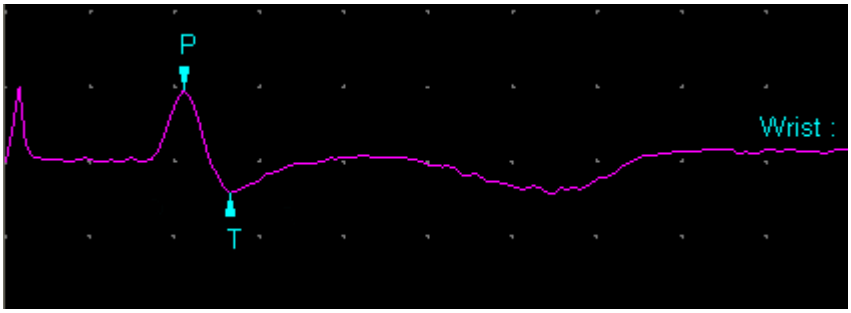
There are five additional fields that can be added to the trace label. Simply click in the first blank field and make a selection from the pop-up list. The above example shows how to add the Gain setting to the trace label.

Cursor Display:

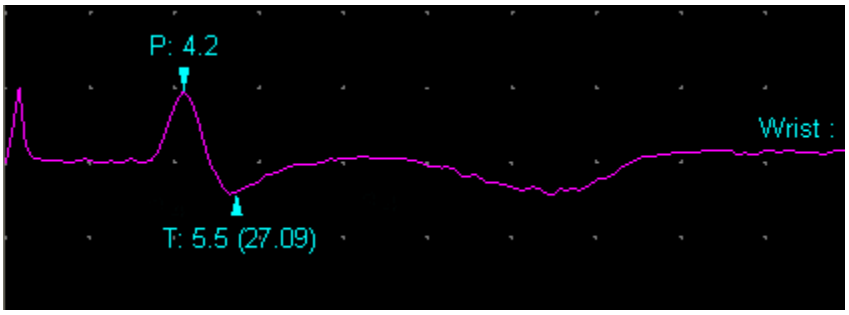
There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.



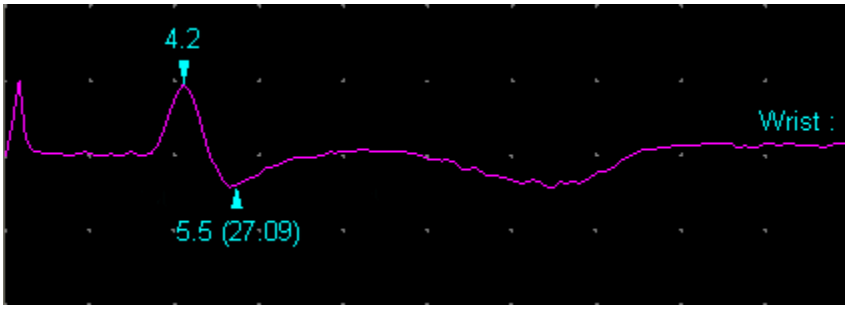
- **Show Labels** - shows the labels **O** (onset), **P** (peak), **T** (trough), and **R** (recovery).



- **Labels and Values** - shows the labels mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.

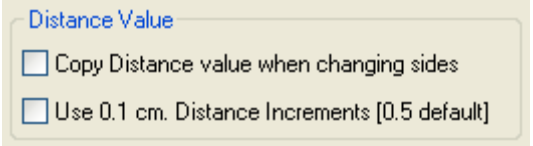


Lock Cursor Order:

Check this box to 'lock' the cursor order. This will prevent the user from being able to move the Onset cursor past the Peak cursor, the Peak past the Trough, and so on.

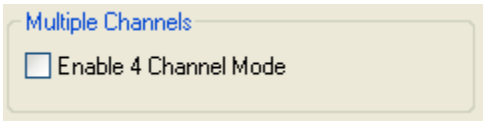
Distance Value:

- **Copy Distance value when changing sides** - enabling this feature causes the program to automatically copy all segment distances entered for one side of a nerve to the opposite side when it is selected for testing.
- **Use 0.1 cm Distance Increments** - enabling this feature causes the wheel on the stimulator handle to increment the distance value in 0.1 cm increments rather than 0.5 cm increments.



Multiple Channels:

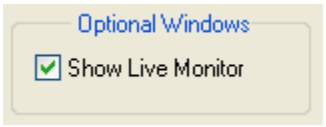
Enabling this feature allows channels 3 & 4 to be used in the NCV test protocol.



Optional Windows:

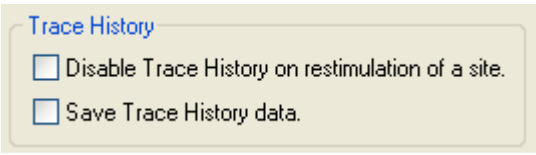
- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.



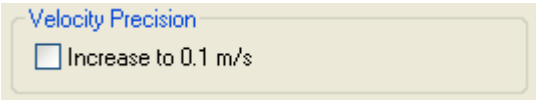
Trace History:

- **Disable Trace History on restimulation of a site -** when this box is checked the Trace History window will be suppressed (hidden) during restimulation of a site.
- **Save Trace History data** - when this box is checked the program will store all Trace History data in the patient's record.

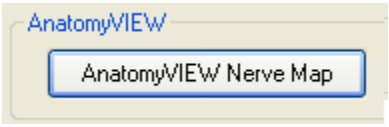


Velocity Precision:

Enabling this feature will cause all velocity values to be displayed with one decimal place.



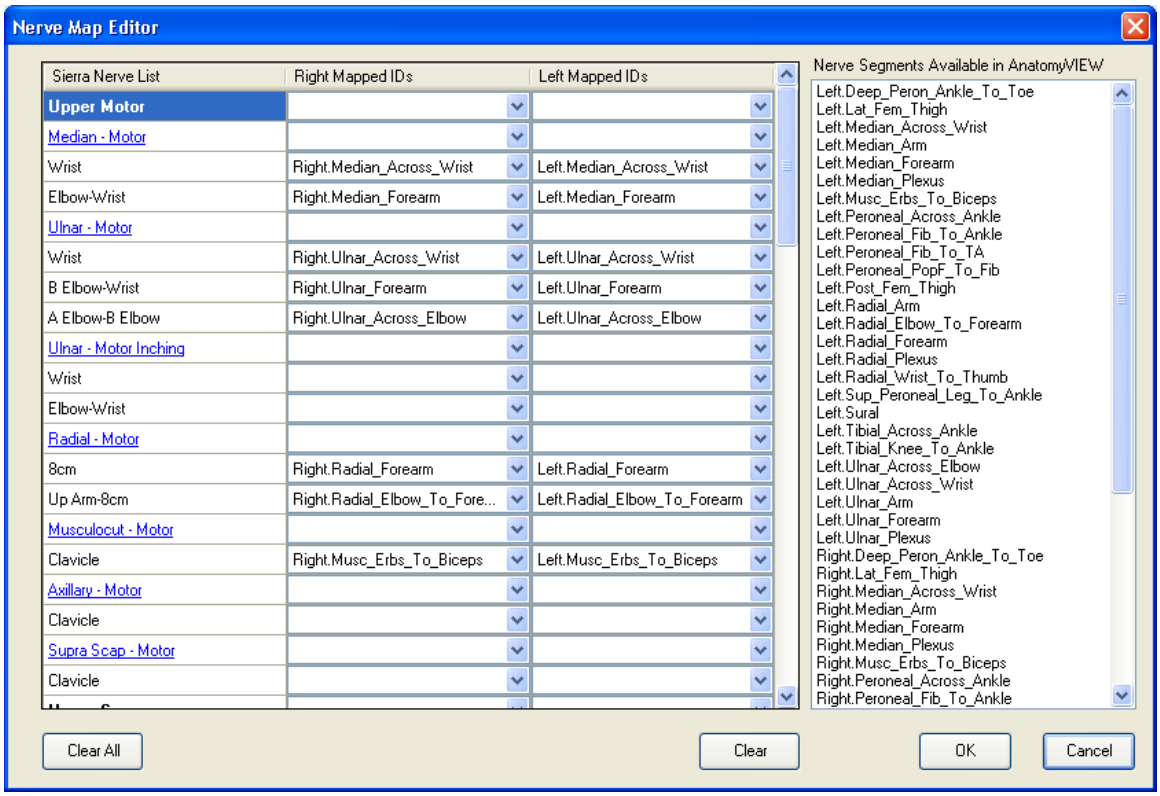
AnatomyView Nerve Map:



The AnatomyVIEW feature allows the NCV nerve segment data to be displayed on a 3D color-coded anatomical model.

The Sierra Wave is very flexible in that each user can create and name their own nerves, sites, and segments; and change the name of factory default nerves. Therefore, the program must be able to match each users name for a nerve segment to the nerve segment ID that is recognized by the AnatomyVIEW window. This is done using the **Nerve Map Editor**.

Click on the **AnatomyVIEW Nerve Map button** to open the **Nerve Map Editor** window.



Nerve Map Editor window.

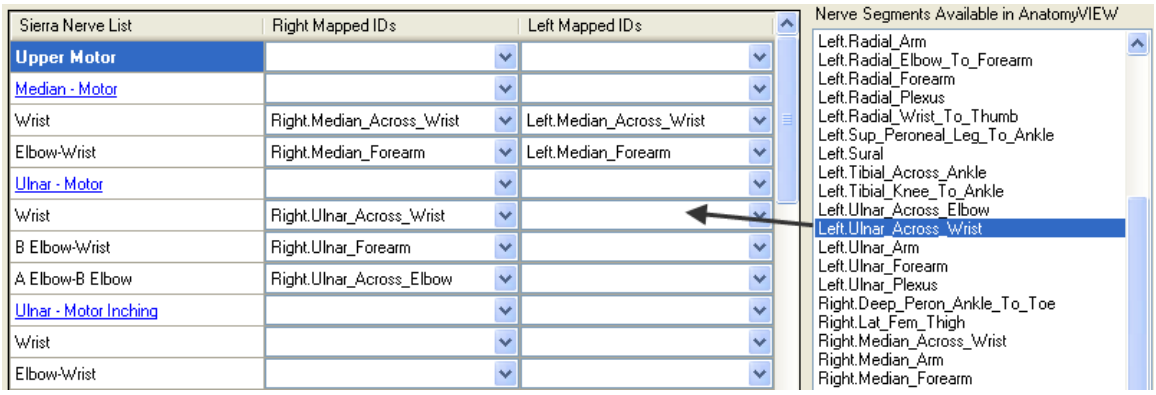
Column Descriptions:

- **Sierra Nerve List** - this column shows the user's nerve list, as read from the NCV test protocol setup window. Only those sites and segments with corresponding normal values (latency, amplitude, or velocity) are shown in the list.

- **Right Mapped IDs** - this column shows the nerve segment ID's from the Viewer that have been assigned to this site/segment for the Right side.
- **Left Mapped IDs** - this column shows the nerve segment ID's from the Viewer that have been assigned to this site/segment for the Left side.
- **Nerve Segments Available in AnatomyVIEW** - this column lists all the nerve segment IDs that the Viewer is able to display.

To Map a Viewer Nerve Segment ID to a Site/Segment:

1. Find the appropriate **nerve segment ID** in the **Viewer List**.
2. **Left click** on the **nerve segment ID** and **drag it over** to the appropriate **Right** or **Left Mapped ID** cell.
3. **Release** the mouse button **to drop** the nerve segment ID into the cell.



Click and Drag nerve segment available in Viewer and drop into appropriate user site/segment

To Clear an Assignment:

1. **Highlight** the appropriate cell by clicking on it with the mouse.
2. Click on the **Clear** button.

To Clear All Assignments:

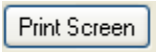
1. Click on the **Clear All** button.

To Save the Assignments:

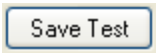
1. Click on the **OK** button.

 The nerve mapping data is saved to a file in the user's setup folder. This file is named "NerveMap.xml" and it is automatically included in the Preserve & Restore functions.

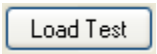
Window Buttons:



Clicking the **Print Screen** button will send an image of the screen to your default printer.

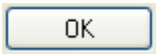


Clicking the **Save Test** button will open the Save Test window. This allows the NCV test protocol to be saved to a file.

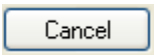


Clicking the **Load Test** button will open the Load Test window. Use this feature to load the NCV test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the NCV settings from that file.



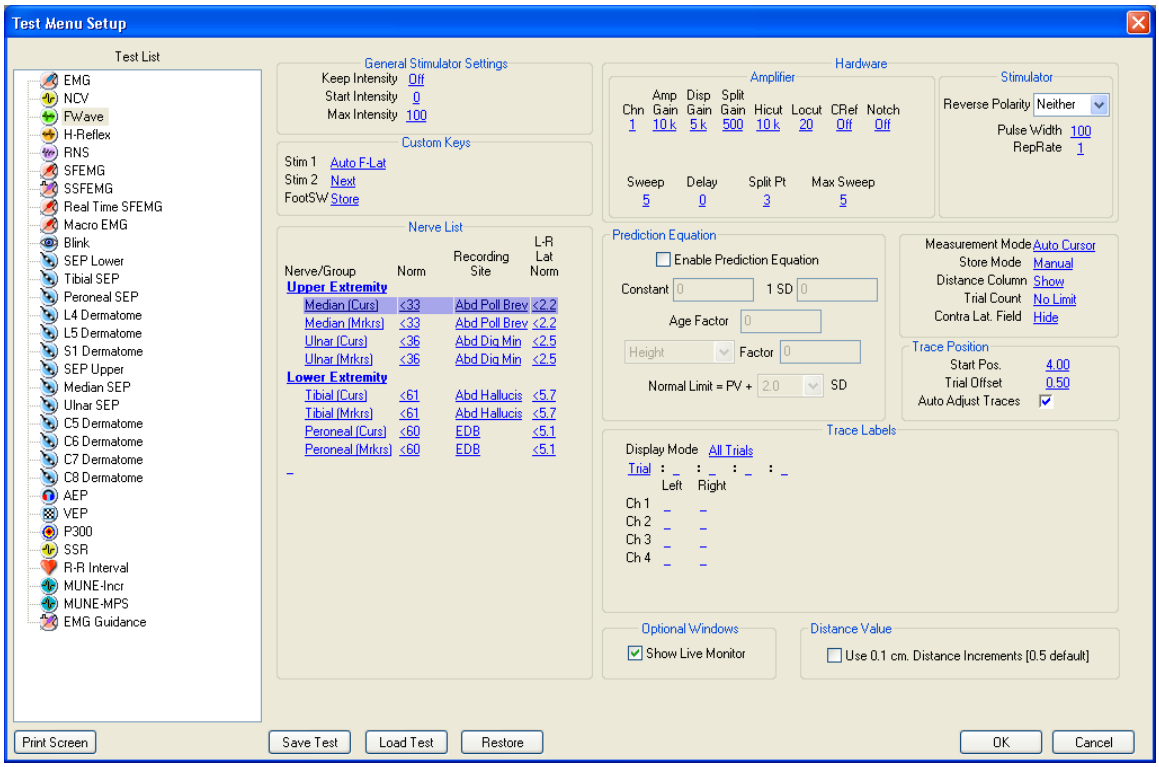
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the NCV test protocol settings. (All nerves are saved)



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the NCV test protocol settings.

F Wave Setup

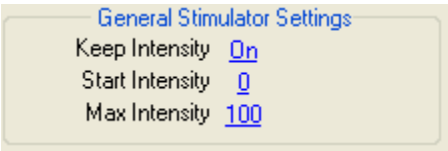
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **F Wave** test protocol in the test list. The **F Wave** test protocol settings will be displayed on the right hand side of the screen.



F Wave Setup window.

General Stimulator Settings

This section has settings that affect the electrical stimulator intensity. These settings apply to all the nerves listed in the Nerve List.

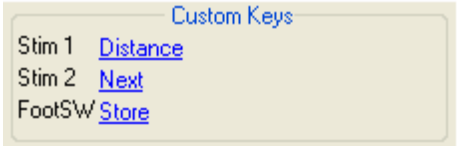


- **Keep Intensity On/Off** - when set to **On**, the stimulus intensity will not be reset to zero milliamps when changing from one nerve to the next. The intensity will remain at what was used last. When this parameter is set to **Off**, the stimulus intensity will always be reset to zero milliamps when changing from one nerve to the next.

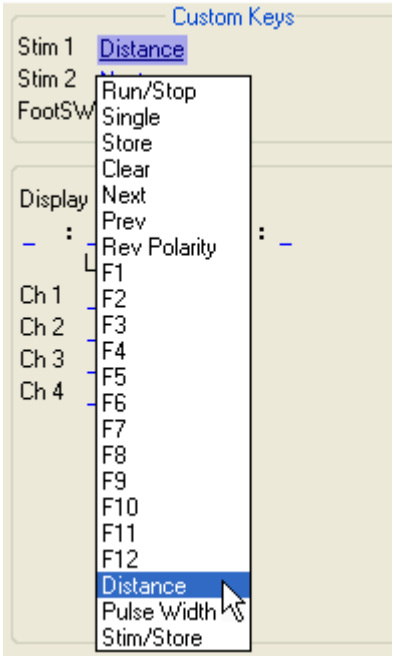
- **Start Intensity** - sets the initial starting stimulus intensity for the first nerve to be selected. Possible selections are 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.
- **Max Intensity** - sets the maximum intensity level in milliamps. Possible selections are 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch. These settings apply to all the nerves listed in the Nerve List.



Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Nerve List

This section is used to specify the types of F Wave tests that will be performed. For each nerve that is defined, you can program the default normal value, L-R

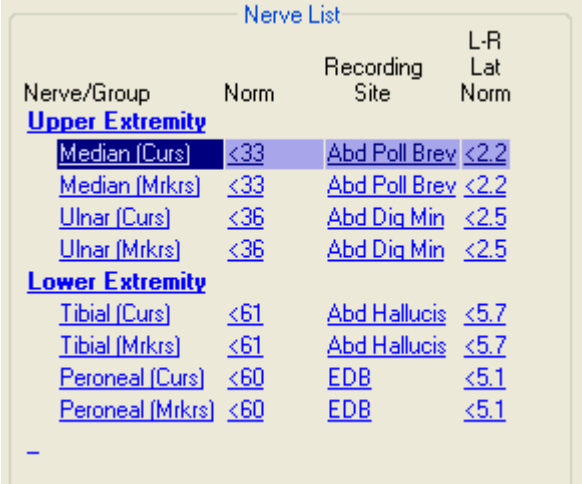
normal value, recording site, amplifier settings, stimulator settings, test options, and trace position settings.

There are two types of F Wave test, **Markers** mode or **Cursors** mode.

- **Markers Mode** - a single latency marker is used for the minimum F wave latency.
- **Cursors Mode** - auto cursors are placed on each trace and the min, max, mean, F/M ratio, and velocity can be calculated.

Each F Wave type has its own table in the TabData summary window and in printed reports.

To Select a Nerve in the list: Click on the nerve name with the left mouse button. Once the nerve is selected its parameter settings, and test options will be displayed on the right hand side of the screen. See the section below titled, **Hardware Settings**, for information on how to change these settings.



To insert a new Nerve into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the Nerve name, then click in the Norm field and type a normal latency value, and finally, click in the Recording Site field and enter the muscle name.

Within the list - right click the mouse over an existing nerve name. From the pop-up menu select **Insert**. A new row will appear above the nerve you right clicked on. Enter the nerve name, then click in the Norm field and type a normal latency value, and finally, click in the Recording Site field and enter the muscle name.

To insert a Group Heading name into the list: Right click the mouse over an existing nerve name. From the pop-up menu select **Insert Group**. A new row will appear above the nerve that you right clicked on. Enter the heading name in the Nerve/Group name field. Group Headings are automatically shown in bold text:

To change the name of a Nerve: Click on the nerve name you want to change. Type the new name and press **Enter**.

To change the order of the nerve list: Changing the order of the nerve list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the nerve or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the nerve or group heading to go and select **Paste** from the pop-up menu (the nerve or group heading will be pasted above the row you right clicked upon). Repeat this process for all the nerves or group headings you want to move.

To delete a nerve or group heading from the list: Right click on the nerve or group heading you want to delete, then select **Delete** from the pop-up menu.

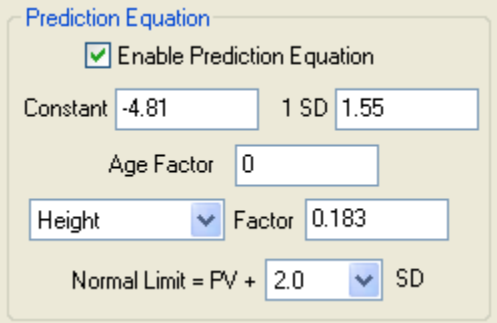
To enter a Normal Value for a nerve: There are two methods for entering normal values; **Simple Value Limit** or **Prediction Equation**.

- **Simple Value Limit:**

  Click in the normal value column of the nerve list and type the desired value. For example, <33.0.

- **Prediction Equation:**

  The normal F wave latency can be predicted using the patient's **Age** and **Height**. To use the prediction equation, check the box labeled **Enable Prediction Equation**. You can then input the factors for Age, Height, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. If the equation is enabled, the normal value in the nerve list is ignored and the norm will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height** have been input in the Patient Information window.



The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

If the standard deviation is known then:

Normal Value = Predicted Value + 'x' Standard Deviations

Typically:

F Wave Latency Norm = Predicted Value + 2 SD

To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

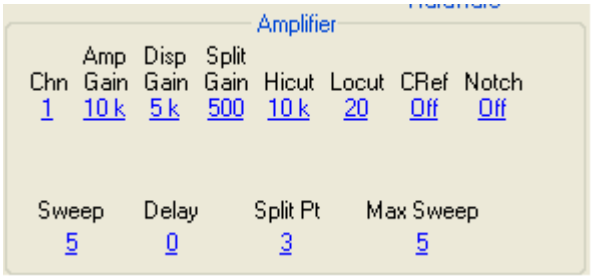
If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

Hardware Settings

Once a nerve has been selected from the Nerve/Group list its parameter settings and test options will be displayed in the Hardware settings section.

Amplifier:



Only Channel 1 is supported in the F Wave test protocol.

Amp Gain: Click here to select the default M Wave Amplifier Gain setting in microvolts per division (uV/Div).

Disp Gain: Click here to select the default M Wave Display Gain setting in microvolts per division (uV/Div).

Split Gain: Click here to select the default F Wave Display Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

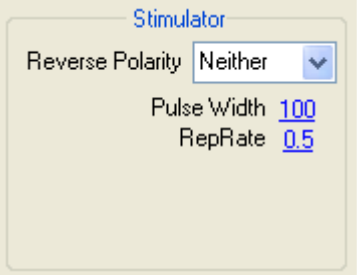
Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Split Pt: Click here to set the default position of the gain split point in divisions.

Max Sweep: Click here to select the maximum sweep speed that can be used for the test in milliseconds per division (ms/Div).

Stimulator:



Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

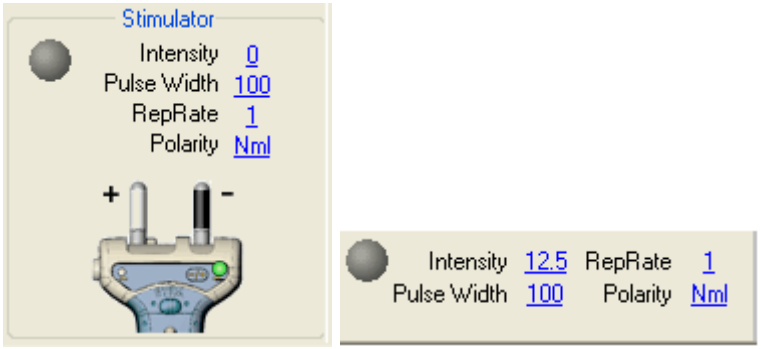
- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the

Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For F Wave Studies, the **Cathode (-) should be positioned away from the recording electrodes** (i.e., Cathode proximal, Anode Distal).

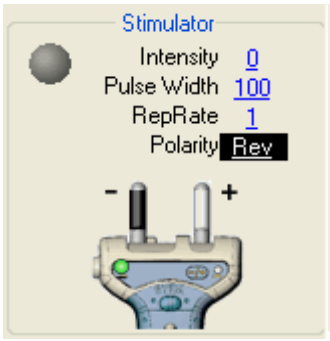
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

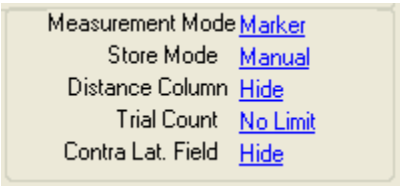
Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Test Options:



Measurement Mode: Click here to select either **Marker** or **Auto-Cursor** mode. In Marker mode a single latency marker is used to determine the minimal F latency. In Auto-Cursor mode each trace receives auto cursors and the F min, F mean, F max, Dispersion (F min - F max), F/M ratio, and Velocity are calculated.

Store Mode: Click here to select either **Manual** or **Auto-Store** mode. In Manual mode the user must press the Store key after each stimulation. In Auto-Store mode the program will automatically store each trace after stimulation.

Distance Column: Click here to select either **Show** or **Hide**. When Show is selected the test will provide a distance field and a velocity field for the calculation and display of F wave velocity. When Hide is selected both the distance and velocity fields will be hidden.

Trial Count: Click here to select either **No Limit**, **5**, **10**, **15**, **20**, **30**, or **50**. When No Limit is selected the test will not limit the number of traces that can be acquired and stored. When one of the listed values is selected the program will automatically stop acquiring and storing traces when that value is reached.

Contra Lat. Field: Click here to select **Show** or **Hide**. When Show is selected the test will show the latency value for the contralateral side in the measurement table. When Hide is selected this value is not shown in the table.

Trace Position

Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

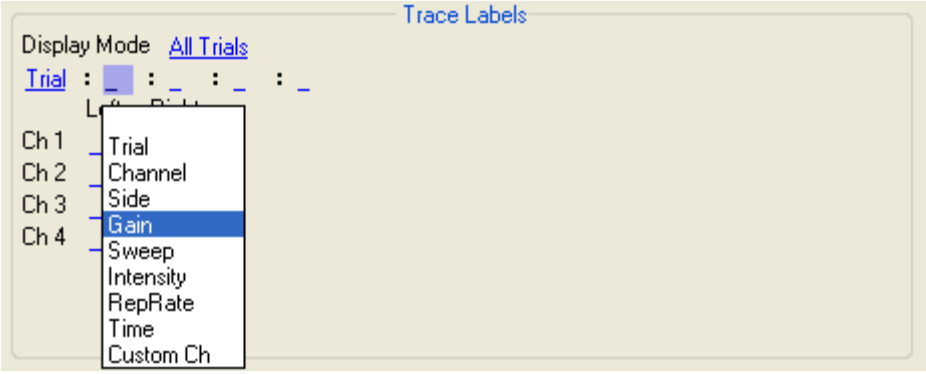
Trial Offset: This setting determines how much space will separate each stored F Wave trace. In this example the setting is 0.5 divisions, therefore the second F Wave trace will be displayed 0.5 divisions below the first trace. If a third F Wave trace is acquired it will be displayed 0.5 divisions below the second F Wave trace and so on.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the Trace window.

Trace Position settings can be changed during data acquisition by right-clicking with the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

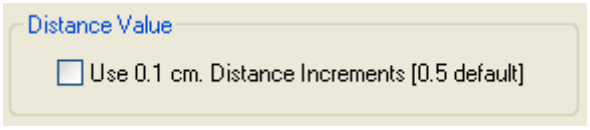
By default, all F Wave traces are automatically displayed with the Trial Number for a trace label (e.g., Tr1, Tr2, Tr3). These settings can be used to add other information to the trace label.



There are five additional fields that can be added to the trace label. Simply click in the first blank field and make a selection from the pop-up list. The above example shows how to add the Gain setting to the trace label.

Distance Value

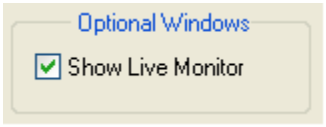
This setting determines the increments that will be used when the wheel on the electrical stimulator is used to enter distance measurements. When checked, the wheel will use 0.1 cm increments.



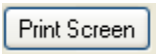
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.

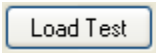


Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

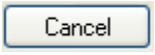
Clicking the **Save Test** button will open the Save Test window. This allows the F Wave test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the F Wave test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the F Wave settings from that file.

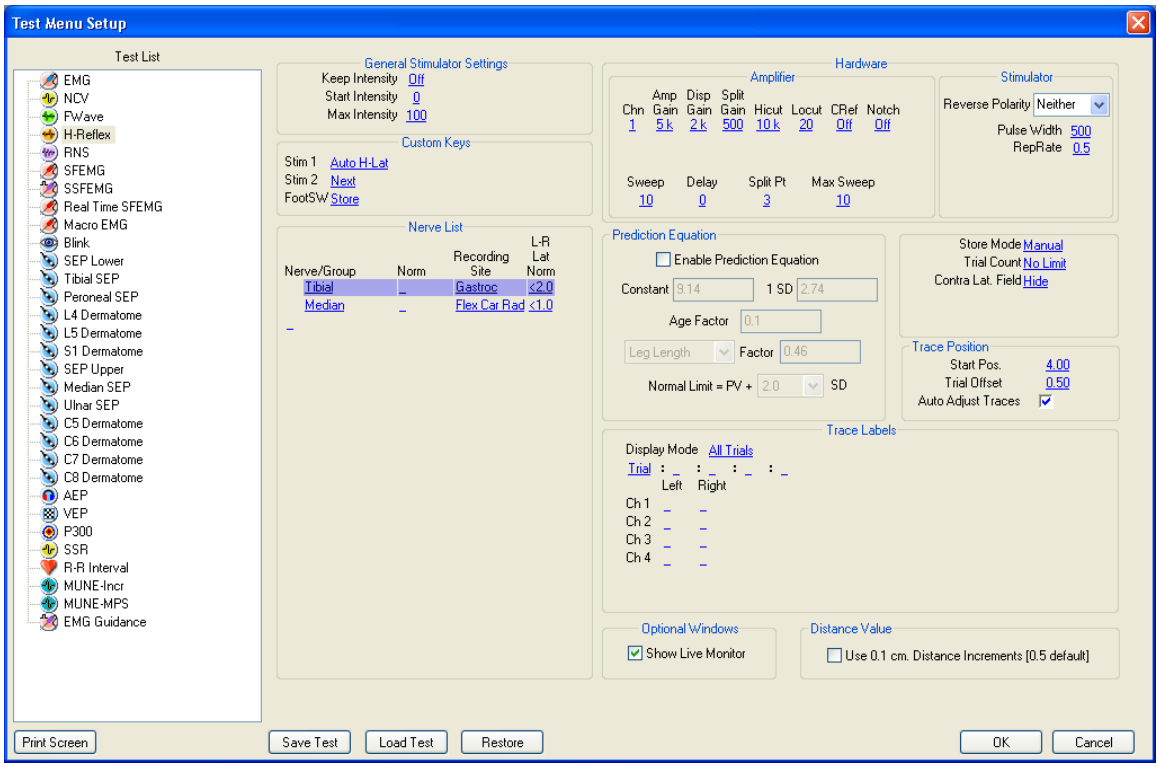
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the F Wave test protocol settings. (All nerves are saved)



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the F Wave test protocol settings.

H Reflex Setup

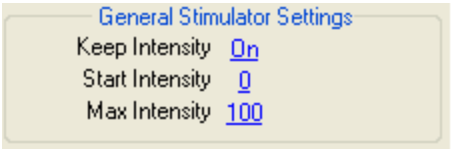
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **H Reflex** test protocol in the test list. The **H Reflex** test protocol settings will be displayed on the right hand side of the screen.



H Reflex Setup window.

General Stimulator Settings

This section has settings that affect the electrical stimulator intensity. These settings apply to all the nerves listed in the Nerve List.



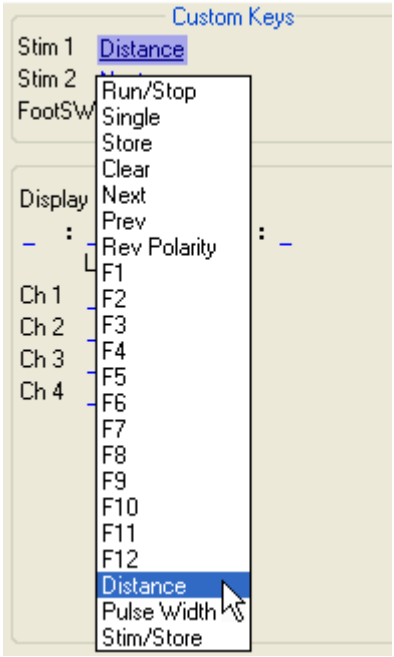
- **Keep Intensity On/Off** - when set to **On**, the stimulus intensity will not be reset to zero milliamps when changing from one nerve to the next. The intensity will remain at what was used last. When this parameter is set to **Off,** the stimulus intensity will always be reset to zero milliamps when changing from one nerve to the next.

- **Start Intensity** - sets the initial starting stimulus intensity for the first nerve to be selected. Possible selections are 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.
- **Max Intensity** - sets the maximum intensity level in milliamps. Possible selections are 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 milliamps.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch. These settings apply to all the nerves listed in the Nerve List.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.

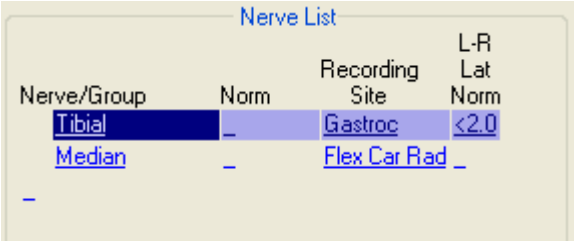


Custom Key selection list.

Nerve List

This section is used to specify the types of H Reflex tests that will be performed. For each nerve that is defined, you can program the default normal value, L-R normal value, recording site, amplifier settings, stimulator settings, test options, and trace position settings.

To Select a Nerve in the list: Click on the nerve name with the left mouse button. Once the nerve is selected its parameter settings, and test options will be displayed on the right hand side of the screen. See the section below titled, **Hardware Settings**, for information on how to change these settings.



To Insert a new Nerve into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the Nerve name, then click in the Norm field and type a normal latency value, and finally, click in the Recording Site field and enter the muscle name.

Within the list - right click the mouse over an existing nerve name. From the pop-up menu select **Insert**. A new row will appear above the nerve you right clicked on. Enter the nerve name, then click in the Norm field and type a normal latency value, and finally, click in the Recording Site field and enter the muscle name.

To insert a Group Heading name into the list: Right click the mouse over an existing nerve name. From the pop-up menu select **Insert Group**. A new row will appear above the nerve that you right clicked on. Enter the heading name in the Nerve/Group name field. Group Headings are automatically shown in bold text:

To change the name of a Nerve: Click on the nerve name you want to change. Type the new name and press Enter.

To change the order of the nerve list: Changing the order of the nerve list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the nerve or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the nerve or group heading to go and select **Paste** from the pop-up menu (the nerve or group heading will be pasted above the row you right clicked upon). Repeat this process for all the nerves or group headings you want to move.

To delete a nerve or group heading from the list: Right click on the nerve or group heading you want to delete, then select **Delete** from the pop-up menu.

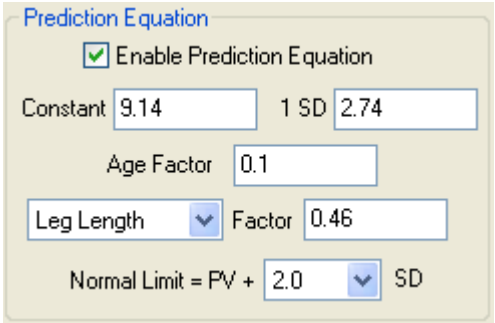
To enter a Normal Value for a nerve: There are two methods for entering normal values; **Simple Value Limit** or **Prediction Equation**.

- **Simple Value Limit:**

  Click in the normal value column of the nerve list and type the desired value. For example, <37.0.

- **Prediction Equation:**

  The normal H Reflex latency can be predicted using the patient's **Age** and either **Height**, **Leg Length** or **Arm Length**. To use the prediction equation, check the box labeled **Enable Prediction Equation**. You can then input the factors for Age, Height or Leg/Arm Length, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. If the equation is enabled, the normal value in the nerve list is ignored and the norm will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height or Leg/Arm Length** have been input.



The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

Leg or Arm Length and appropriate Factor can be substituted for Height.

If the standard deviation is known then:

Normal Value = Predicted Value + 'x' Standard Deviations

Typically:

H Reflex Latency Norm = Predicted Value + 2 SD

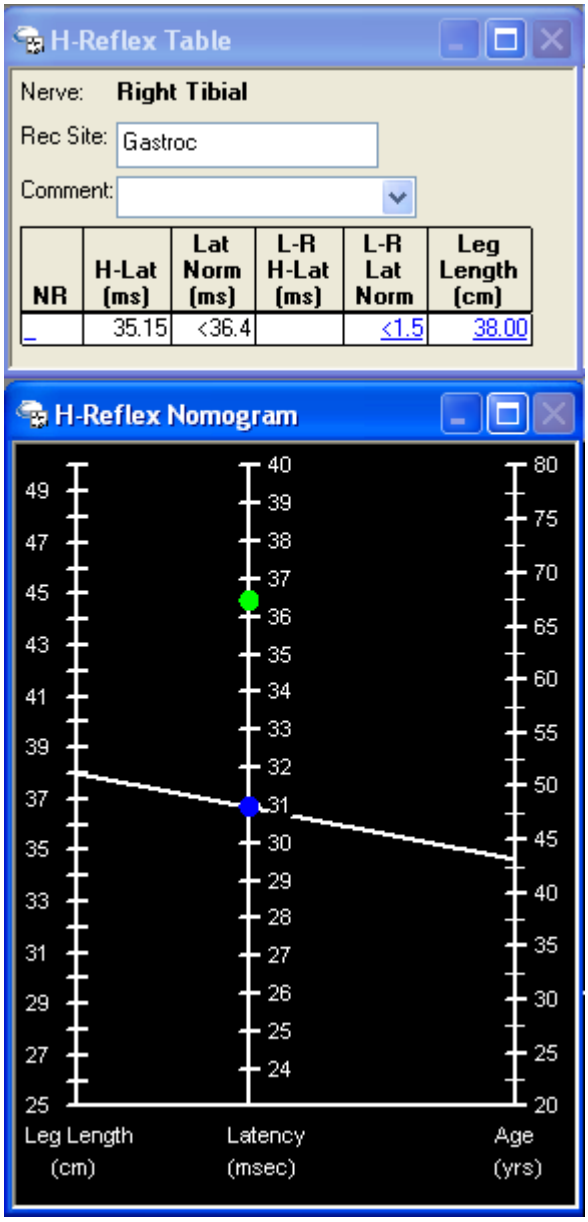
 To use the prediction equation the patient's height or leg/arm length must be entered in **centimeters**.

 Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

 If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

 There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

If **Leg Length** is selected for the Tibial H Reflex, the standard **H Reflex Nomogram** will be displayed on the acquisition screen and a Leg Length field will be shown in the measurement table. After entering the patient's leg length in the table a line will be drawn in the nomogram to indicate the predicted normal latency, the blue dot marks the predicted value and the green dot marks the upper limit of normal based on the specified standard deviation.

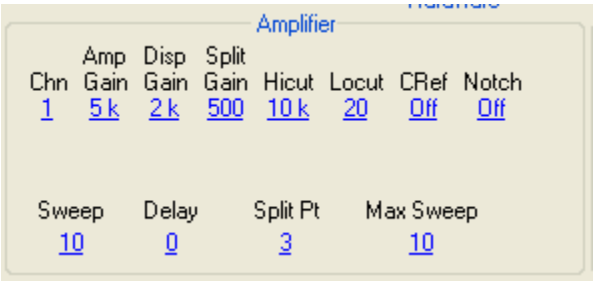


H Reflex Nomogram

Hardware Settings

Once a nerve has been selected from the Nerve/Group list its parameter settings and test options will be displayed in the Hardware settings section.

Amplifier:



Only Channel 1 is supported in the H Reflex test protocol.

Amp Gain: Click here to select the default M Wave Amplifier Gain setting in microvolts per division (uV/Div).

Disp Gain: Click here to select the default M Wave Display Gain setting in microvolts per division (uV/Div).

Split Gain: Click here to select the default H Reflex Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

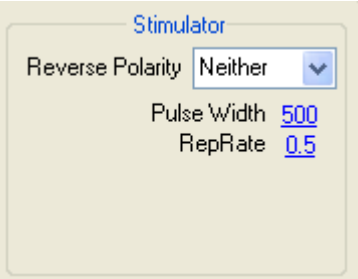
Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Split Pt: Click here to set the default position of the gain split point in divisions.

Max Sweep: Click here to select the maximum sweep speed that can be used for the test in milliseconds per division (ms/Div).

Stimulator:

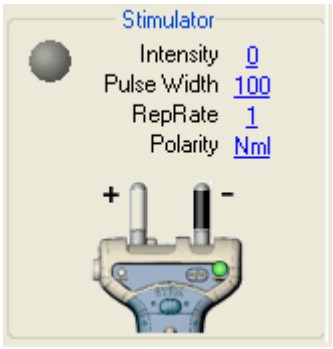


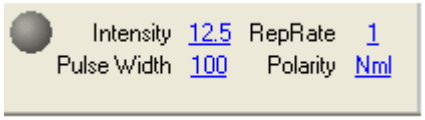
Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For H Reflex Studies, the **Cathode (-) should be positioned away from the recording electrodes** (i.e., Cathode proximal, Anode Distal).

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

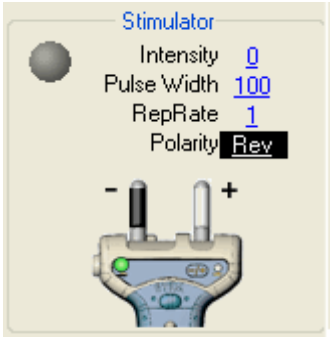




Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

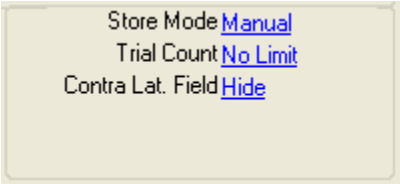
Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Test Options:



Store Mode: Click here to select either **Manual** or **Auto-Store** mode. In Manual mode the user must press the Store key after each stimulation. In Auto-Store mode the program will automatically store each trace after stimulation.

Trial Count: Click here to select either **No Limit**, **5**, **10**, **15**, **20**, **30**, or **50**. When No Limit is selected the test will not limit the number of traces that can be acquired and stored. When one of the listed values is selected the program will automatically stop acquiring and storing traces when that value is reached.

Contra Lat. Field: Click here to select **Show** or **Hide**. When Show is selected the test will show the latency value for the contralateral side in the measurement table. When Hide is selected this value is not shown in the table.

Trace Position

Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 2 divisions below the top of the window.

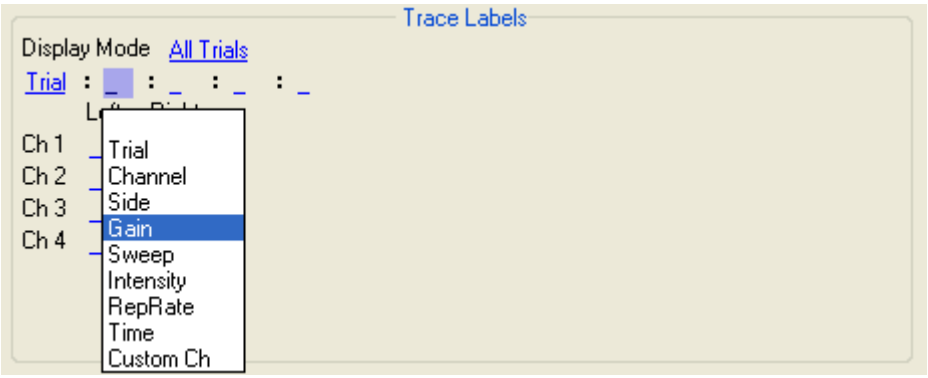
Trial Offset: This setting determines how much space will separate each stored H Reflex trace. In this example the setting is 1.5 divisions, therefore the second H Reflex trace will be displayed 1.5 divisions below the first trace. If a third H Reflex trace is acquired it will be displayed 1.5 divisions below the second H Reflex trace and so on.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the Trace window.

Trace Position settings can be changed during data acquisition by right-clicking with the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

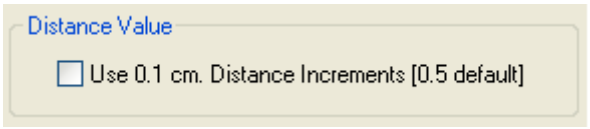
By default, all H Reflex traces are automatically displayed with the Trial Number for a trace label e.g., Tr1, Tr2, Tr3). These settings can be used to add other information to the trace label.



There are five additional fields that can be added to the trace label. Simply click in the first blank field and make a selection from the pop-up list. The above example shows how to add the Gain setting to the trace label.

Distance Value

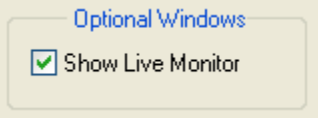
This setting determines the increments that will be used when the wheel on the electrical stimulator is used to enter distance measurements. When checked, the wheel will use 0.1 cm increments.



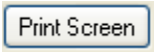
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

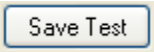
This window can be positioned, sized, and saved as part of the default settings for the test protocol.



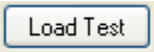
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

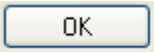


Clicking the **Save Test** button will open the Save Test window. This allows the H Reflex test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the H Reflex test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the H Reflex settings from that file.

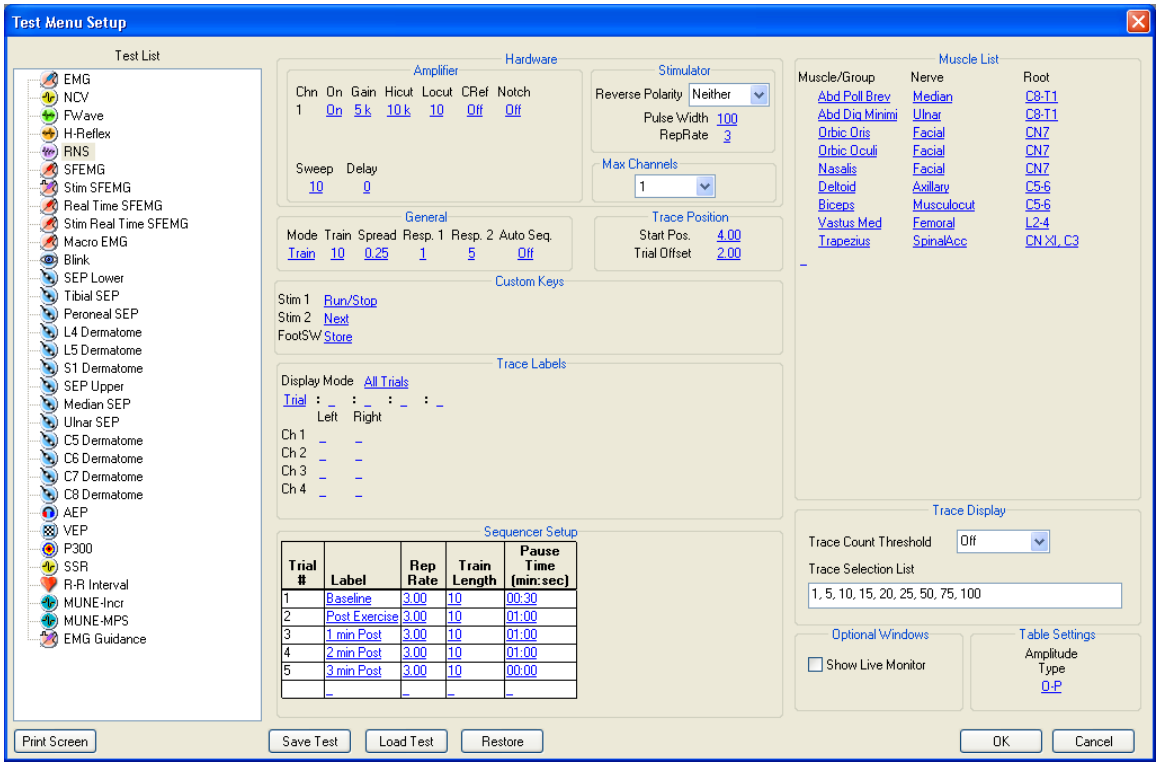


Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the H Reflex test protocol settings. (All nerves are saved)

Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the H Reflex test protocol settings.

RNS Setup

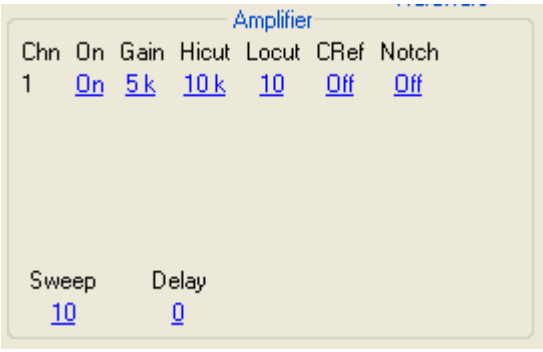
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **RNS** (Repetitive Nerve Stimulation) test protocol in the test list. The RNS test protocol settings will be displayed on the right hand side of the screen.



RNS Test Setup window.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

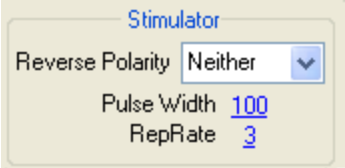
CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Stimulator:



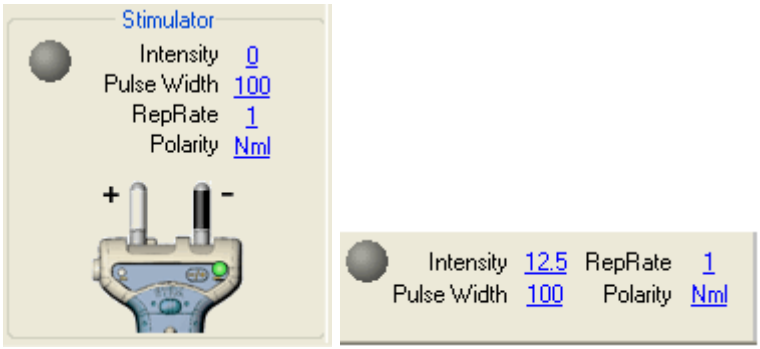
Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For RNS Studies, the **Cathode (-) should be positioned closest to the recording electrodes.**

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

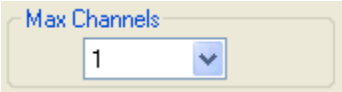
Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

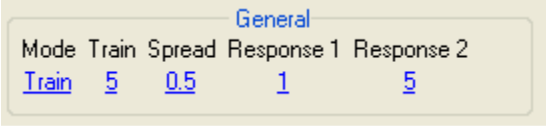
Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Max Channels:



To enable 2 Channel recording capability; change this value from **1** to **2.** For more information on 2 Channel recording mode, see the topic *2 Channel Recording*.

General Settings



Mode: Click to select the default stimulus mode for the test. Choices are **Train** or **Single**.

- Train - When the Stim button on the handheld stimulator or the Run/Stop button is pressed a train of stimuli will be delivered.
- Single - When the Stim button on the hand held stimulator or the Single button is pressed a single stimulus will be delivered. The Run/Stop button is disabled in this mode. This mode is useful for determining supramaximal stimulation prior to delivering a train of stimuli.

Train: Click to select the number of stimuli to be delivered in a train. The maximum number is 150.

Spread: Click here to select the default spacing between individual traces within a train, this setting is in divisions. To superimpose all the traces on top of each other, set this value to zero.

Response 1: Click here to select the first response in the train that will be analyzed for amplitude and area measurements.

Response 2: Click here to select the second response in the train that will be analyzed for amplitude and area measurements. In addition, the percentage

difference between this response and the trace selected for Response 1 will be computed.

Trace Position

Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first train will be positioned 4 divisions below the top of the window.

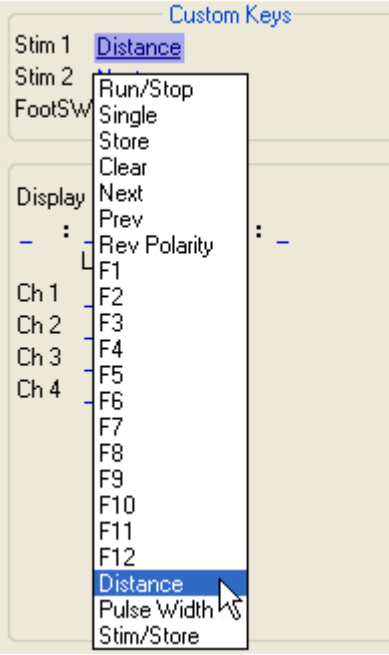
Trial Offset: This setting determines how much space will separate each stored RNS train from other stored (purple) trains. In this example the setting is 2.00 divisions, therefore the second stored RNS train will be displayed 2.00 divisions below the first. If a third RNS train is acquired it will be displayed 2.00 divisions below the second stored RNS train and so on.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Labels

This section is used to configure how the train labels are displayed and allows you to choose the type of information that is included in the train labels. The train label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).

Display Mode: Click here to specify how the train labels will be displayed during data acquisition. The choices are;

- **All Trials** - train labels are shown on all trains.
- **No Trials** - train labels are not shown on any trains.
- **First Trial** - only the first train acquired has a train label.
- **Active Trial** - only the active train (white) has train labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.
- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or A1-Cz montage designations).

Left / Right Custom Labels:

When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (−), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

Muscle List

This section is used to setup your RNS muscle list. The list can contain muscle names, nerve names, and root levels.

To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, and root level.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, and root level.

To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

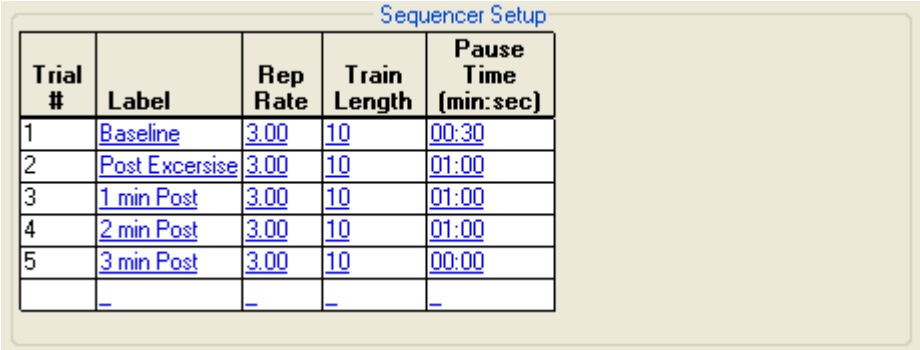
To change the name of an existing muscle:
Click on the muscle name you want to change. Type the new name and press **Enter**.

To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Sequence Setup

This section is used to program the stimulus train sequence that will be delivered during the test procedure.

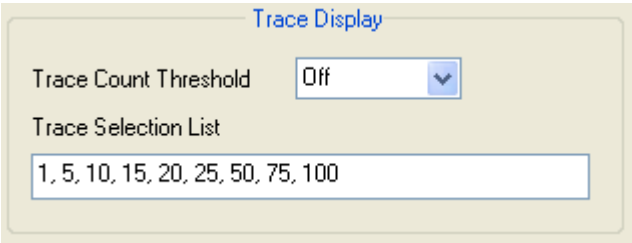


Trial #	Label	Rep Rate	Train Length	Pause Time (min:sec)
1	Baseline	3.00	10	00:30
2	Post Excersise	3.00	10	01:00
3	1 min Post	3.00	10	01:00
4	2 min Post	3.00	10	01:00
5	3 min Post	3.00	10	00:00
	_	_	_	_

- **Label** - this is a label that describes the stimulus train, it appears in the trace window as well as in the results table.
- **Rep Rate** - sets the repetition rate (Hz) for the stimulus train.
- **Train Length** - sets the number of stimuli that will be delivered in the stimulus train. The maximum train length is 150 (1 channel mode) and 75 (2 channel mode).
- **Pause Time** - sets the amount of time the program will pause at the end of the stimulus train before automatically advancing to the next stimulus train.

Trace Display

The settings in this section apply to long stimulus trains.



- **Trace Count Threshold** - sets a threshold for the Trace Selection List. If the number of stimuli in a stimulus train exceeds the value set for the threshold, the traces indicated in the Trace Selection List will be displayed in the Trace window for that train.
- **Trace Selection List** - numbers separated by a comma indicate which traces within the stimulus train will be displayed in the trace window.

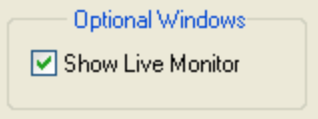
Table Settings

- **Amplitude Type** - determines how amplitude is measured. Choices are Onset-to-Peak (O-P) or Peak-to-Trough (P-T).

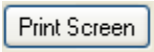
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

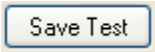
  This window can be positioned, sized, and saved as part of the default settings for the test protocol.



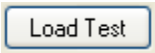
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.



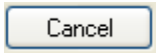
Clicking the **Save Test** button will open the Save Test window. This allows the RNS test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the RNS test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the RNS settings from that file.

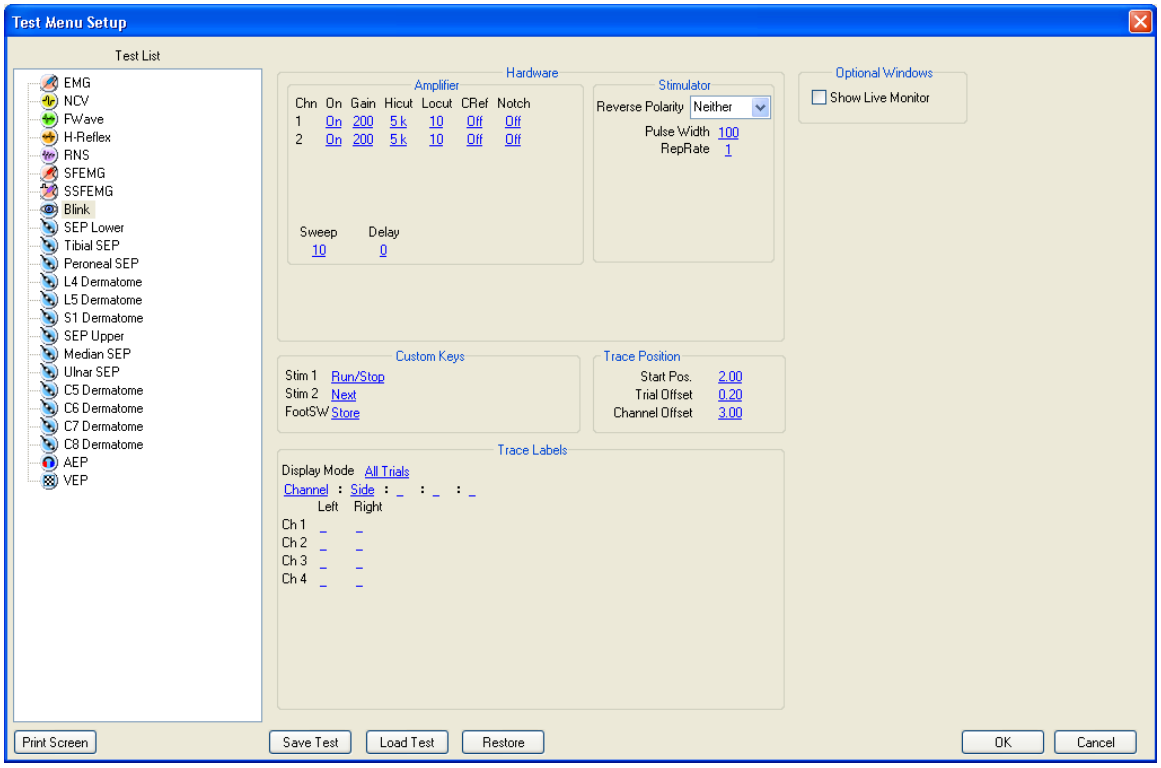
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the RNS test protocol settings.



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the RNS test protocol settings.

Blink Setup

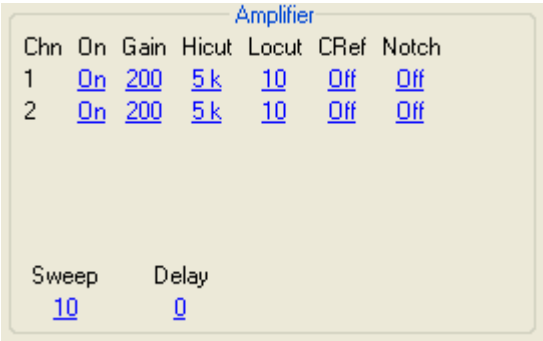
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **Blink** test protocol in the test list. The Blink test protocol settings will be displayed on the right hand side of the screen.



Blink Test Setup window.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off. The Blink test protocol only supports 2 channels maximum.

Connect the electrode leads from the patient's **left side (obicularis oculi) to the CH 1** inputs on the amplifier, and connect the leads from the patient's **right side to the CH 2** inputs. The electrodes must be connected to the amplifier in this configuration to ensure the correct display of the test data and marker information.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

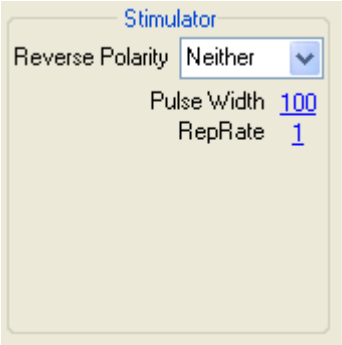
CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Stimulator:

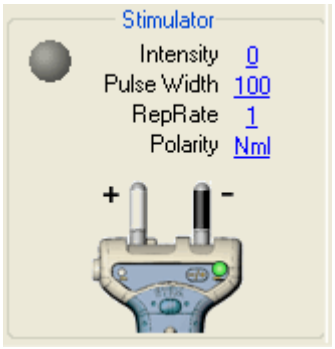


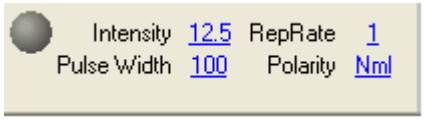
Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For Blink Studies, the **Cathode (-) should be positioned closest to the recording electrodes.**

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

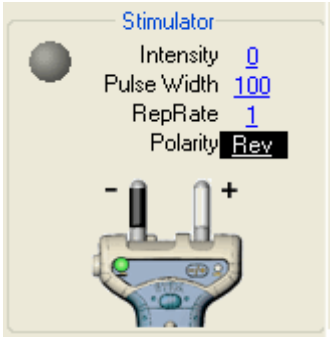




Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

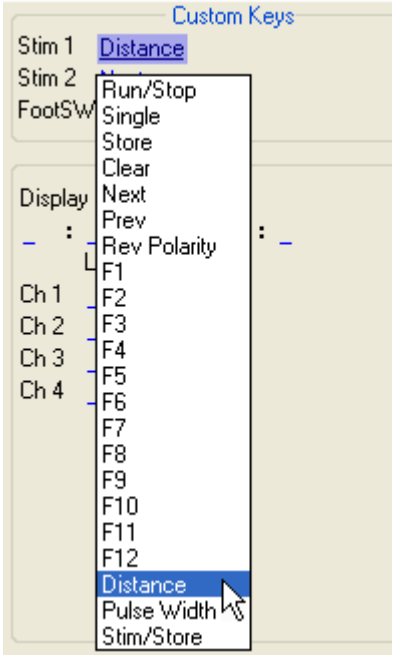
Display Settings:

The Blink test protocol splits the trace window horizontally by side, left sided responses are displayed in the top half of the trace window, right sided traces are displayed in the bottom half of the trace window. This parameter can't be changed.

Custom Keys

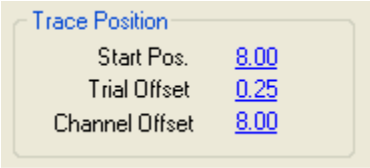
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 8 divisions below the top of the window.

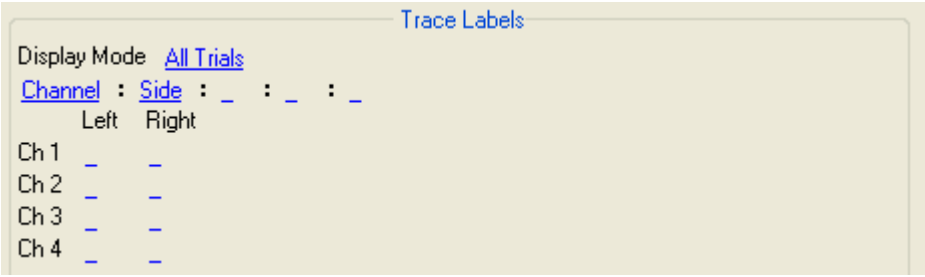
Trial Offset: This setting determines how much space will separate each stored Blink trace from both the active (white) and other stored (purple) traces. In this example the setting is 0.25 divisions, therefore the first stored Blink trace will be displayed 0.25 divisions below the active trace. If a second Blink trace is acquired and stored it will be displayed 0.25 divisions below the first stored Blink trace and so on. If you want all the traces from each channel superimposed on each other set this value to 0.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Active (white) channels.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).



Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.
- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.
- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or A1-Cz montage designations).

Left / Right Custom Labels:

When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

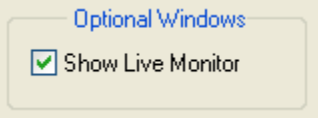
Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

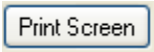
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.

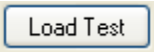


Window Buttons



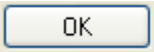
Clicking the **Print Screen** button will send an image of the screen to your default printer.

Clicking the **Save Test** button will open the Save Test window. This allows the Blink test protocol to be saved to a file.

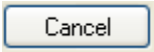


Clicking the **Load Test** button will open the Load Test window. Use this feature to load the Blink test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the Blink settings from that file.



Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the Blink test protocol settings.

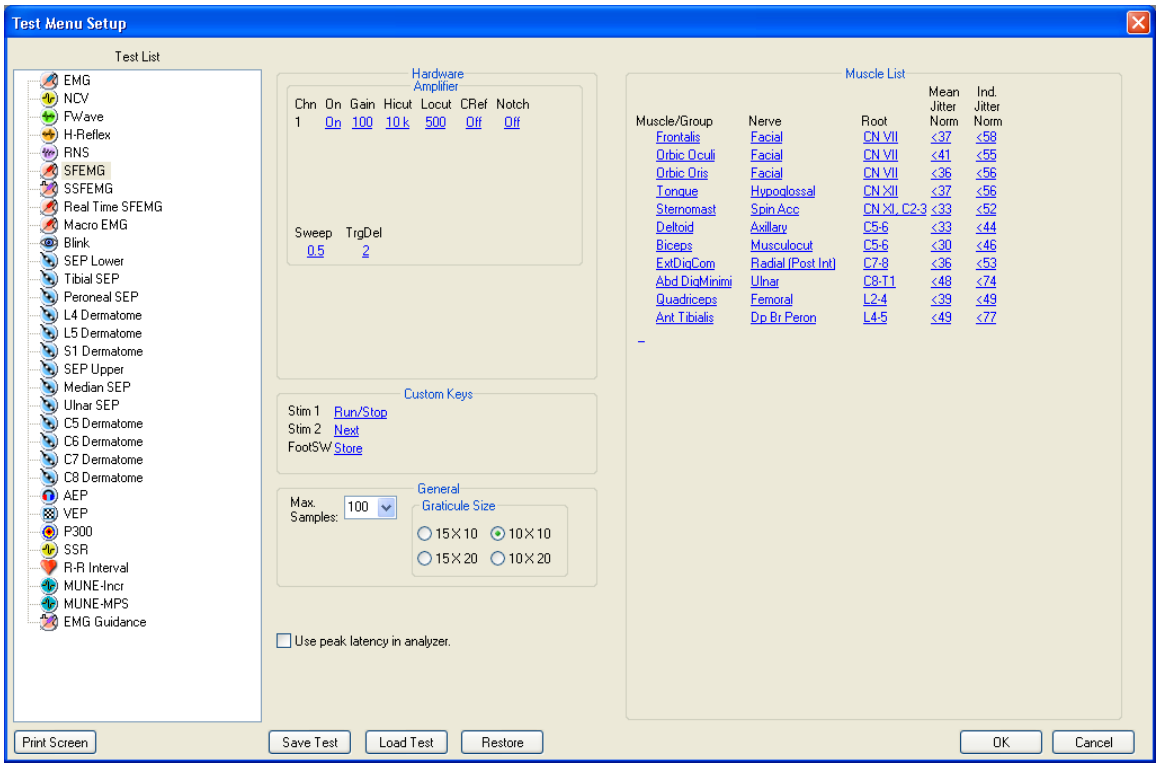


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the Blink test protocol settings.

Single Fiber EMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **SFEMG** test protocol in the test list. The SFEMG test protocol settings will be displayed on the right hand side of the screen.

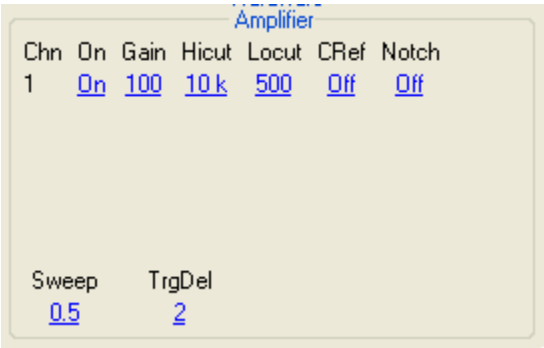
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Trace positioning, Custom Key settings, and the Muscle List.



SFEMG Setup window.

Hardware Settings

Amplifier Settings



On: Click here to program a channel as either On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

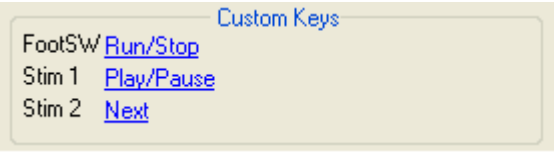
Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

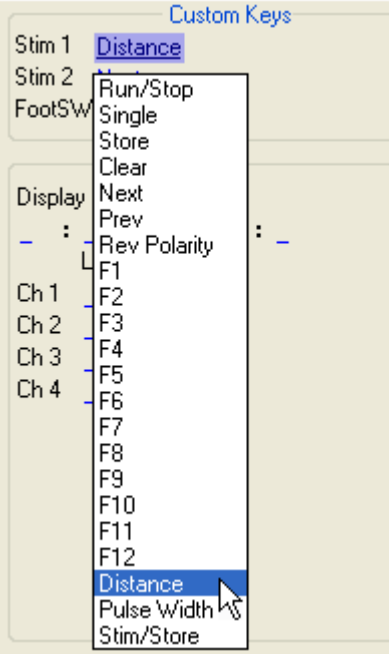
TrgDel: Click here to select the trigger delay point. The choices are 1 to 9 divisions in 0.1 increments.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

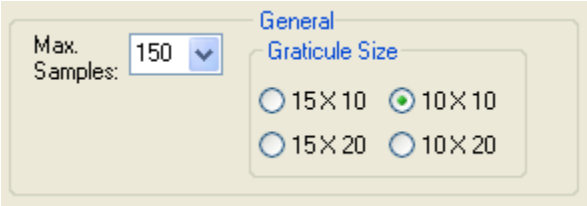


Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



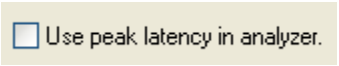
Custom Key selection list.

General Settings



Max Samples: Sets the maximum number of traces that can be held in the captured trace buffer. Choices are 10, 20, 30, 50, 70, 100, 150, and 200.

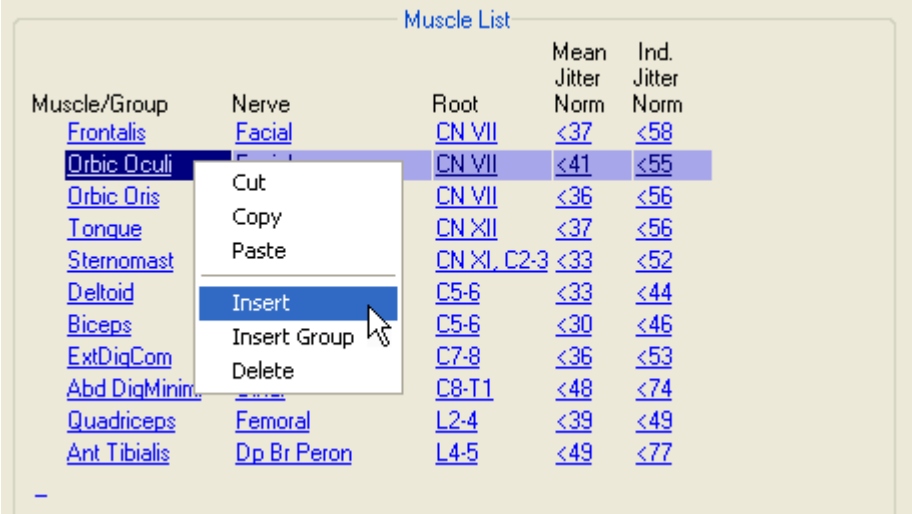
Graticule Size: These selections change the number of Vertical and Horizontal divisions that are displayed in the SFEMG Trace window. The first number is for the number of vertical divisions and the second number is for the number of horizontal divisions.



Check this box to enable jitter measurement by interpolated peak latency rather than by the point on the rising slope that crosses through the analysis marker.

Muscle List

This section is used to setup your SFEMG muscle list. The list can contain group headings, muscle names, nerve names, root levels, and normal values for Jitter.



To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, root level, and MCD normal value.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, root level, and normal values.

To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle:
Click on the muscle name you want to change. Type the new name and press **Enter**.

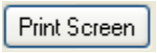
To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Normal Values:

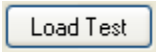
- **Mean Jitter Norm** - this is the muscle's overall normal value for mean MCD of 20 fiber pairs.
- **Ind. Jitter Norm** - this is the normal value for individual single fiber pairs.

Window Buttons



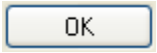
Clicking the **Print Screen** button will send an image of the screen to your default printer.

Clicking the **Save Test** button will open the Save Test window. This allows the SFEMG test protocol to be saved to a file.

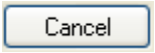


Clicking the **Load Test** button will open the Load Test window. Use this feature to load the SFEMG test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the SFEMG settings from that file.



Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the SFEMG test protocol settings.

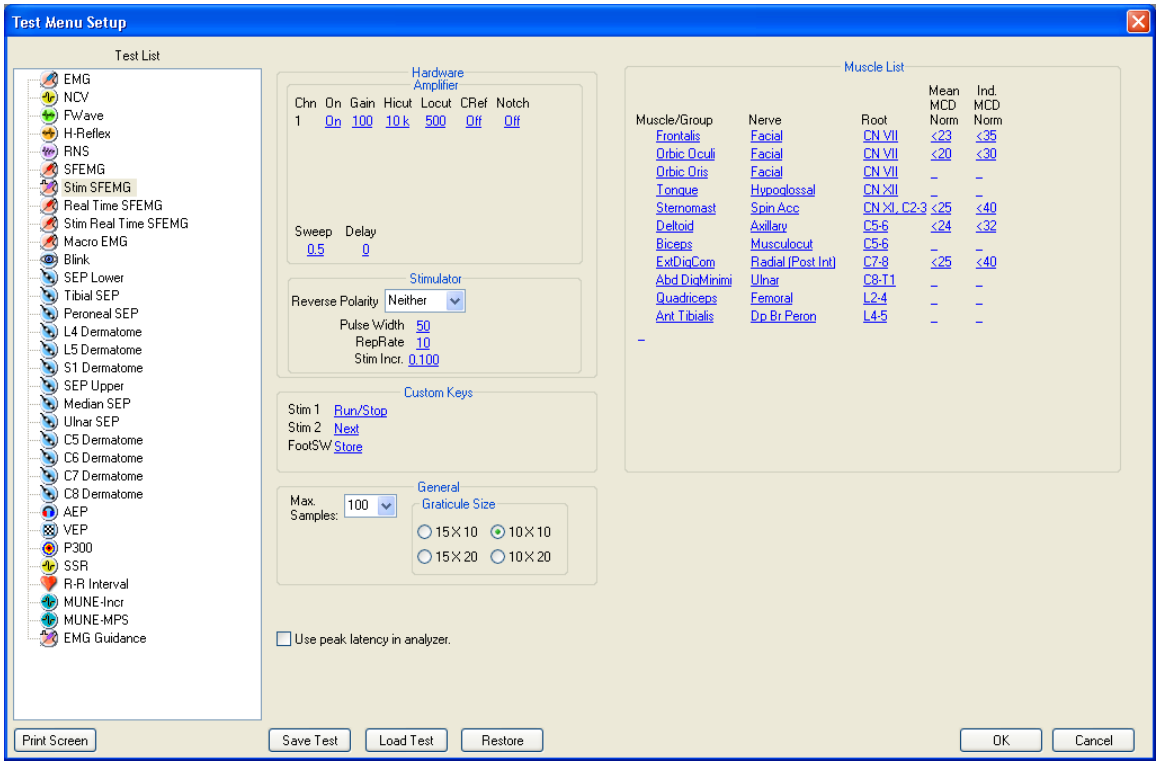


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the SFEMG test protocol settings.

Stimulated Single Fiber EMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **Stim SFEMG** test protocol in the test list. The Stim SFEMG test protocol settings will be displayed on the right hand side of the screen.

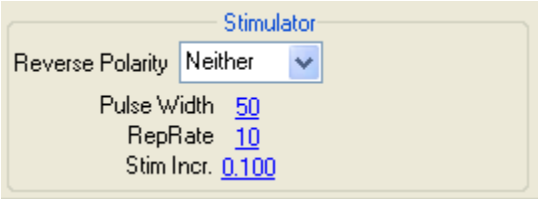
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Stimulator settings, Trace positioning, Custom Key settings, and the Muscle List.



Stim SFEMG (stimulated single fiber emg) Setup window.

The only difference between **Stim SFEMG** and **SFEMG** setup is the addition of electrical stimulator settings. Therefore this topic will only cover the electrical stimulator controls. For information about the other settings, please go to the SFEMG setup topic.

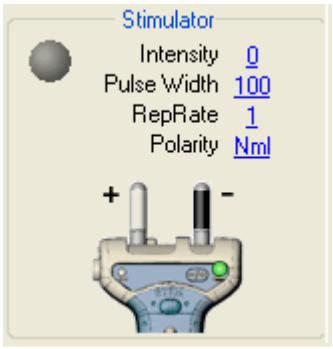
Stimulator Settings

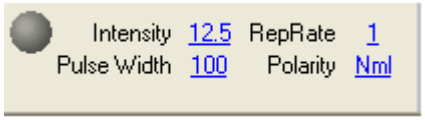


Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

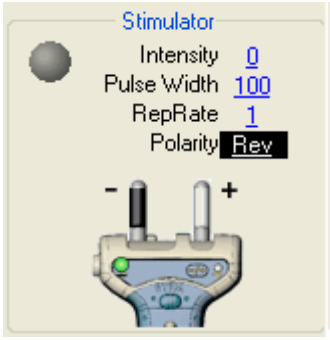




Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

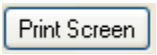
To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

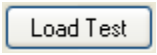
Stim Incr.: Click here to set the default intensity increments for the electrical stimulator. Values are in milliamps (mA).

Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

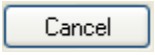
Clicking the **Save Test** button will open the Save Test window. This allows the SSFEMG test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the SSFEMG test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the SSFEMG settings from that file.

Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the SSFEMG test protocol settings.

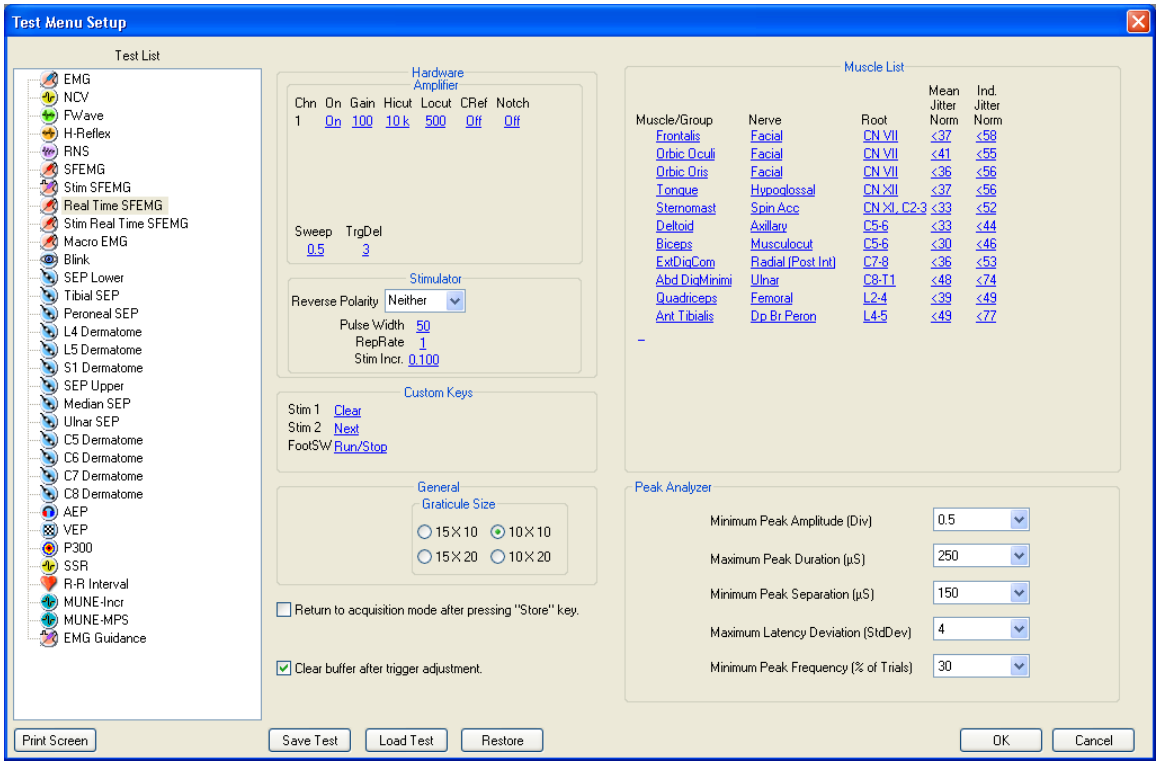


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the SSFEMG test protocol settings.

Real Time SFEMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **Real Time SFEMG** test protocol in the test list. The Real Time SFEMG test protocol settings will be displayed on the right hand side of the screen.

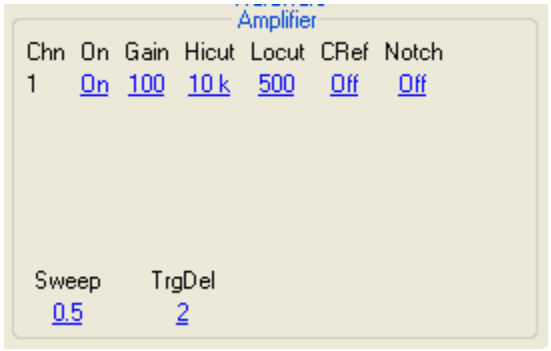
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Stimulator Settings, Custom Key settings, Peak Analyzer settings, and the Muscle List.



Real Time SFEMG Setup window.

Hardware Settings

Amplifier Settings



On: Click here to program a channel as either On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

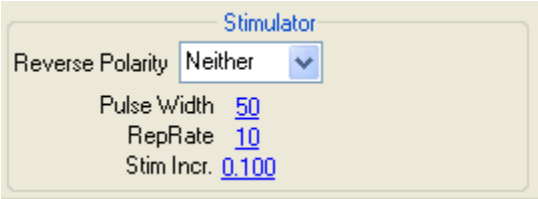
CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

TrgDel: Click here to select the trigger delay point. The choices are 1 to 9 divisions in 0.1 increments.

Stimulator Settings



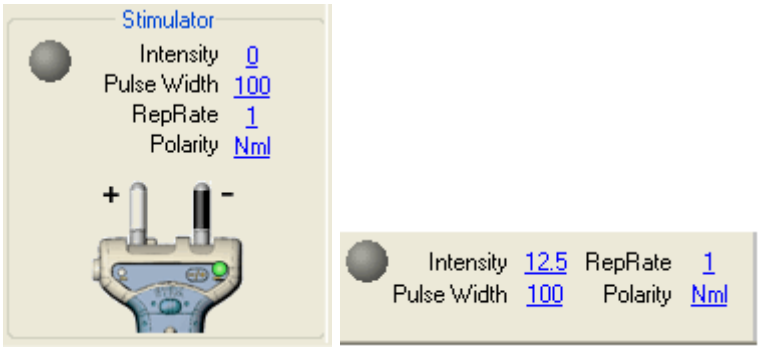
Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal

mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

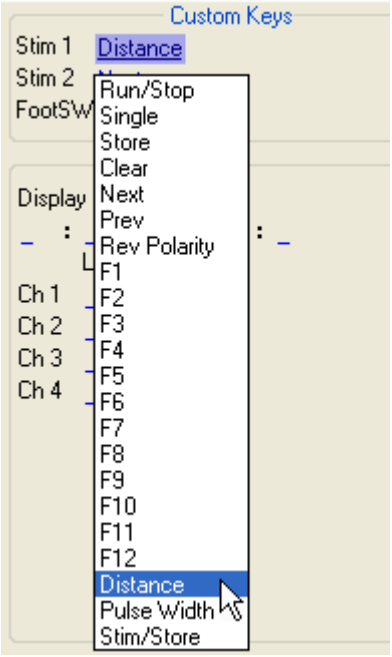
Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Stim Incr.: Click here to set the default intensity increments for the electrical stimulator. Values are in milliamps (mA).

Custom Keys

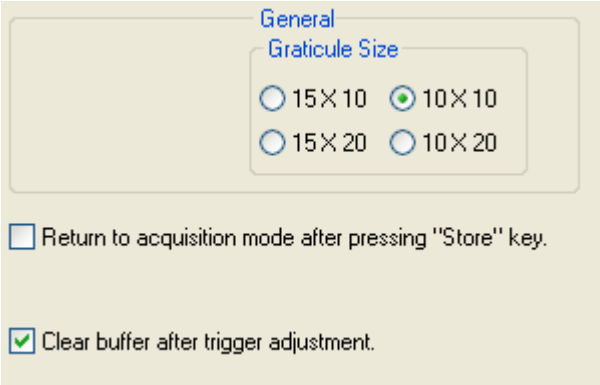
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

General Settings

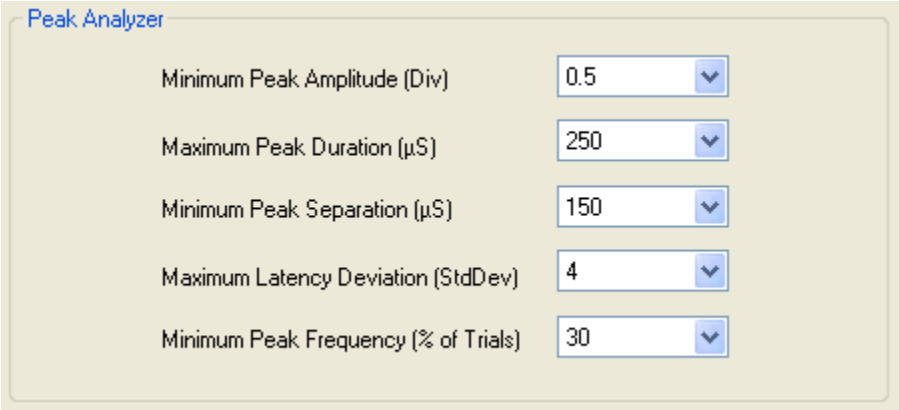


Graticule Size: These selections change the number of Vertical and Horizontal divisions that are displayed in the SFEMG Trace window. The first number is for the number of vertical divisions and the second number is for the number of horizontal divisions.

Return to Acquisition mode after pressing Store key: Enabling this check box causes the program to automatically return to acquisition mode as soon as the Store key is pressed in analysis mode.

Clear buffer after trigger adjustment: Enabling this check box causes the program to automatically clear the capture buffer, and peak detect window, when the trigger indicator position is changed.

Peak Analyzer



This section is used to adjust the automatic peak detection criteria.

Minimum Peak Amplitude (Div) - choices are 0.25 or 0.5 divisions. The default setting is 0.5.

Maximum Peak Duration (uS) - choices are 250, 300, or 350. The default setting is 250.

Minimum Peak Separation (uS) - choices are 150, 100, or 50. The default setting is 150.

Maximum Latency Deviation (StdDev) - choices are 4, 3, or 2. The default setting is 4.

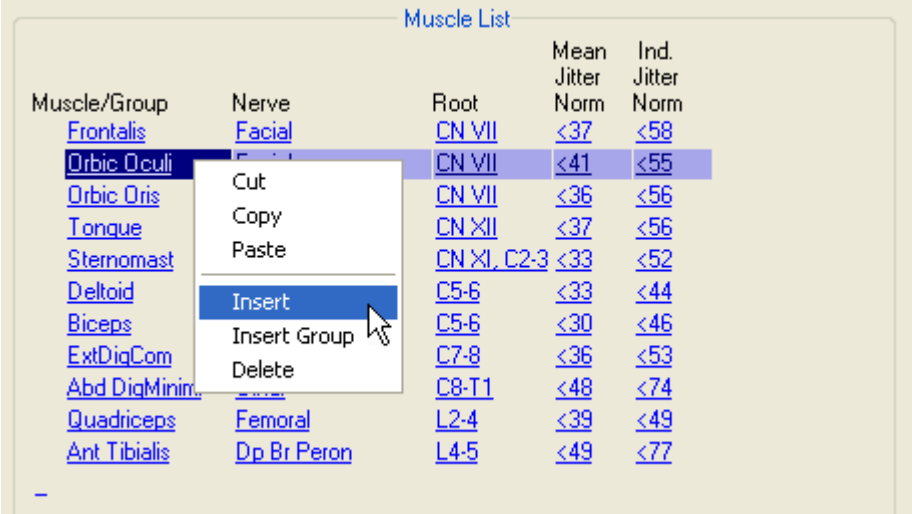
Minimum Peak Frequency (% of Trials) - choices are 30, 20, 10, or 0. The default setting is 30.

The peak analyzer settings must be adjusted prior to data acquisition.

For more information on the peak detection critera, click here.

Muscle List

This section is used to setup your Real Time SFEMG muscle list. The list can contain group headings, muscle names, nerve names, root levels, and normal values for Jitter.



To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, root level, and MCD normal value.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, root level, and normal values.

To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle:
Click on the muscle name you want to change. Type the new name and press **Enter**.

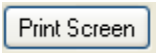
To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

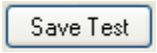
Normal Values:

- **Mean Jitter Norm** - this is the muscle's overall normal value for mean MCD of 20 fiber pairs.
- **Ind. Jitter Norm** - this is the normal value for individual single fiber pairs.

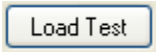
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.



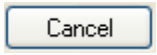
Clicking the **Save Test** button will open the Save Test window. This allows the Real Time SFEMG test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the Real Time SFEMG test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the Real Time SFEMG settings from that file.

Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the Real Time SFEMG test protocol settings.

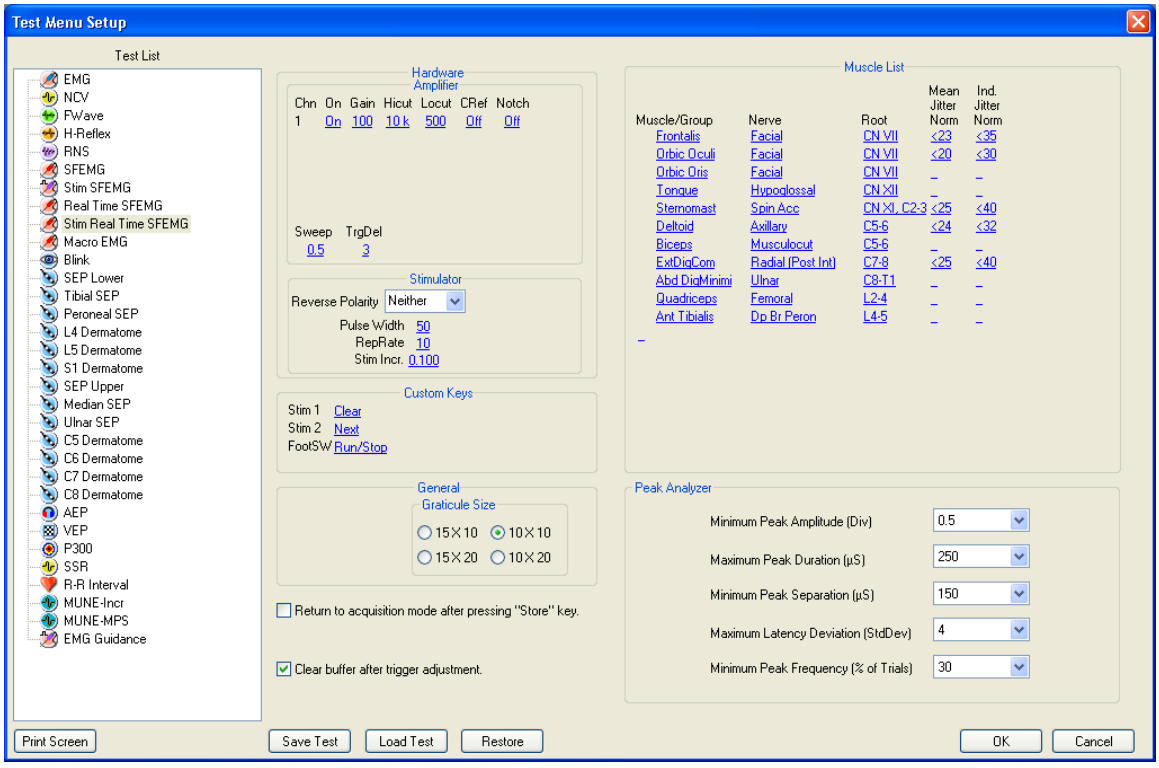


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the Real Time SFEMG test protocol settings.

Stim Real Time SFEMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **Stim Real Time SFEMG** test protocol in the test list. The Stim Real Time SFEMG test protocol settings will be displayed on the right hand side of the screen.

Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Stimulator settings, Custom Key settings, Peak Analyzer Settings, and the Muscle List.



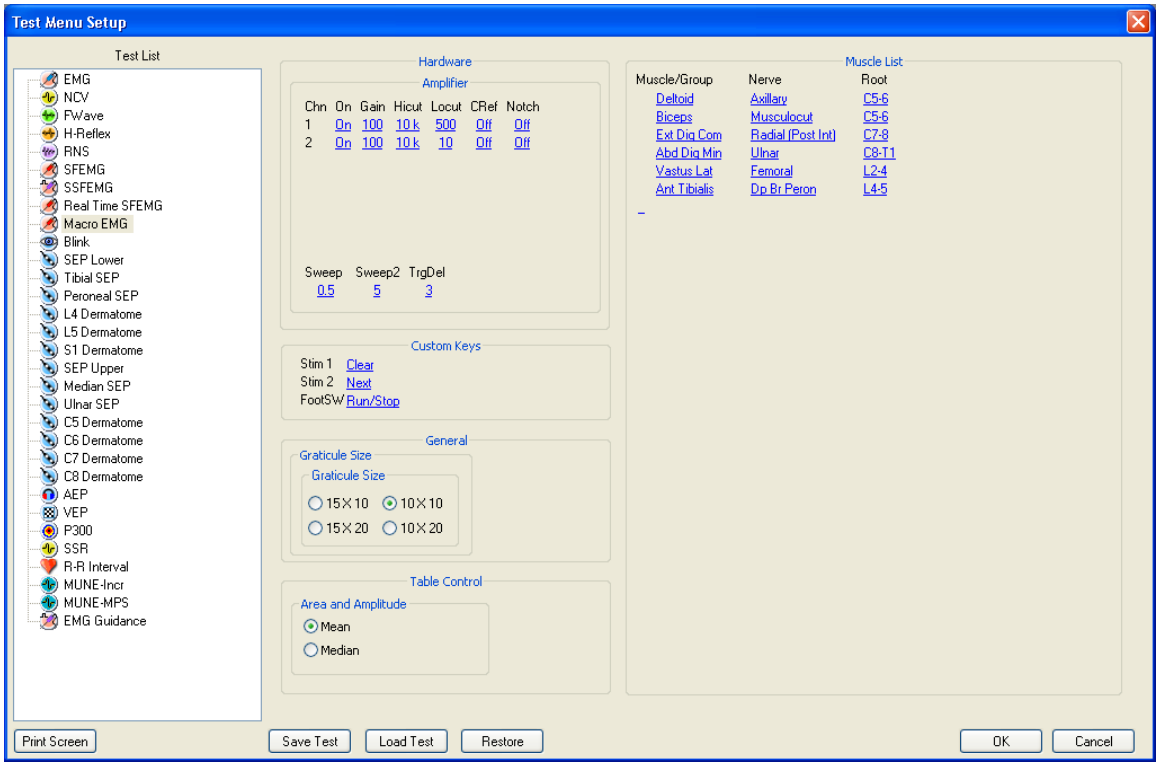
Stim Real Time SFEMG setup window.

The only difference between **Stim Real Time SFEMG** and **Real Time SFEMG** setup is that different normal values have bee programmed for the muscles. Please go to the Real Time SFEMG setup topic for a description of the setup parameters.

Macro EMG Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the Macro EMG test protocol in the test list. The Macro EMG test protocol settings will be displayed on the right hand side of the screen.

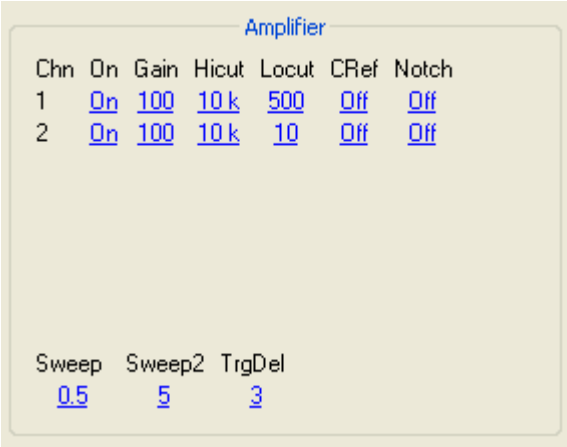
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Custom Key settings, and the Muscle List.



Macro EMG Setup window.

Hardware Settings

Amplifier Settings



On: Click here to program a channel as either On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting for channel 1 (SFEMG channel) in milliseconds per division (ms/Div).

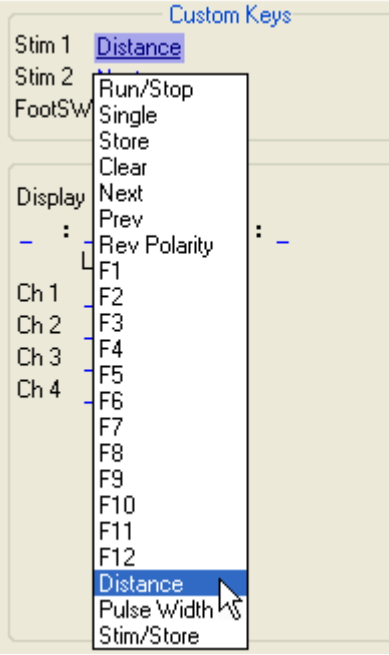
Sweep2: Click here to select the default sweep speed setting for channel 2 (Macro channel) in milliseconds per division (ms/Div).

TrgDel: Click here to select the trigger delay point. The choices are 1 to 9 divisions in 0.1 increments.

Custom Keys

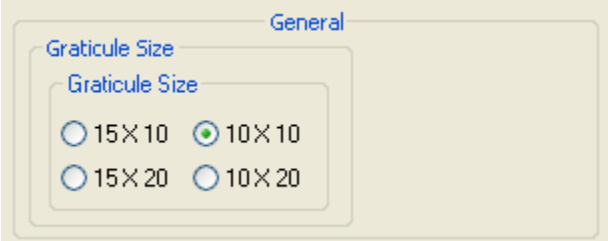
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

General Settings



Graticule Size: These selections change the number of Vertical and Horizontal divisions that are displayed in the SFEMG and Macro Trace windows. The first number is for the number of vertical divisions and the second number is for the number of horizontal divisions.

Muscle List

This section is used to setup your Macro EMG muscle list. The list can contain group headings, muscle names, nerve names, and root levels.

To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, and root level.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, and root level.

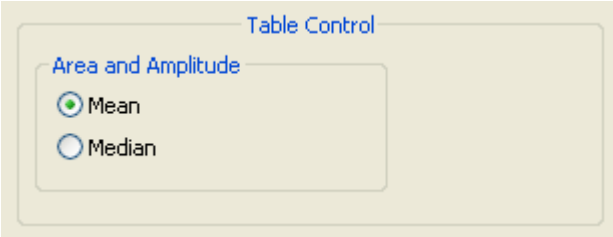
To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle:
Click on the muscle name you want to change. Type the new name and press **Enter**.

To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

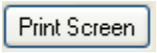
To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Table Control

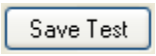


Area & Amplitude - this setting determines how the summarized data for a muscle is displayed. The data for amplitude and area can either be displayed as the mean or median value.

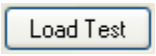
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.



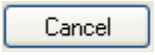
Clicking the **Save Test** button will open the Save Test window. This allows the Macro EMG test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the Macro EMG test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the Macro EMG settings from that file.

Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the Macro EMG test protocol settings.

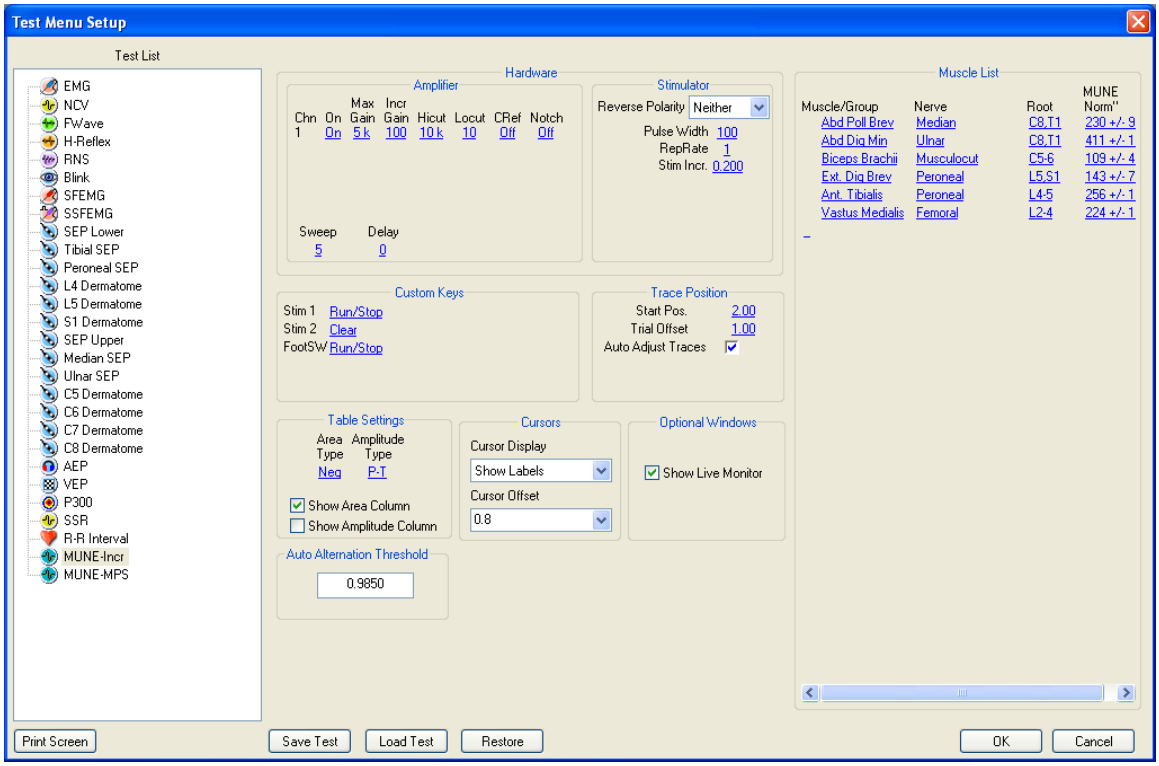


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the Macro EMG test protocol settings.

MUNE (Incremental) Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **MUNE-Incr** test protocol in the test list. The MUNE-Inr (Motor Unit Number Estimation - Incremental) test protocol settings will be displayed on the right hand side of the screen.

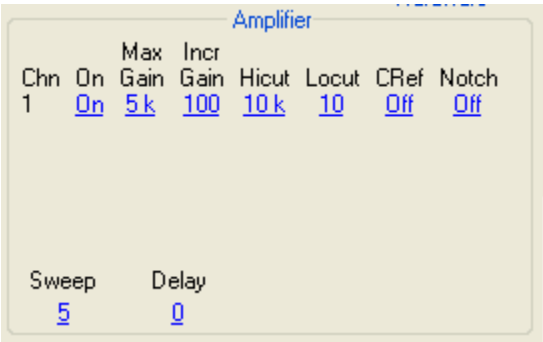
Use the settings on this screen to program the default parameters for Amplifier settings, Stimulator settings, Trace positioning, Custom Key settings, Table settings, and the Muscle List.



MUNE-Incr Setup window

Hardware Settings

Amplifier Settings



On: Click here to program a channel as either On or Off.

Max Gain: Click here to select the default gain setting in microvolts per division (uV/Div) for the maximum CMAP trace.

Incr Gain: Click here to select the default gain setting in microvolts per division (uV/Div) for the individual incremental SMUP (single motor unit potential) traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

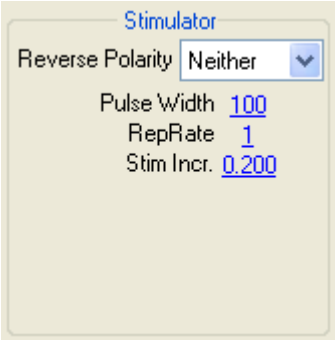
CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

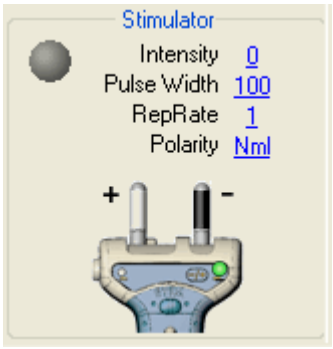
Stimulator Settings

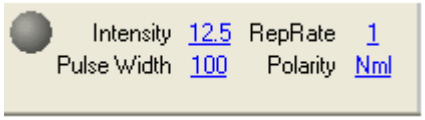


Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

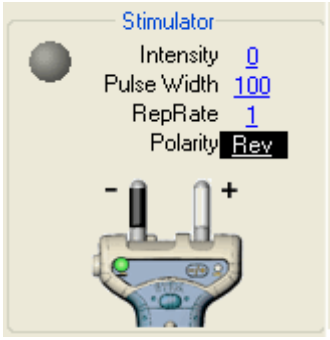




Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

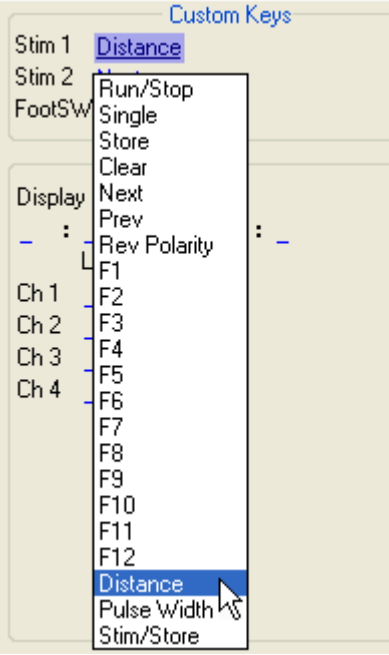
Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Stim Incr. : Click here to set the value of the electrical stimulus increments, in milliamps (mA). Choices are 0.026, 0.03, 0.04, 0.05, 0.08. 0.1, 0.2, 0.3, and 0.5.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position

Start Position: This is the default trace within the incremental SMUP trace window. It specifies the number of vertical divisions below the top of the trace window. In this example, the first incremental trace will be positioned 2 divisions below the top of the window.

Trial Offset: This setting determines how much space will separate each stored incremental trace. In this example the setting is 1.0 divisions, therefore the second incremental trace will be displayed 1.0 divisions below the first trace. The third incremental trace will be displayed 1.0 divisions below the second trace and so on.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the incremental trace window.

Trace Position settings can be changed during data acquisition by right-clicking with the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Muscle List

This section is used to setup your MUNE-Incr muscle list. The list can contain group headings, muscle names, nerve names, root levels, and normal values.

To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, root level, and MUNE normal value.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, root level, and normal values.

To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle:

Click on the muscle name you want to change. Type the new name and press **Enter**.

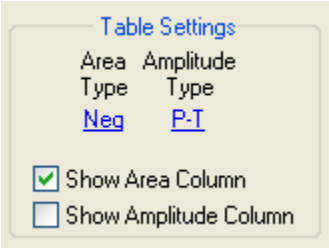
To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Normal Values:

- **MUNE Norm** - enter the normal value for the muscle here.

Table Settings



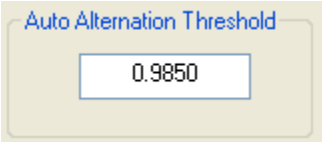
Area Type: the MUNE can be calculated using the area of the maximum CMAP divided by the area of the mean SMUP. Choices for the area measurement are **Neg** Area or **Full** Area.

Amplitude Type: the MUNE can be calculated using the amplitude of the maximum CMAP divided by the amplitude of the mean SMUP. Choices for the area measurement are **O-P** (Onset to Peak) or **P-T** (Peak to Trough).

Show Area Column: when enabled the area of the maximum CMAP, the area of the mean SMUP, and the MUNE value based on the area will be shown in the table.

Show Amplitude Column: when enabled the amplitude of the maximum CMAP, the amplitude of the mean SMUP, and the MUNE value based on the amplitude will be shown in the table.

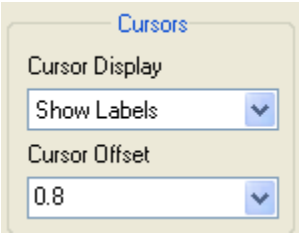
Auto Alternation Threshold



Sets the value of the **Cross-Correlation threshold** used by the Auto-Alternation detection algorithm. The cross-correlation is normalized to the largest amplitude incremental trace.

Alternation refers to the problems that occur when two or more motor units are capable of being activated at the same stimulus intensity. One or the other (or both) motor units may be recruited at any given time. Alternation results in a larger number of perceived increments, which in turn results in a smaller mean SMUP value, and hence a larger or overestimated MUNE value. The alternation detection function sorts the increment waveforms by increasing negative peak amplitude and then subtracts each incremental waveform from all subsequent ones; any identical solutions are considered to be examples of alternation.

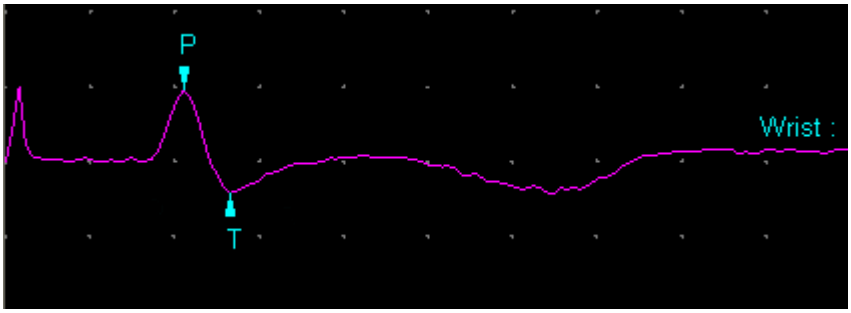
Cursors



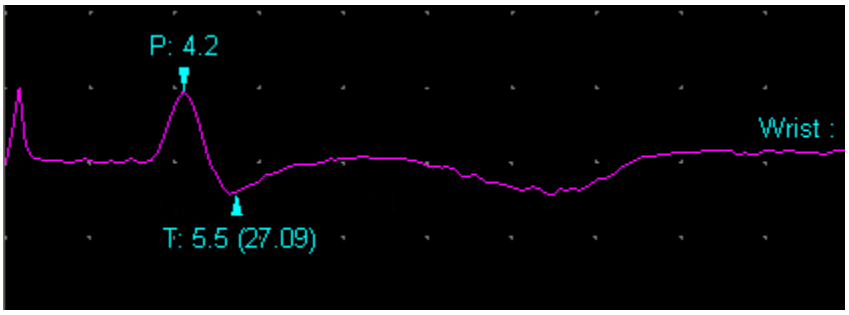
Cursor Display:

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

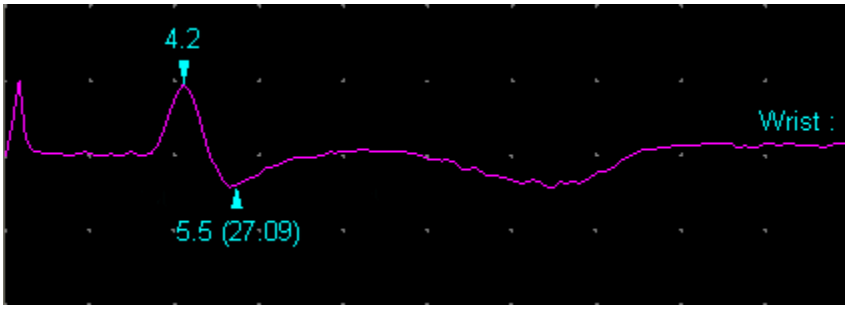
- **Show Labels** - shows the labels **O** (onset), **P** (peak), **T** (trough), and **R** (recovery).



- **Labels and Values** - shows the labels mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.

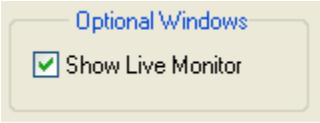


Cursor Offset: This parameter determines the starting point (in milliseconds) for the auto-cursor algorithm. Data prior to this setting is ignored by the algorithm.

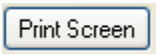
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.

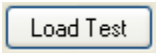


Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

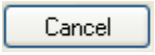
Clicking the **Save Test** button will open the Save Test window. This allows the MUNE-Incr test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the MUNE-Incr test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the MUNE-Incr settings from that file.

Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the MUNE-Incr test protocol settings.

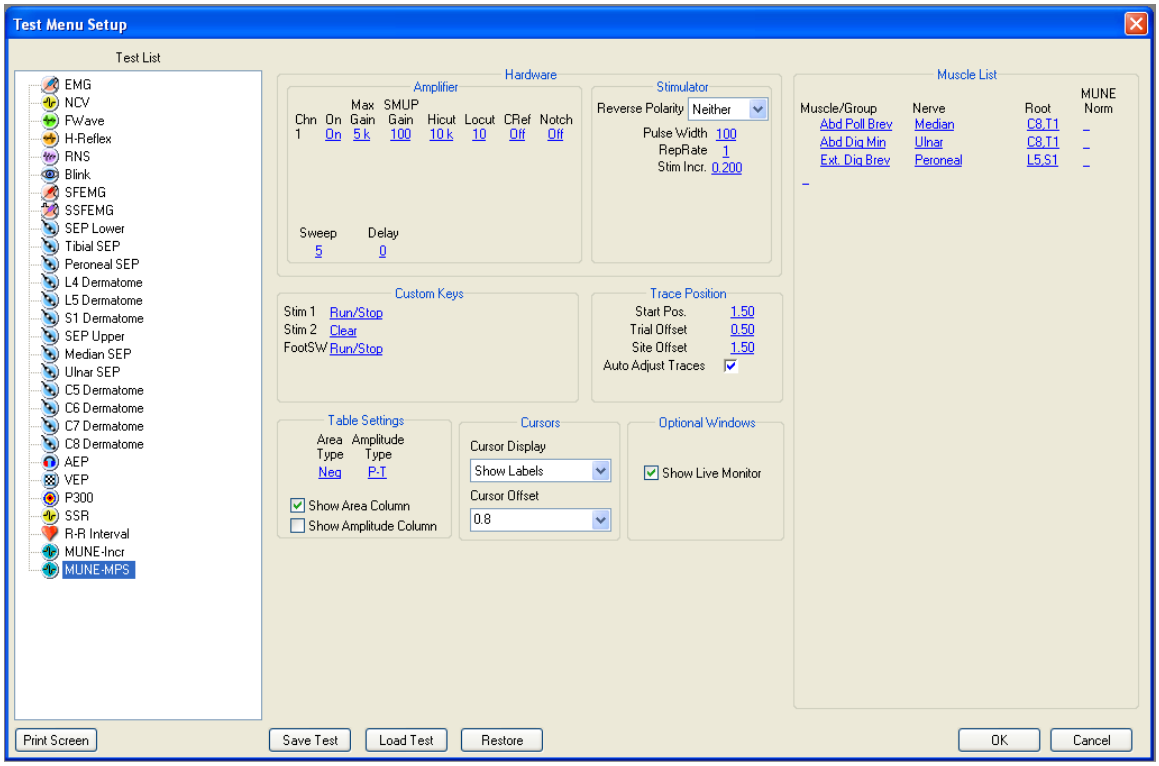


Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the MUNE-Incr test protocol settings.

MUNE (MPS) Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **MUNE-MPS** test protocol in the test list. The MUNE-MPS (Motor Unit Number Estimation - Multiple Point Stimulation) test protocol settings will be displayed on the right hand side of the screen.

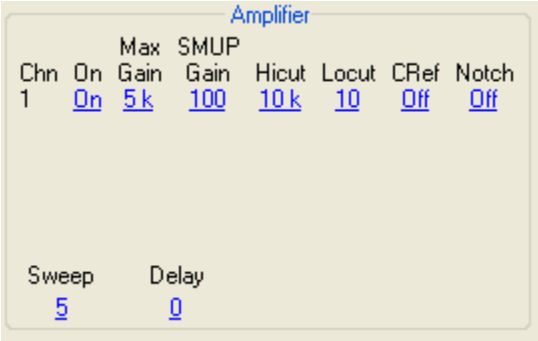
Use the settings on this screen to program the default parameters for Amplifier settings, Stimulator settings, Trace positioning, Custom Key settings, Table settings, and the Muscle List.



MUNE-MPS Setup window.

Hardware Settings

Amplifier Settings



On: Click here to program a channel as either On or Off.

Max Gain: Click here to select the default gain setting in microvolts per division (uV/Div) for the maximum CMAP trace.

SMUP Gain: Click here to select the default gain setting in microvolts per division (uV/Div) for the individual SMUP (single motor unit potential) traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

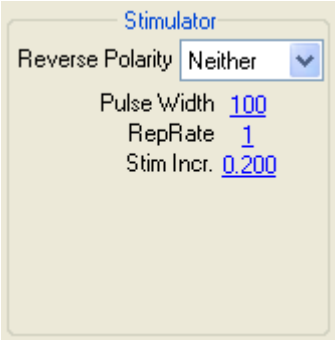
CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

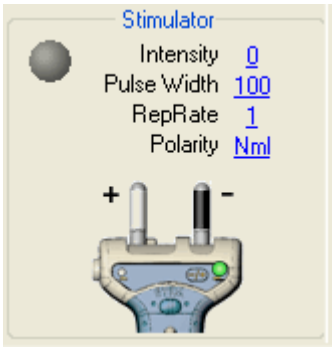
Stimulator Settings

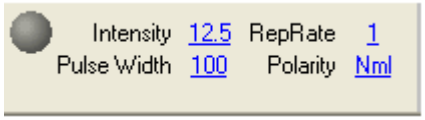


Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

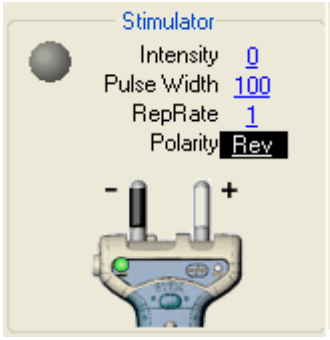




Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

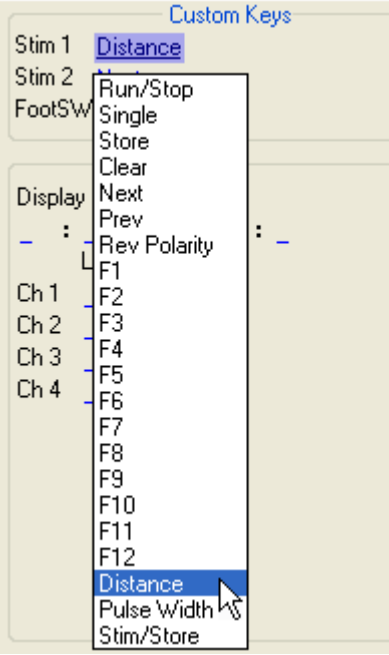
Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Stim Incr. : Click here to set the value of the electrical stimulus increments, in milliamps (mA). Choices are 0.026, 0.03, 0.04, 0.05, 0.08. 0.1, 0.2, 0.3, and 0.5.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position

Start Position: This is the default trace within the individual SMUP trace window. It specifies the number of vertical divisions below the top of the trace window. In this example, the first SMUP trace will be positioned 1.5 divisions below the top of the window.

Trial Offset: This setting determines how much space will separate each stored SMUP trace acquired from the same stimulus site. In this example the setting is 0.5 divisions, therefore the second SMUP trace will be displayed 0.5 divisions below the first trace. The third SMUP trace will be displayed 0.5 divisions below the second trace and so on.

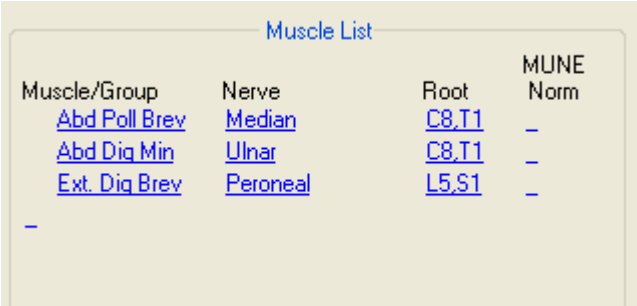
Site Offset: This setting determines how much space will separate the stored SMUP traces from different stimulus sites. In this example the setting is 1.5 divisions, therefore the second stimulus site's SMUP will be displayed 1.5 divisions below the last stored trace for the first stimulus site.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the SMUP trace window.

Trace Position settings can be changed during data acquisition by right-clicking with the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Muscle List

This section is used to setup your MUNE-MPS muscle list. The list can contain group headings, muscle names, nerve names, root levels, and normal values.



To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, root level, and MUNE normal value.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name, root level, and normal values.

To insert a Group Heading into the list:
Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right

clicked on. Enter the heading name in the muscle/group name field, leave the remaining fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle:
Click on the muscle name you want to change. Type the new name and press **Enter**.

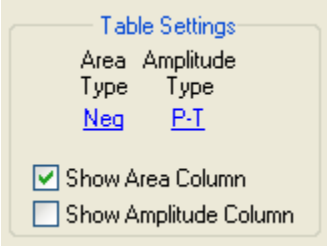
To change the order of the muscles in the list:
Changing the order of the muscle list requires the use of the **Cut** & **Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

To delete a muscle from the list:
Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Normal Values:

- **MUNE Norm** - enter the normal value for the muscle here.

Table Settings



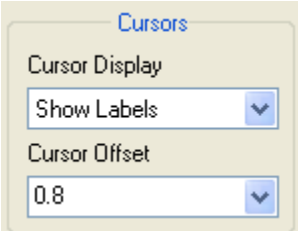
Area Type: the MUNE can be calculated using the area of the maximum CMAP divided by the area of the average SMUP. Choices for the area measurement are **Neg** Area or **Full** Area.

Amplitude Type: the MUNE can be calculated using the amplitude of the maximum CMAP divided by the amplitude of the average SMUP. Choices for the area measurement are **O-P** (Onset to Peak) or **P-T** (Peak to Trough).

Show Area Column: when enabled the area of the maximum CMAP, the area of the average SMUP, and the MUNE value based on the area will be shown in the table.

Show Amplitude Column: when enabled the amplitude of the maximum CMAP, the amplitude of the average SMUP, and the MUNE value based on the amplitude will be shown in the table.

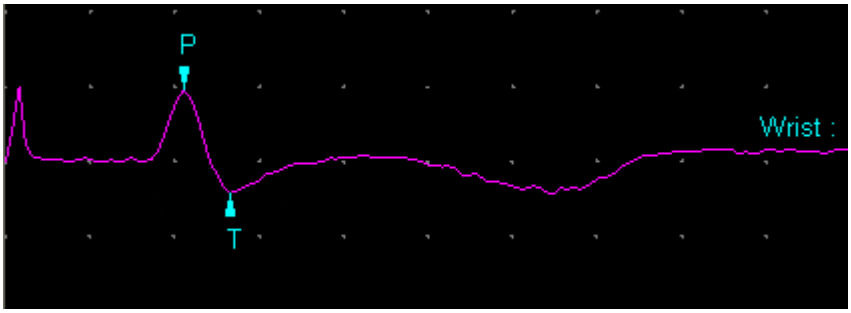
Cursors



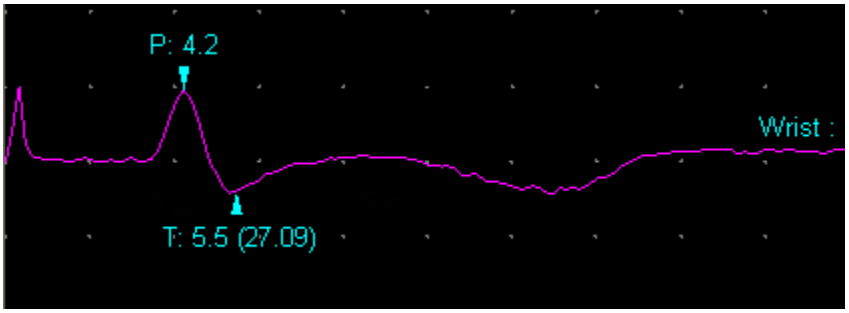
Cursor Display:

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

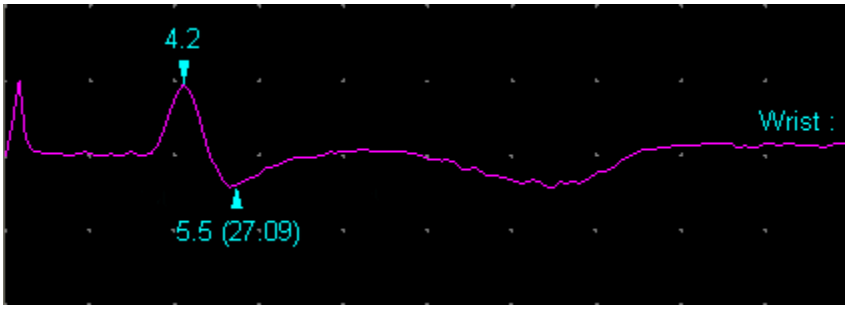
- **Show Labels** - shows the labels **O** (onset), **P** (peak), **T** (trough), and **R** (recovery).



- **Labels and Values** - shows the labels mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.

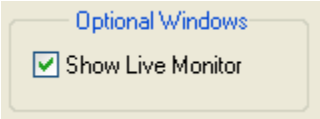


Cursor Offset: This parameter determines the starting point (in milliseconds) for the auto-cursor algorithm. Data prior to this setting is ignored by the algorithm.

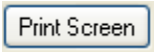
Optional Windows

- **Show Live Monitor** - when this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.

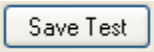
This window can be positioned, sized, and saved as part of the default settings for the test protocol.



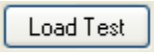
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

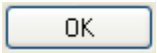


Clicking the **Save Test** button will open the Save Test window. This allows the MUNE-MPS test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the MUNE-MPS test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the MUNE-MPS settings from that file.



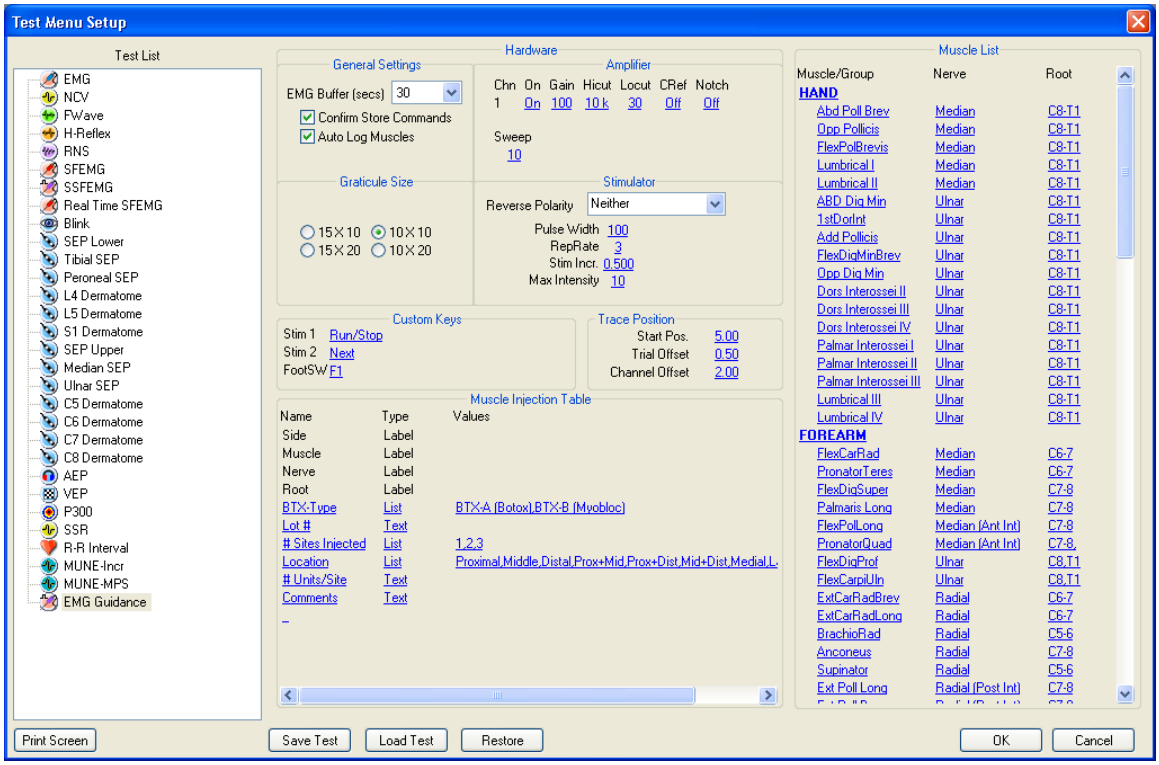
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the MUNE-MPS test protocol settings.

Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the MUNE-MPS test protocol settings.

EMG Guidance Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **EMG Guidance** test protocol in the test list. The EMG Guidance test protocol settings will be displayed on the right hand side of the screen.

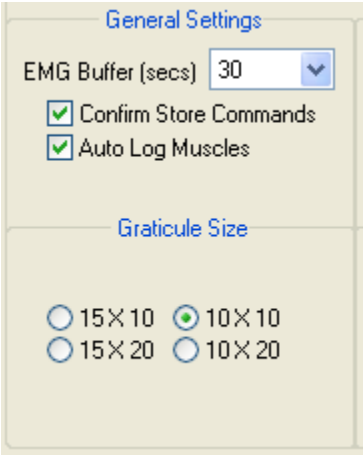
Use the settings on this screen to program the default parameters for Graticule size, Amplifier settings, Trace positioning, Custom Key settings, Injection Log selections, and the Muscle List.



EMG Guidance Setup window.

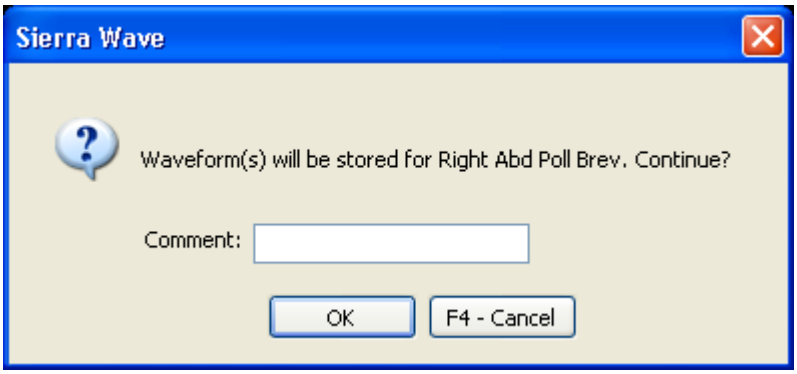
Hardware Settings

General Settings



EMG Buffer (secs): Sets the maximum length of the Live EMG Buffer. Choices are 30, 60, 120, 240, 360, and 600 seconds.

Confirm Store Commands: When this box is checked the program will display a confirmation window whenever an EMG Guidance Snapshot, or Live Buffer is stored. This ensures that the data is stored with the correct muscle name and side.



Auto Log Muscles: When this box is checked the program will automatically add all muscles in the Study List to the Muscle Injection Table as soon as the EMG Guidance protocol is loaded. If this box is not checked, you will need to manually add the muscles by using the **F2 (Muscle Sel/Add to Log)** knob.

Graticule Size: These selections change the number of Vertical and Horizontal divisions that are displayed in the EMG Guidance Trace window. The first number is for the number of vertical divisions and the second number is for the number of horizontal divisions.

Amplifier Settings

On: Click here to turn channel one On or Off.

Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

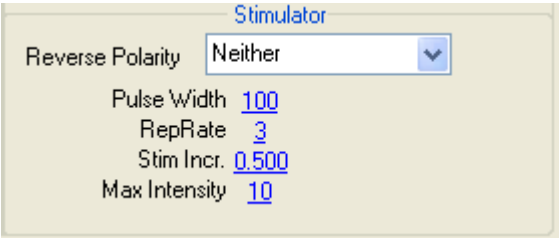
Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Stimulator Settings



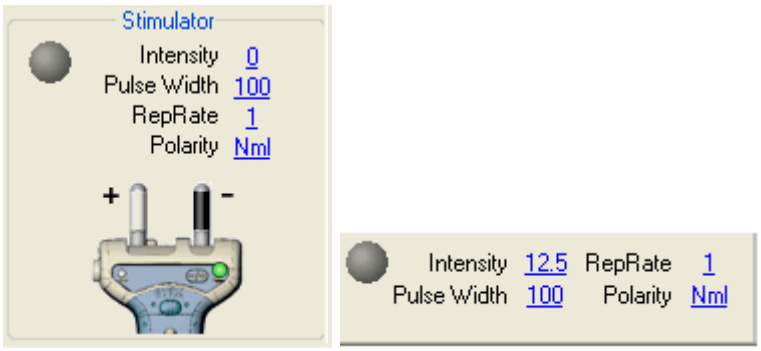
Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the

Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (usec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

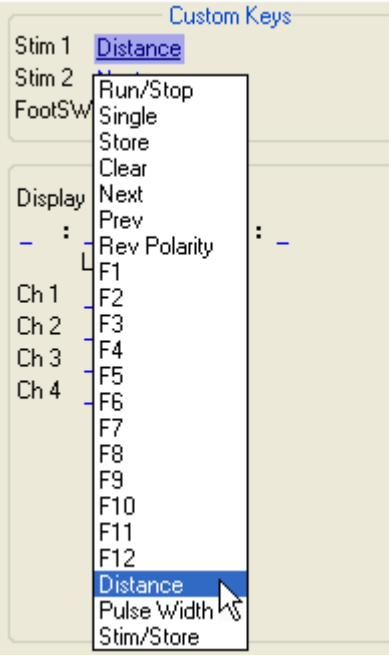
Stim Incr. : Click here to set the value of the electrical stimulus increments, in milliamps (mA). Choices are 0.026, 0.03, 0.04, 0.05, 0.08. 0.1, 0.2, 0.3, and 0.5.

Max Intensity: Click here to set the maximum stimulus intensity, in milliamps (mA). Choices are 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100.

Custom Keys

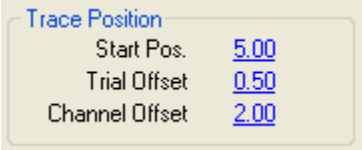
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position Settings



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the trace will be positioned 5 divisions below the top of the window.

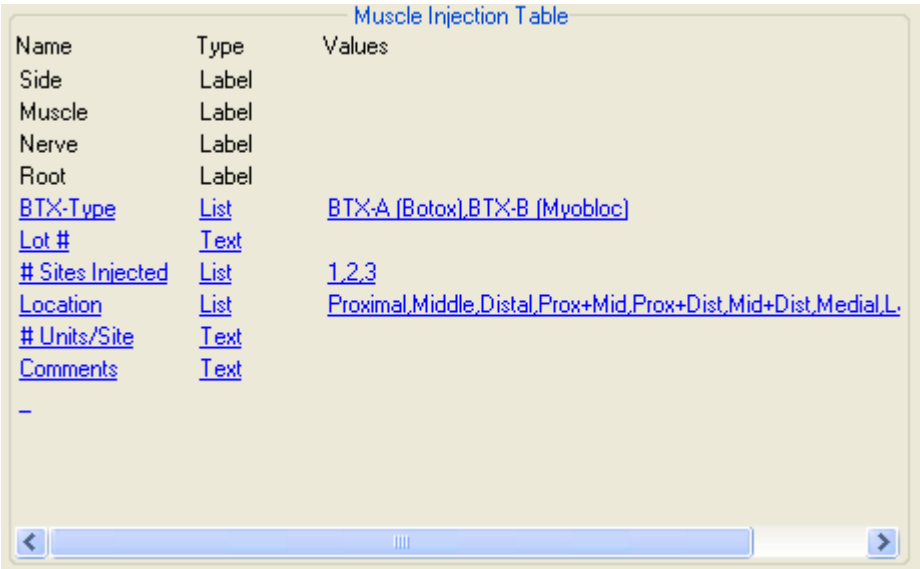
Trial Offset: This setting determines where the first stored EMG Guidance snapshot is displayed within the trace window and also how much space will separate additional stored snapshots within the same trace window. In this example the setting is 0.5 divisions, therefore the first stored snapshot will be displayed 0.5 divisions below the Live trace. If another snapshot is stored within the same trace window it will be displayed 0.5 divisions below the first stored snapshot and so on.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Live channels.

These settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Muscle Injection Table

This section is used to setup your muscle injection table column names (i.e., BTX-Type, Lot #, # Sites Injected), the column type (List or Text), and if applicable the default values (i.e., choices) for the column.



Name column: These entries will be displayed as the column headings across the top of your muscle injection table. The first four entries **Side**, **Muscle**, **Nerve**, and **Root** are fixed and cannot be altered. The remaining entries are programmable. To change an existing name simply select it by clicking on it with the mouse, then type the new name and press Enter. To enter a new name, click on the blank entry at the bottom of the list, then type the name for the entry and press Enter.

It is a good idea to keep the Name entries as short as possible. This will allow more column headings to be entered and displayed across the report table.

Type column: After entering the name for the column you can specify the column type. Simply click on the type setting and select Label, List, or Text.

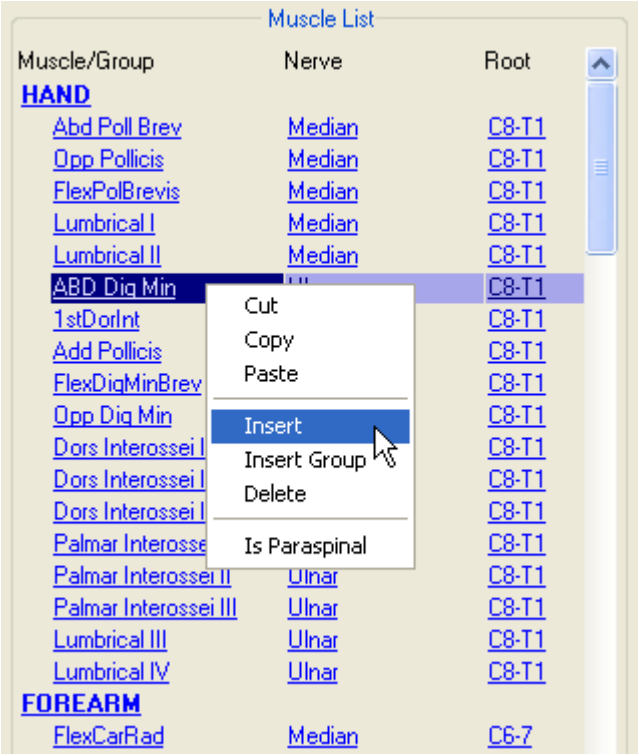
- **Label** - simply inserts the column name into the muscle injection table.
- **Text** - allows free form typing to be entered for that column.
- **List** - allows you to program a list of value choices for that column. Once the List type is selected the **Values** section will be enabled and you can

enter your choices. Simply click on the Values area and type your choices, the choices must be separated by a comma.

Norm column: If the entry is a List, you can preset the value that should be displayed when the muscle is initially entered into the table.

Muscle List

This section is used to setup your EMG Guidance muscle list. The list can contain group headings (i.e., Hand, Forearm), muscle names, nerve names, and root levels.



To insert a New Muscle into the list:

At the end of the list - click on the blank entry at the bottom of the list. Type in the muscle name, nerve name, and root level.

Within the list - right click the mouse over an existing muscle name. From the pop-up menu select **Insert**. A new row will appear above the muscle you right clicked on. Enter the muscle name, nerve name and root level.

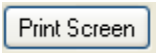
To insert a Group Heading into the list: Right click the mouse over an existing muscle name. From the pop-up menu select **Insert Group**. A new row will appear above the muscle that you right clicked on. Type the heading name in the muscle/group name field, leave the nerve and root fields blank. Group Headings are automatically shown in bold text:

To change the name of an existing muscle: Click on the muscle name you want to change. Type the new name and press **Enter**.

To change the order of the muscles in the list: Changing the order of the muscle list requires the use of the **Cut & Paste** features on the right-click pop-up menu. Begin by right clicking on the muscle name or group heading that you want to move, select **Cut** from the pop-up menu. Now, right click in the list where you want the muscle or group heading to go and select **Paste** from the pop-up menu (the muscle or group heading will be pasted above the row you right clicked upon). Repeat this process for all the muscles and group headings you want to move.

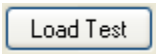
To delete a muscle from the list: Right click on the muscle you want to delete, then select **Delete** from the pop-up menu.

Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

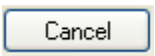
Clicking the **Save Test** button will open the Save Test window. This allows the EMG Guidance test protocol to be saved to a file.



Clicking the **Load Test** button will open the Load Test window. Use this feature to load the EMG Guidance test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the EMG Guidance settings from that file.

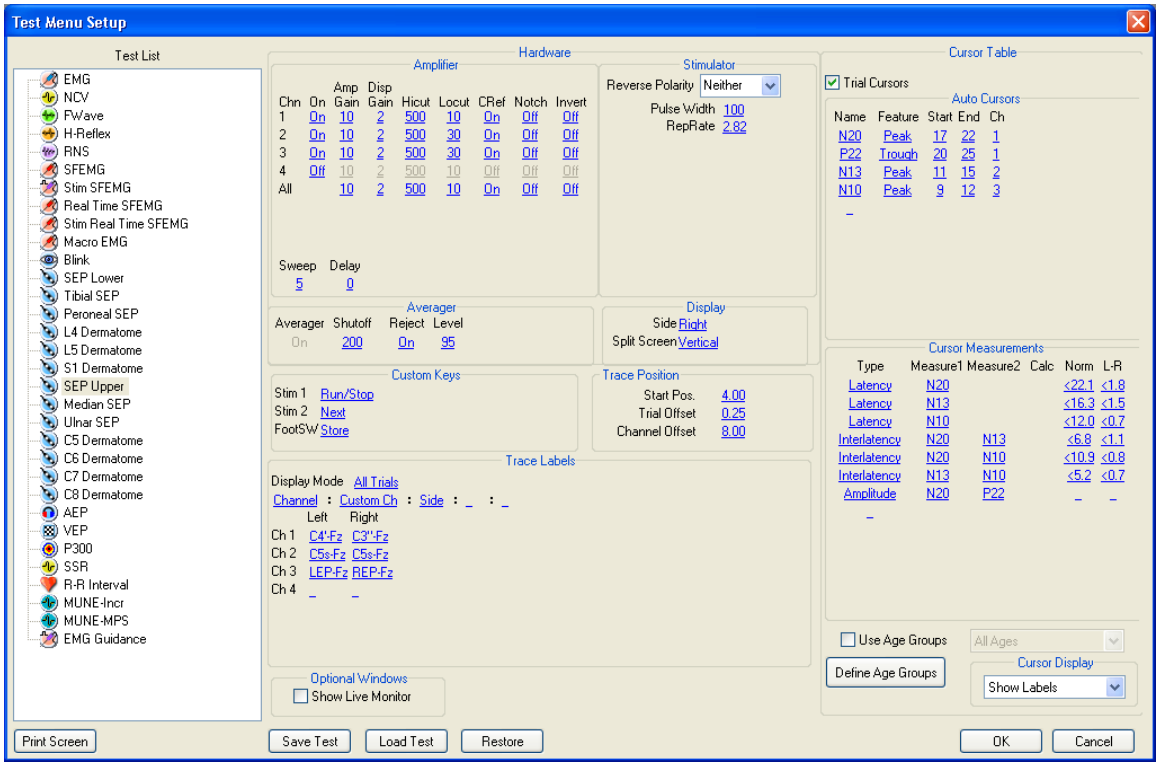
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the EMG Guidance test protocol settings.



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the EMG Guidance test protocol settings.

SEP Setup

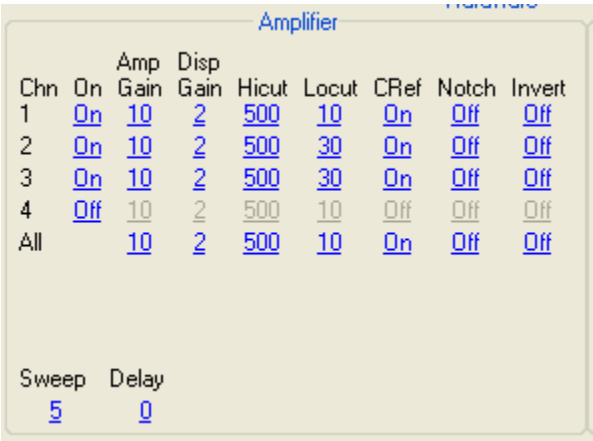
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **SEP** (Somatosensory Evoked Potential) test protocol in the test list (e.g., SEP Upper, Median SEP, or Tibial SEP). The SEP test protocol settings will be displayed on the right hand side of the screen.



SEP Upper Test Setup window.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off.

Amp Gain: Click here to select the default Amp Gain setting in microvolts per division (uV/Div). This is also known as Live Gain and is the setting used when viewing the Live, un-averaged traces.

Disp Gain: Click here to select the default Display Gain setting in microvolts per division (uV/Div). This is the setting that is used when viewing the averaged traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

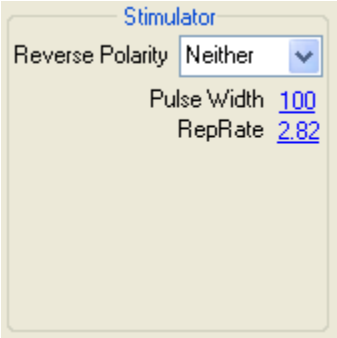
Invert: Click and select ON to automatically invert all traces recorded from this channel.

All: Provides a quick method of changing the parameters for all the channels at one time.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Stimulator:

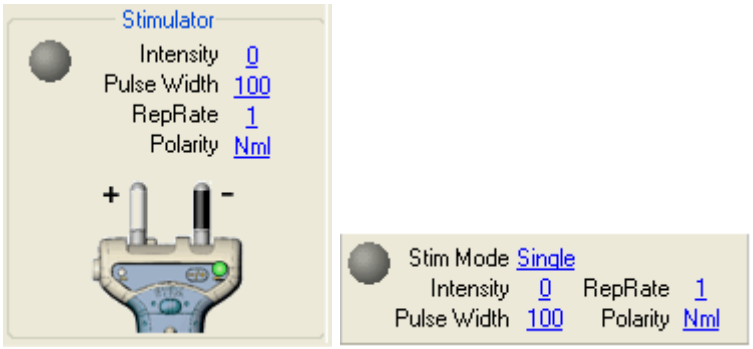


Reverse Polarity: The electrical stimulator polarity can be pre-programmed in the **Normal** or **Reversed** mode on a **Side** basis. Clicking the drop down arrow for this parameter will list four choices, **Neither**, **Left**, **Right**, and **Bilateral (both)**.

- **Neither** - the stimulator polarity will be initialized in the **Normal** mode when either the **Left or Right side** is selected for the nerve being tested. In the Normal mode, the **right-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Left** - the stimulator polarity will be initialized in the **Reversed** mode when the **Left side** is selected for the nerve being tested. When the Right side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Right** - the stimulator polarity will be initialized in the **Reversed** mode when the **Right side** is selected for the nerve being tested. When the Left side is selected the stimulator polarity will initialize in the Normal mode. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED.
- **Bilateral** - the stimulator polarity will be initialized in the **Reversed** mode when both the **Left and Right side** is selected for the nerve being tested. In the Reversed mode, the **left-side probe** will be the **Cathode (-)** and is indicated by a green LED..

For SEP Studies, the **Cathode (-) should be positioned proximally with the Anode distally.**

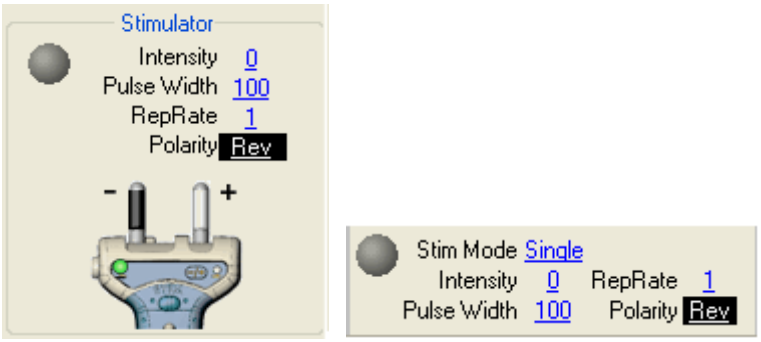
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

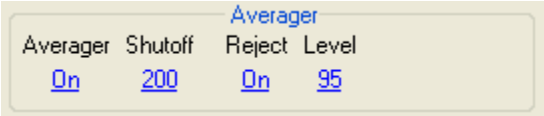
Reversed mode (left probe is Cathode).

To **determine whether the probe is right or left**, hold the stimulator with the Stim button facing you and the probes pointing up.

Pulse Width: Click here to set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Averager:



Averager: Click here to set the default setting for the averager as either **On** or **Off**. For evoked potentials, the averager is **always On**.

Shutoff: Click here to set the default setting for the shutoff count. This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject: Click here to set the default setting for the artifact rejection feature as either **On** or **Off**. When this feature is turned On the program will monitor the Live un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level: Click here to set the default reject sensitivity level in percent full scale. Choices are 30 to 100 % in increments of 5.

Reject is based on the Live un-averaged data and the Amp Gain setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uv/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

Display Settings:

Side: Click here to set the default setting for the **side of stimulation**. The choices are **Left**, **Right**, and **Bilateral**. For example, selecting Right will always set the initial side of stimulation to "Right" when the test protocol is

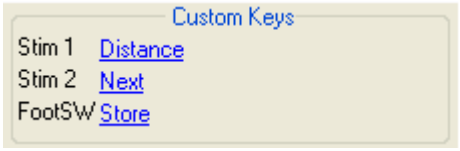
selected. This setting can be changed on the acquisition screen if you want to begin stimulation on the opposite side.

Split Screen: Click here to set the default setting for how the trace window is displayed. The choices are **Full**, **Vertical** and **Horizontal**.

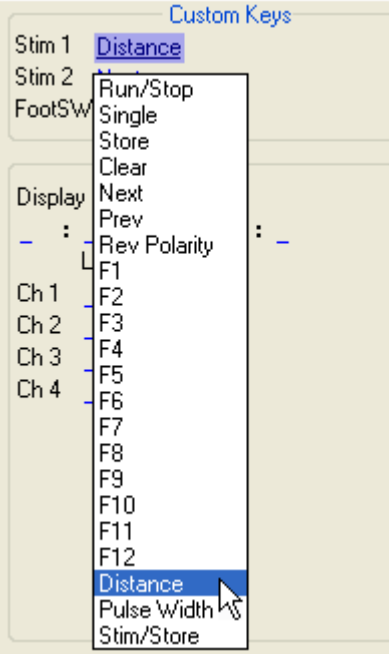
- **Full** - sets the trace area to full, all data from all sides are displayed in the same trace area.
- **Vertical** - splits the trace area into two equal halves with a vertical divider. Left sided traces are displayed on the left half of the trace window. Right sided traces are displayed on the right half of the trace window.
- **Horizontal** - splits the trace area into two equal halves with a horizontal divider. Left sided traces are displayed in the top half of the trace window. Right sided traces are displayed in the lower half of the trace window.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

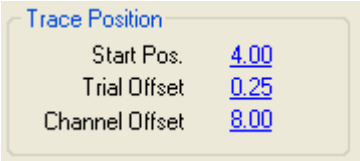


Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

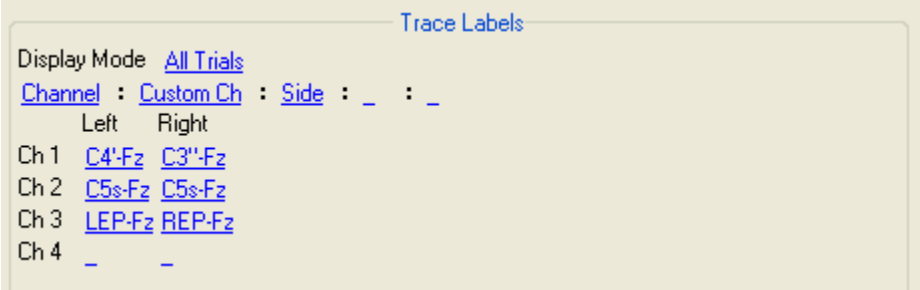
Trial Offset: This setting determines how much space will separate each stored SEP trace from both the active (white) and other stored (purple) traces. In this example the setting is 0.25 divisions, therefore the first stored SEP trace will be displayed 0.25 divisions below the active trace. If a second SEP trace is acquired and stored it will be displayed 0.25 divisions below the first stored SEP trace and so on. If you want all the traces from each channel superimposed on each other set this value to 0.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Active (white) channels.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).



Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.
- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.

- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or A1-Cz montage designations).

Left / Right Custom Labels:

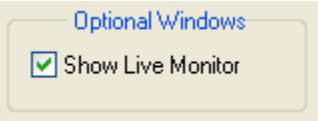
When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

Show Live Monitor

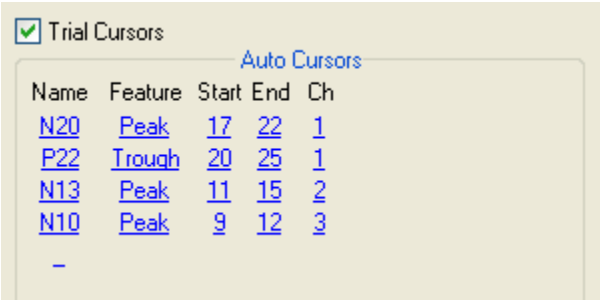
When this window is enabled it displays the “Live” activity coming from the recording electrodes. When stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.



This window can be positioned, sized, and saved as part of the default settings for the test protocol.

Cursor Table

This section is used to configure the cursors that will be used in the evoked potential test. You can enter the name of the cursor, select its feature type (Peak, Trough, or Onset), set a latency search window for the cursor, and assign cursors to specific channels.



Trial Cursors:

When this box is checked, the program will allow you to assign the cursors to specific channels. This is most commonly done for SEP test protocols since the cursors are not all applied to the same channel. If this boxed is unchecked, the channel column is hidden.

Auto Cursors:

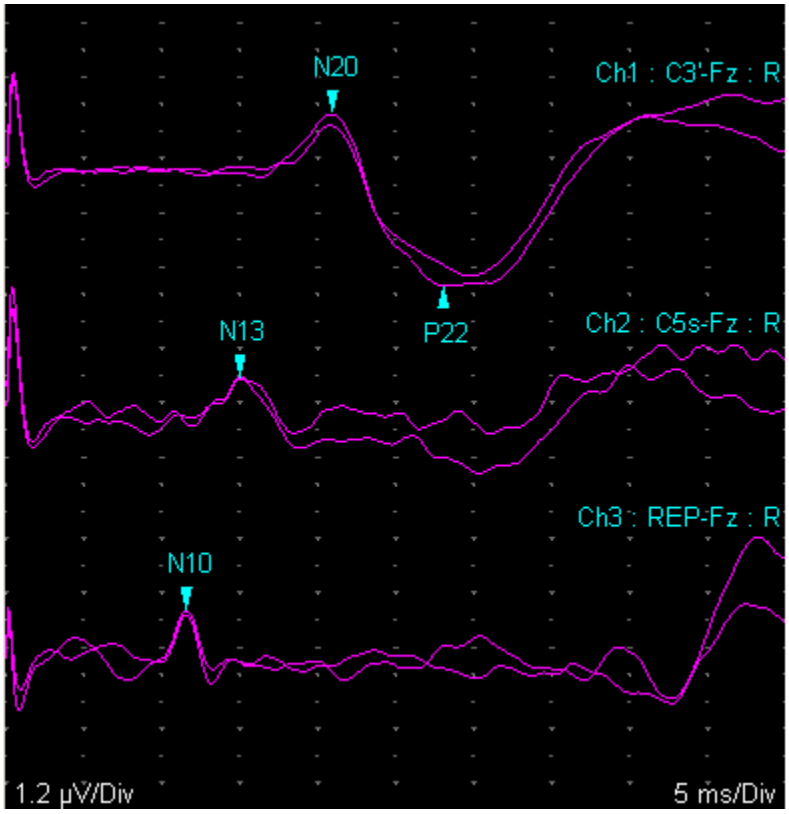
Name - click here to enter a name for the cursor, up to ten characters can be used.

Feature - click here to define the trace feature that the cursor will be searching for.

- Choose **Peak** to locate the highest point within the specified latency window.
- Choose **Trough** to locate the lowest point within the specified latency window.
- Choose **Onset** to locate the initial change from baseline before a peak.

Start / End - click here to enter the time, in milliseconds, that you want the program start and stop searching for the specified trace feature. *If the program does not find the feature within the start and end latency times it will place the cursor at the start latency position.*

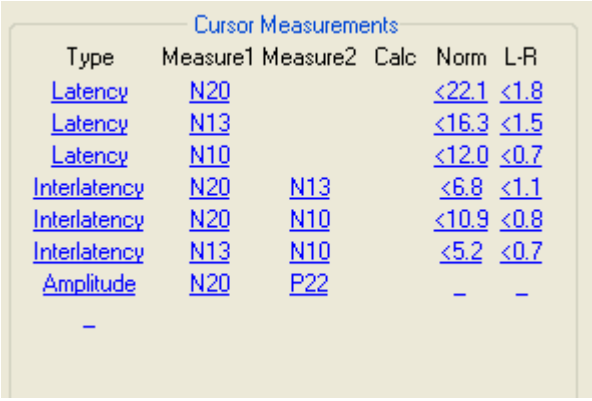
Ch - click here to assign the cursor to a specific channel. This column is only available if the **Trial Cursors** mode has been enabled.



Median SEP with cursors placed on one trial.

Cursor Measurements

This section is used to specify the measurements that will be displayed during data acquisition and in printed reports. The Cursor Table section must be completed before any selections in this table can be made.



Type: Click here to pick the type of measurement from a pop up list.

- **Latency -** displays the **time**, in milliseconds, between stimulus delivery and the selected cursor in the Measure1 column.

- **Amplitude -** displays the **amplitude**, in microvolts, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure amplitude, the two selected cursors should be placed on the same trace.
- I**nterlatency -** displays the **time difference**, in milliseconds, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure interlatency, you must first define two latency types.
- **Interamplitude -** displays either the **amplitude Difference** or **Ratio** (see Calc column below) between the two selected amplitude types in Measure1 and Measure2. In order to measure interamplitude, you must first define two amplitude types.
- **None -** select this option to remove the line from the cursor measurements.

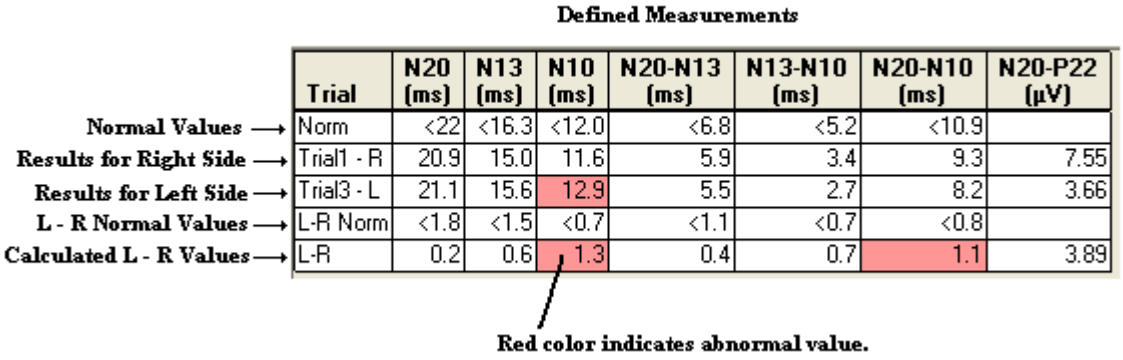
Measure 1 and Measure 2: Click here to select the cursor name from a pop up list. These names were defined previously in the Cursor Table section.

Calc: This column is only available for Interamplitude measurements.

- **Difference** - the difference, in microvolts, between the two selected amplitude types is displayed. (Measure1 - Measure2)
- **Ratio** - the result of dividing the first amplitude by the second amplitude is displayed. (Measure1 / Measure2)

Norm: Use this field to enter a normal value for the measurement. You can use a less than (<) or a greater than (>) symbol. The program will compare the measured value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

L-R: Use this field to enter a normal value for the left minus right difference for the measurement. The program will calculate the left minus right values for each defined measurement if cursors have been placed on one left and one right side trial. The program will compare the measured left minus right value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".



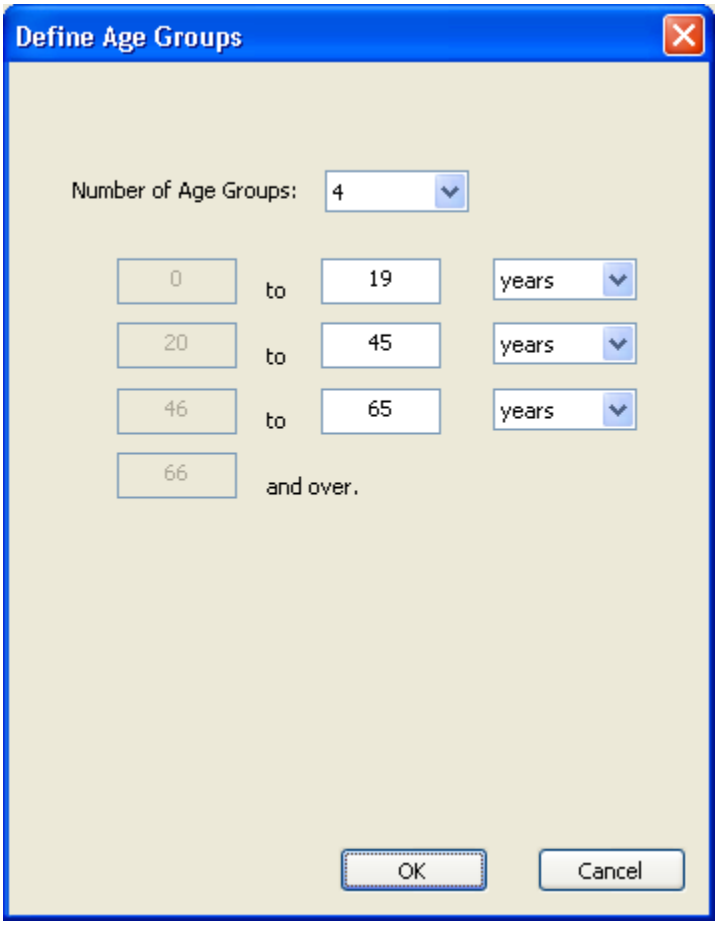
Median SEP cursor table example.

Age Group Norms

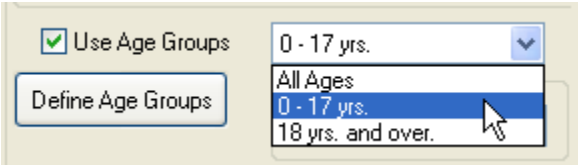
Up to 8 Age Groups can be defined and normal values can be entered for each group. The Sierra Wave program will compute the patient's age based on their date-of-birth and then use the appropriate age group norms.

To define the Age Groups:

1. Click on the **Define Age Groups** button.



2. Select the **number** of Age Groups, the maximum is 8.
3. Fill in the **upper age limit** for each group, select **years** or **months**, and click **OK**.
4. Check the **Use Age Groups** box. This will enable the **age groups drop-down list**.



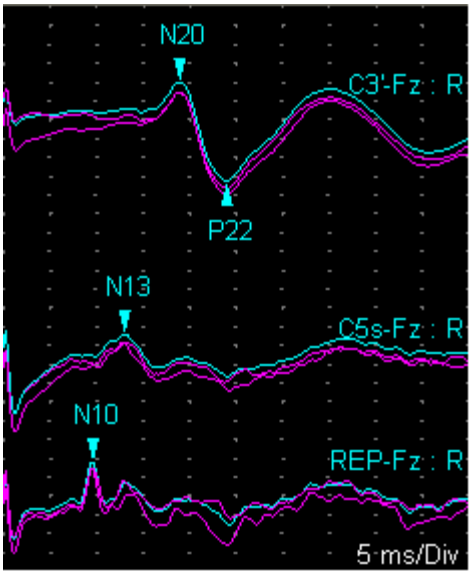
6. Enter the normal values for this age group into the **Cursor** table. Repeat for each age group in the drop-down list.

If the patient's **date-of-birth is not entered** into the patient information window, the program will use the normal values entered for the **All Ages** group.

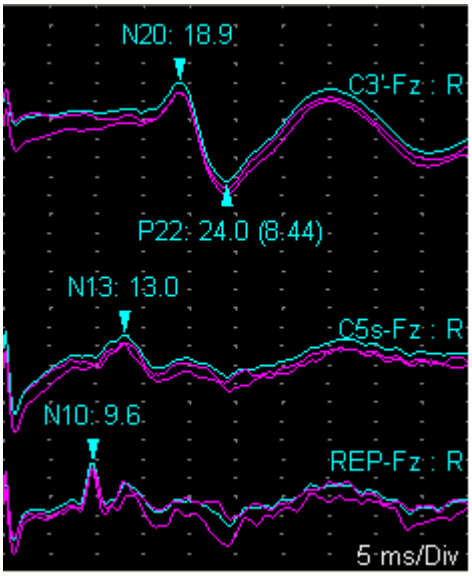
Cursor Labels

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

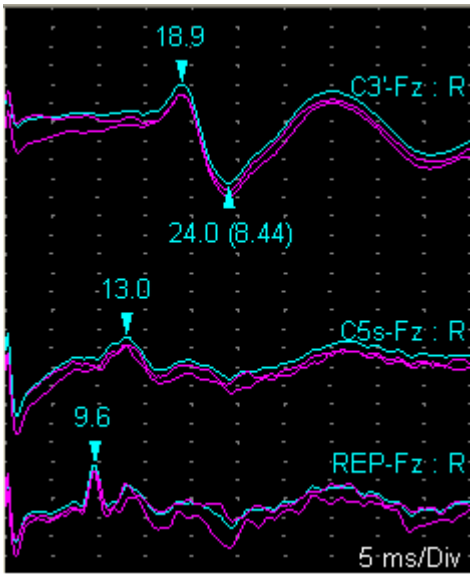
- **Show Labels** - shows the label names as entered in the auto-cursor table.



- **Labels and Values** - shows the label names mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.



Window Buttons

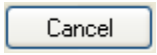
Clicking the **Print Screen** button will send an image of the screen to your default printer.

Clicking the **Save Test** button will open the Save Test window. This allows the SEP test protocol to be saved to a file.

Clicking the **Load Test** button will open the Load Test window. Use this feature to load the SEP test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the SEP settings from that file.

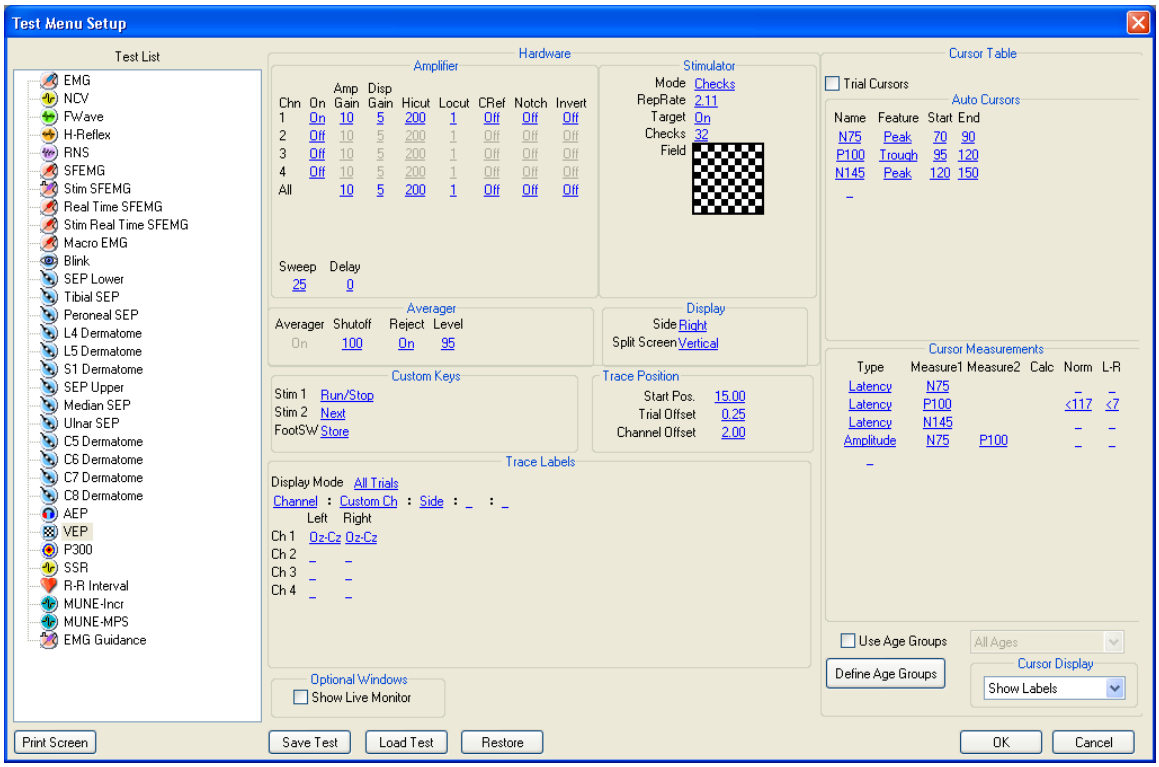
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the SEP test protocol settings.



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the SEP test protocol settings.

VEP Setup

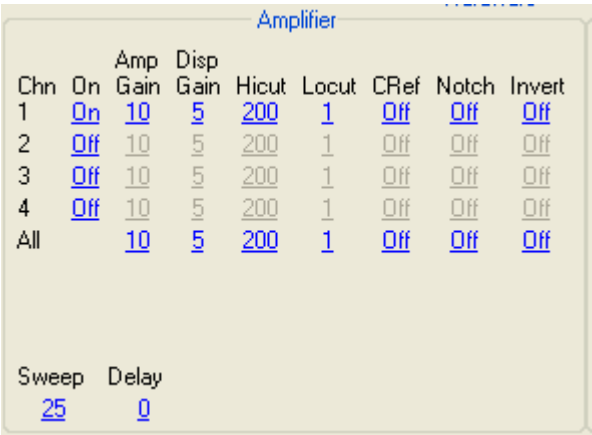
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **VEP** (Visual Evoked Potential) test protocol in the test list. The VEP test protocol settings will be displayed on the right hand side of the screen.



VEP Test Setup window.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off.

Amp Gain: Click here to select the default Amp Gain setting in microvolts per division (uV/Div). This is also known as Live Gain and is the setting used when viewing the Live, un-averaged traces.

Disp Gain: Click here to select the default Display Gain setting in microvolts per division (uV/Div). This is the setting that is used when viewing the averaged traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Invert: Click and select ON to automatically invert all traces recorded from this channel.

All: Provides a quick method of changing the parameters for all the channels at one time.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

Stimulator:

Mode: Click here to select the type of visual stimulus. Choices are **Checks**, **Goggles**, **LED**, and **Flash**.

- **Checks** - selects a reversing black & white checkerboard pattern. When checks are selected as the stimulus type the following additional parameters are available.
    - **Target** - select either On or Off. When turned On a small target is positioned in the center of the black & white monitor, the patient should focus on this target during data acquisition.
    - **Checks** - click here to select the number of checks displayed across a horizontal row. The choices are 1, 2, 4, 8, 16, 32, 64, and 128.
    - **Field** - click in this area to select the field of stimulation. The choices are Full Field, Upper Half, Right Half, Lower Half, Left Half, Left Upper Quarter, Right Upper Quarter, Right Lower Quarter, and Left Lower Quarter.
- **Goggles** - selects the LED Goggles.
- **LED** - selects the 3 inch hand held LED checkerboard stimulator.
- **Flash** - selects the strobe flash stimulator.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Averager:

Averager: Click here to set the default setting for the averager as either **On** or **Off**. For evoked potentials, the averager is **always On**.

Shutoff: Click here to set the default setting for the shutoff count. This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject: Click here to set the default setting for the artifact rejection feature as either **On** or **Off**. When this feature is turned On the program will monitor the Live un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level: Click here to set the default reject sensitivity level in percent full scale. Choices are 30 to 100 % in increments of 5.

Reject is based on the Live un-averaged data and the Amp Gain setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uv/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

Display Settings:

Side: Click here to set the default setting for the **side of stimulation**. The choices are **Left**, **Right**, and **Bilateral**. For example, selecting Right will always set the initial side of stimulation to "Right" when the test protocol is selected. This setting can be changed on the acquisition screen if you want to begin stimulation on the opposite side.

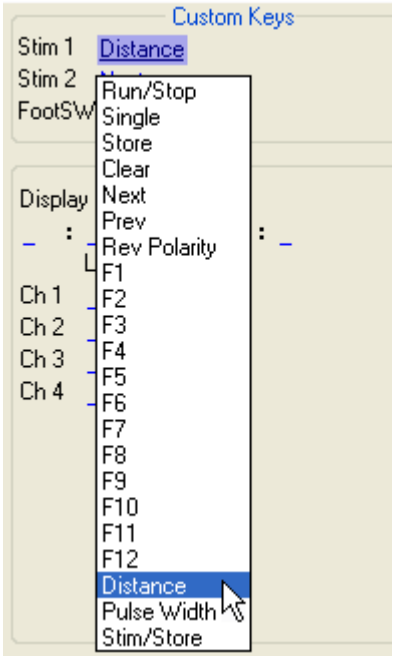
Split Screen: Click here to set the default setting for how the trace window is displayed. The choices are **Full**, **Vertical** and **Horizontal**.

- **Full** - sets the trace area to full, all data from all sides are displayed in the same trace area.
- **Vertical** - splits the trace area into two equal halves with a vertical divider. Left sided traces are displayed on the left half of the trace window. Right sided traces are displayed on the right half of the trace window.
- **Horizontal** - splits the trace area into two equal halves with a horizontal divider. Left sided traces are displayed in the top half of the trace window. Right sided traces are displayed in the lower half of the trace window.

Custom Keys

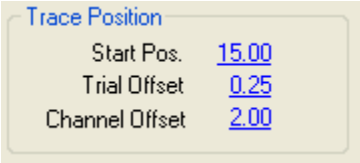
The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 15 divisions below the top of the window.

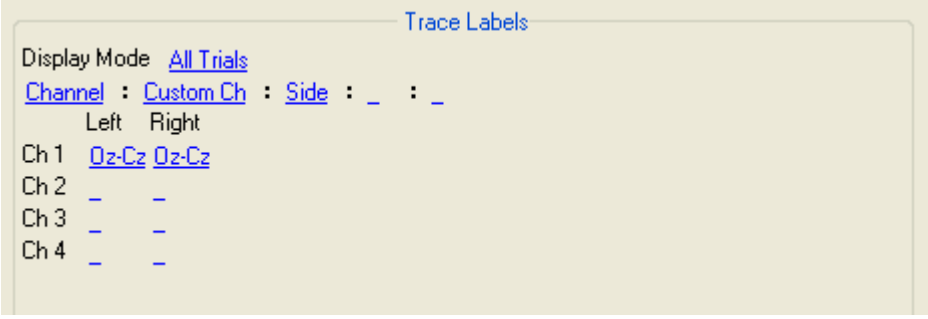
Trial Offset: This setting determines how much space will separate each stored VEP trace from both the active (white) and other stored (purple) traces. In this example the setting is 0.25 divisions, therefore the first stored VEP trace will be displayed 0.25 divisions below the active trace. If a second VEP trace is acquired and stored it will be displayed 0.25 divisions below the first stored VEP trace and so on. If you want all the traces from each channel superimposed on each other set this value to 0.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Active (white) channels.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).



Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.
- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.
- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or Oz-Cz montage designations).

Left / Right Custom Labels:

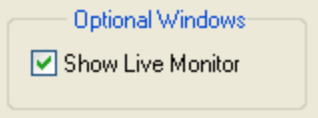
When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

Show Live Monitor

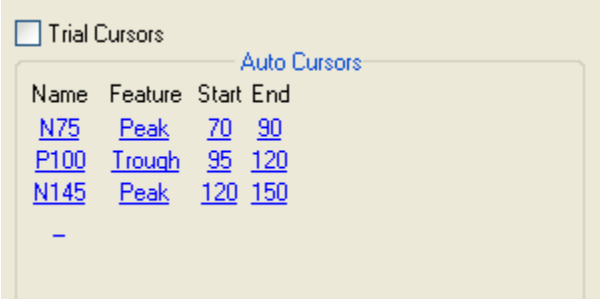
When this window is enabled it displays the “Live” activity coming from the recording electrodes. When stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.



This window can be positioned, sized, and saved as part of the default settings for the test protocol.

Cursor Table

This section is used to configure the cursors that will be used in the evoked potential test. You can enter the name of the cursor, select its feature type (Peak, Trough, or Onset), set a latency search window for the cursor, and assign cursors to specific channels.



Trial Cursors:

When this box is checked, the program will allow you to assign the cursors to specific channels. This is most commonly done for SEP test protocols since the cursors are not all applied to the same channel. If this boxed is unchecked, the channel column is hidden.

Auto Cursors:

Name - click here to enter a name for the cursor, up to ten characters can be used.

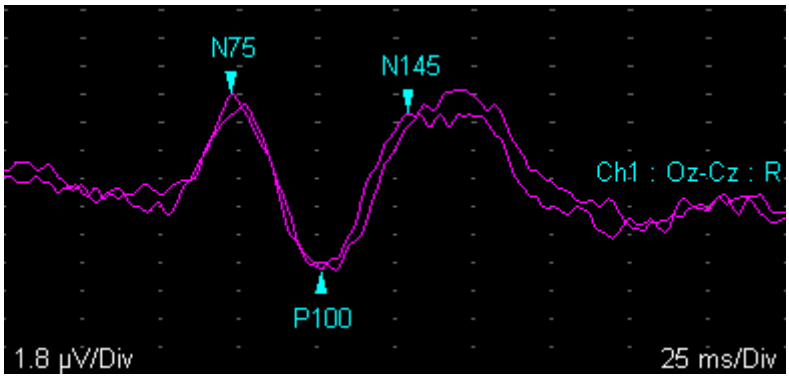
Feature - click here to define the trace feature that the cursor will be searching for.

- Choose **Peak** to locate the highest point within the specified latency window.
- Choose **Trough** to locate the lowest point within the specified latency window.
- Choose **Onset** to locate the initial change from baseline before a peak.

Start / End - click here to enter the time, in milliseconds, that you want the program start and stop searching for the specified trace feature. *If the*

program does not find the feature within the start and end latency times it will place the cursor at the start latency position.

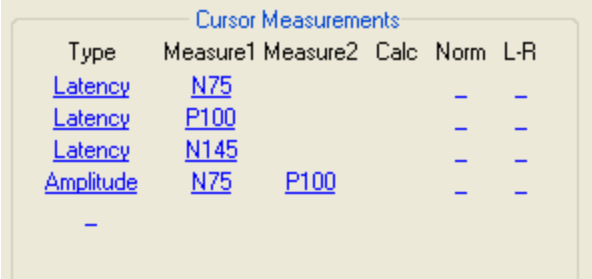
Ch - click here to assign the cursor to a specific channel. This column is only available if the **Trial Cursors** mode has been enabled.



VEP example (right eye) with cursors placed on one trial.

Cursor Measurements

This section is used to specify the measurements that will be displayed during data acquisition and in printed reports. The Cursor Table section must be completed before any selections in this table can be made.



Type: Click here to pick the type of measurement from a pop up list.

- **Latency -** displays the **time**, in milliseconds, between stimulus delivery and the selected cursor in the Measure1 column.
- **Amplitude -** displays the **amplitude**, in microvolts, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure amplitude, the two selected cursors should be placed on the same trace.
- I**nterlatency -** displays the **time difference**, in milliseconds, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure interlatency, you must first define two latency types.

- **Interamplitude -** displays either the **amplitude Difference** or **Ratio** (see Calc column below) between the two selected amplitude types in Measure1 and Measure2. In order to measure interamplitude, you must first define two amplitude types.
- **None -** select this option to remove the line from the cursor measurements.

Measure 1 and Measure 2: Click here to select the cursor name from a pop up list. These names were defined previously in the Cursor Table section.

Calc: This column is only available for Interamplitude measurements.

- **Difference** - the difference, in microvolts, between the two selected amplitude types is displayed. (Measure1 - Measure2)
- **Ratio** - the result of dividing the first amplitude by the second amplitude is displayed. (Measure1 / Measure2)

Norm: Use this field to enter a normal value for the measurement. You can use a less than (<) or a greater than (>) symbol. The program will compare the measured value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

L-R: Use this field to enter a normal value for the left minus right difference for the measurement. The program will calculate the left minus right values for each defined measurement if cursors have been placed on one left and one right side trial. The program will compare the measured left minus right value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

Defined Measurements

	Trace	N75 (ms)	P100 (ms)	N145 (ms)	N75-P100 (µV)
Results for Right Side →	Ch1 : Oz-Cz : R	72.3	101.2	128.9	11.18
Results for Left Side →	Ch1 : Oz-Cz : L	73.4	101.2	148.0	13.39
Calculated L - R Values →	L-R	1.2	0.0	19.1	2.21

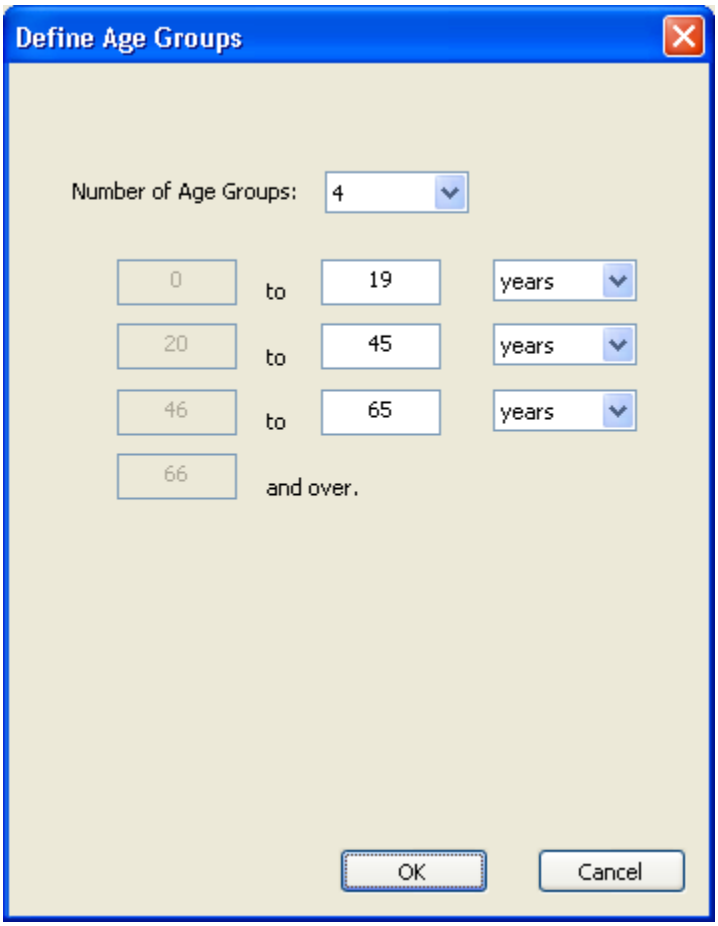
VEP cursor table example.

Age Group Norms

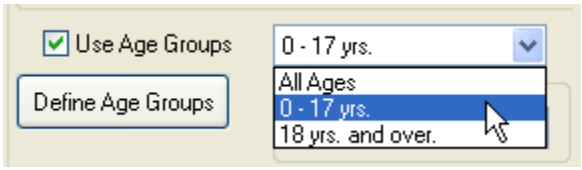
Up to 8 Age Groups can be defined and normal values can be entered for each group. The Sierra Wave program will compute the patient's age based on their date-of-birth and then use the appropriate age group norms.

To define the Age Groups:

1. Click on the **Define Age Groups** button.



2. Select the **number** of Age Groups, the maximum is 8.
3. Fill in the **upper age limit** for each group, select **years** or **months**, and click **OK**.
4. Check the **Use Age Groups** box. This will enable the **age groups drop-down list**.



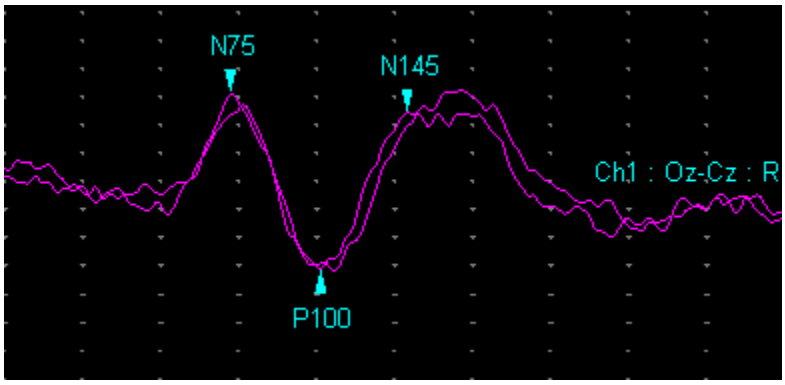
6. Enter the normal values for this age group into the **Cursor** table. Repeat for each age group in the drop-down list.

If the patient's **date-of-birth is not entered** into the patient information window, the program will use the normal values entered for the **All Ages** group.

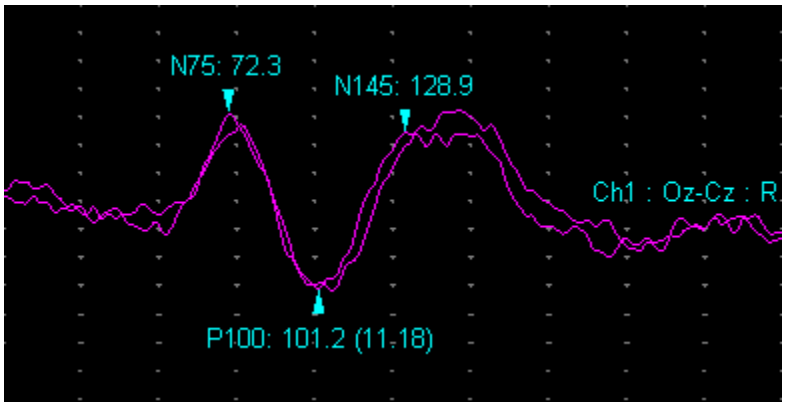
Cursor Labels

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

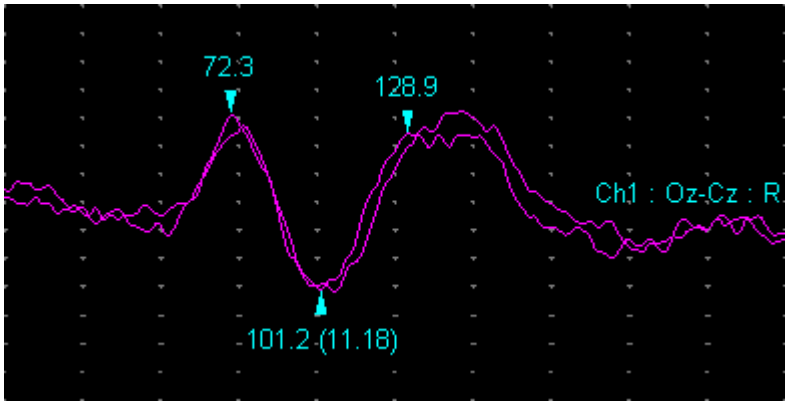
- **Show Labels** - shows the label names as entered in the auto-cursor table.



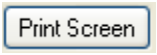
- **Labels and Values** - shows the label names mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



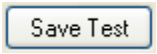
- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.



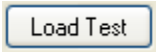
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

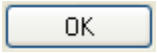


Clicking the **Save Test** button will open the Save Test window. This allows the VEP test protocol to be saved to a file.

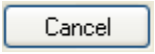


Clicking the **Load Test** button will open the Load Test window. Use this feature to load the VEP test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the VEP settings from that file.



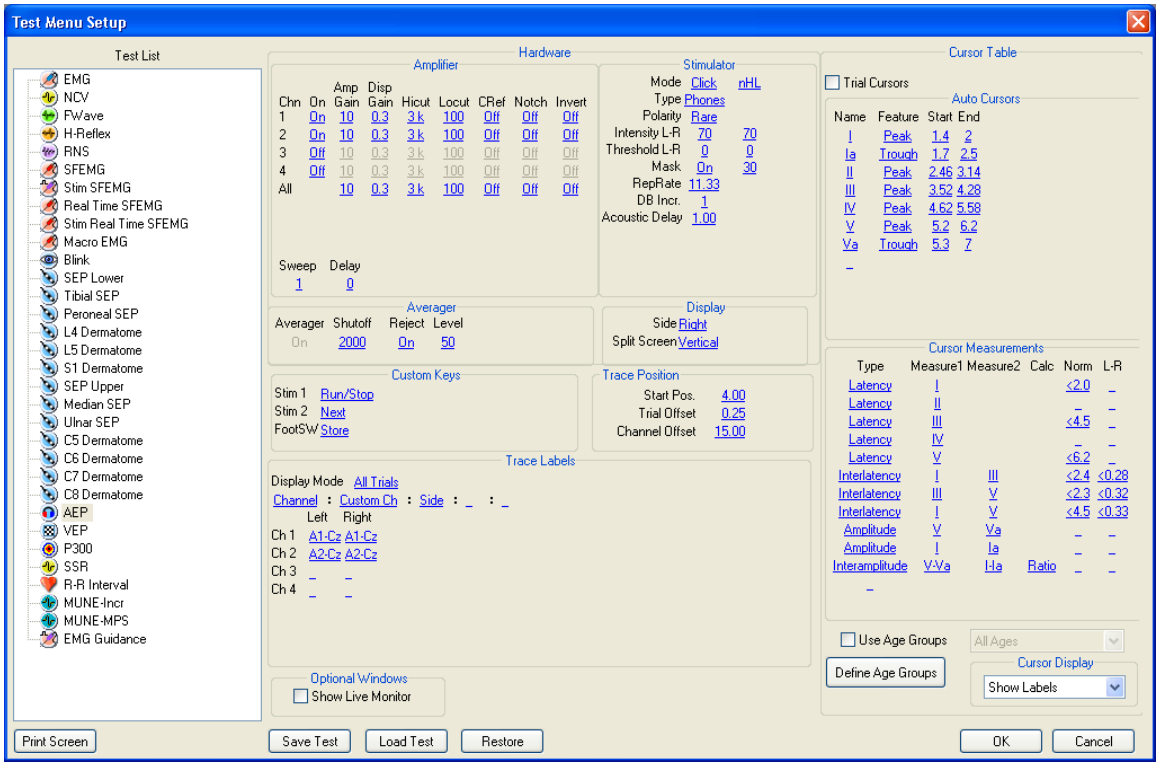
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the VEP test protocol settings.



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the VEP test protocol settings.

AEP Setup

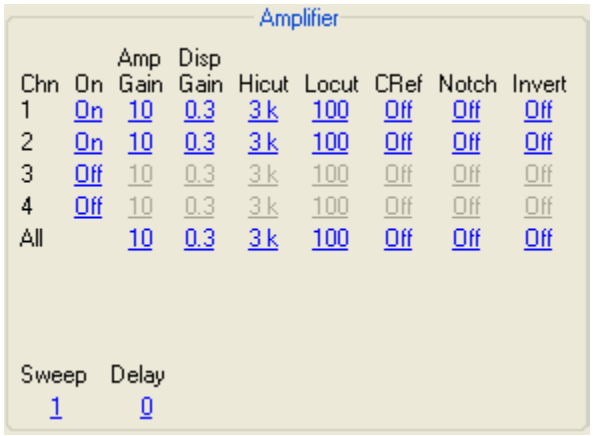
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **AEP** (Auditory Evoked Potential) test protocol in the test list. The AEP test protocol settings will be displayed on the right hand side of the screen.



AEP Test Setup window.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off.

Amp Gain: Click here to select the default Amp Gain setting in microvolts per division (uV/Div). This is also known as Live Gain and is the setting used when viewing the Live, un-averaged traces.

Disp Gain: Click here to select the default Display Gain setting in microvolts per division (uV/Div). This is the setting that is used when viewing the averaged traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

Notch: Click here to enable the 50 or 60 Hertz notch filter.

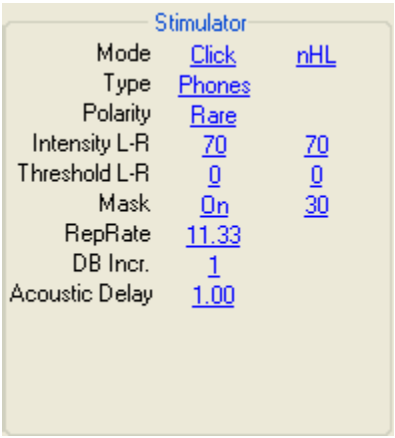
Invert: Click and select ON to automatically invert all traces recorded from this channel.

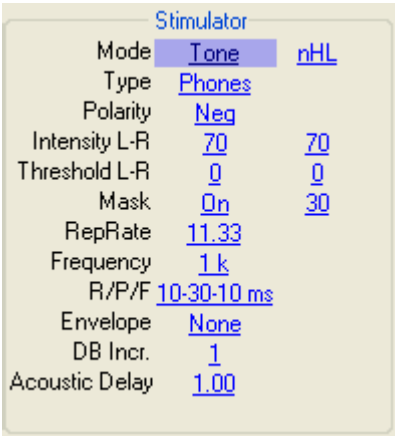
All: Provides a quick method of changing the parameters for all the channels at one time.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

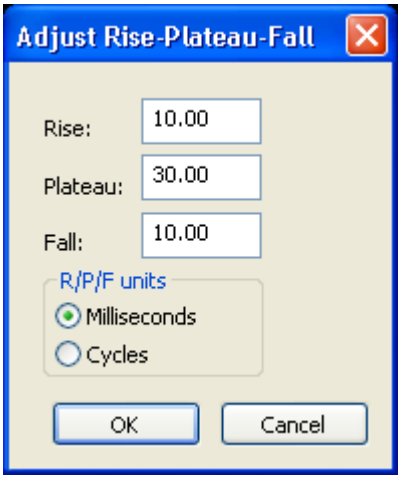
Stimulator:





Mode: Click here to select the auditory stimulus type, choose either **Click**, **Tone**, **Pip202**, or **Pip212**.

- **Click** - this is a 100 microsecond click stimulus.
- **Tone** - this is a 10-30-10 tone burst stimulus. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time. This stimulus is typically used for long latency auditory evoked potentials.
- **Pip 202** or **Pip 212** - these are also tone stimuli but their rise, plateau, and fall times are measured in cycles rather than milliseconds. The 2-0-2 Pip has a 2 cycle rise, 0 cycle plateau, and 2 cycle fall. The 2-1-2 Pip has a 2 cycle rise, 1 cycle plateau, and a 2 cycle fall.
- **Frequency** - when Tone, PiP202, or PiP212 are selected a Frequency setting will be displayed. Click here to select the frequency of the tone/pip. The choices are 250, 500, 750, 1000, 2000, 3000, 4000, 6000, and 8000 Hz.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

- **Envelope** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.

Type: Click here to select the type of stimulus delivery hardware, choose either **Phones** or **Inserts**.

When **Inserts** are selected the program will **automatically subtract 1.0 milliseconds** from all latency calculations to compensate for the delay produced by the plastic tubing. This delay value can be modified by clicking on the **Acoustic Delay** value. This value does not shift the displayed trace.

Polarity: Click here to set the stimulus polarity, the choices vary depending on the stimulus type.

- **For Click** - choose either **Rarefaction**, **Condensation**, or **Alternating** polarity.
- **For Tone or Pip** - choose either **Negative**, **Positive**, or **Alternating** polarity.

Intensity L-R: Click here to set the starting stimulus intensity value. The first column is for the left side, the second column is for the right side.

Threshold L-R: Click here to set the starting behavioral threshold value. The first column is for the left side, the second column is for the right side. During data acquisition the Threshold values are added to the Intensity values to produce the stimulus at the headphones/inserts.

Intensity Units: Choose either **nHL** (normalized hearing level) or **SPL** (sound pressure level). When SPL is selected the Threshold settings are disabled.

dB Incr: Click here to change the intensity value scale. The default setting is 1 dB increments, choices are 1, 2, 5 and 10.

Mask: Click here to set the "white" noise masking as either **On** or **Off** and to set the level for the non-stimulated ear. The amount selected is the number of dB's below the Intensity value. This is known as differential masking and allows the intensity of the masking noise to decrease automatically as the intensity of the stimulus is decreased.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). This setting only applies when delivering repetitive stimulation. It does not apply during manual single stimulus delivery.

Averager:

Averager: Click here to set the default setting for the averager as either **On** or **Off**. For evoked potentials, the averager is **always On**.

Shutoff: Click here to set the default setting for the shutoff count. This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject: Click here to set the default setting for the artifact rejection feature as either **On** or **Off**. When this feature is turned On the program will monitor the Live un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level: Click here to set the default reject sensitivity level in percent full scale. Choices are 30 to 100 % in increments of 5.

Reject is based on the Live un-averaged data and the Amp Gain setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uv/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

Display Settings:

Side: Click here to set the default setting for the **side of stimulation**. The choices are **Left**, **Right**, and **Bilateral**. For example, selecting Right will always set the initial side of stimulation to "Right" when the test protocol is selected. This setting can be changed on the acquisition screen if you want to begin stimulation on the opposite side.

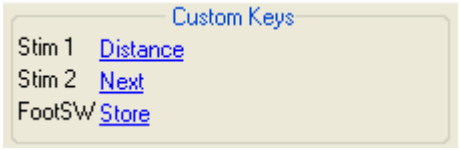
Split Screen: Click here to set the default setting for how the trace window is displayed. The choices are **Full**, **Vertical** and **Horizontal**.

- **Full** - sets the trace area to full, all data from all sides are displayed in the same trace area.
- **Vertical** - splits the trace area into two equal halves with a vertical divider. Left sided traces are displayed on the left half of the trace window. Right sided traces are displayed on the right half of the trace window.

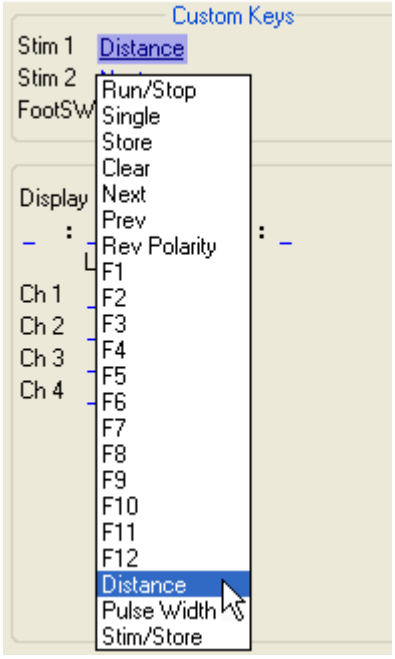
- **Horizontal** - splits the trace area into two equal halves with a horizontal divider. Left sided traces are displayed in the top half of the trace window. Right sided traces are displayed in the lower half of the trace window.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

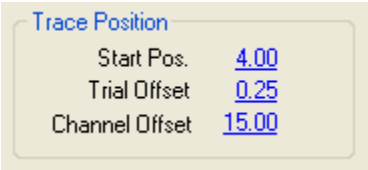


Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

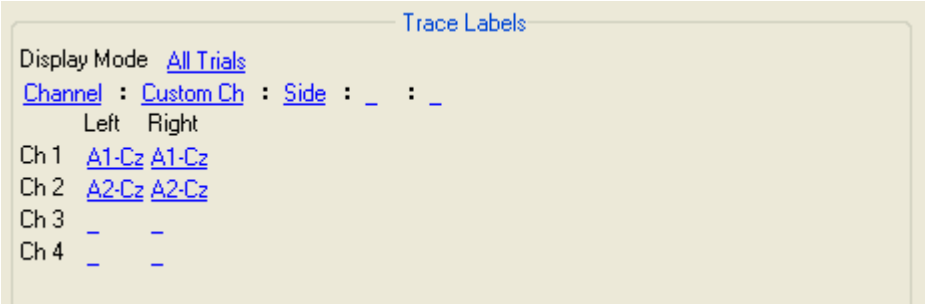
Trial Offset: This setting determines how much space will separate each stored AEP trace from both the active (white) and other stored (purple) traces. In this example the setting is 0.25 divisions, therefore the first stored AEP trace will be displayed 0.25 divisions below the active trace. If a second AEP trace is acquired and stored it will be displayed 0.25 divisions below the first stored AEP trace and so on. If you want all the traces from each channel superimposed on each other set this value to 0.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Active (white) channels.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).



Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.

- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.
- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or A1-Cz montage designations).

Left / Right Custom Labels:

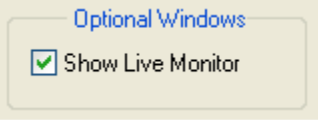
When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

Show Live Monitor

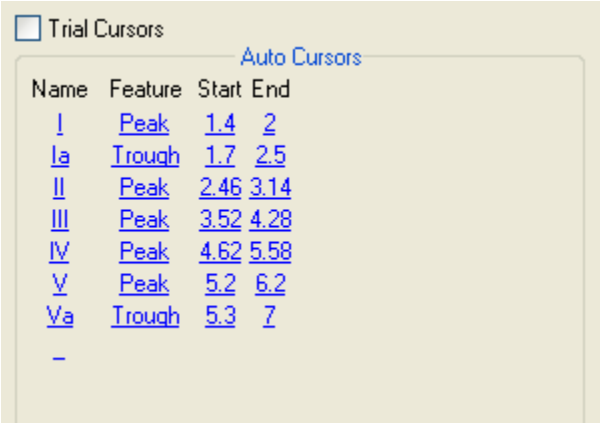
When this window is enabled it displays the “Live” activity coming from the recording electrodes. When stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will go back to display “Live” activity after one second.



This window can be positioned, sized, and saved as part of the default settings for the test protocol.

Cursor Table

This section is used to configure the cursors that will be used in the evoked potential test. You can enter the name of the cursor, select its feature type (Peak, Trough, or Onset), set a latency search window for the cursor, and assign cursors to specific channels.



Trial Cursors:

When this box is checked, the program will allow you to assign the cursors to specific channels. This is most commonly done for SEP test protocols since the cursors are not all applied to the same channel. If this boxed is unchecked, the channel column is hidden.

Auto Cursors:

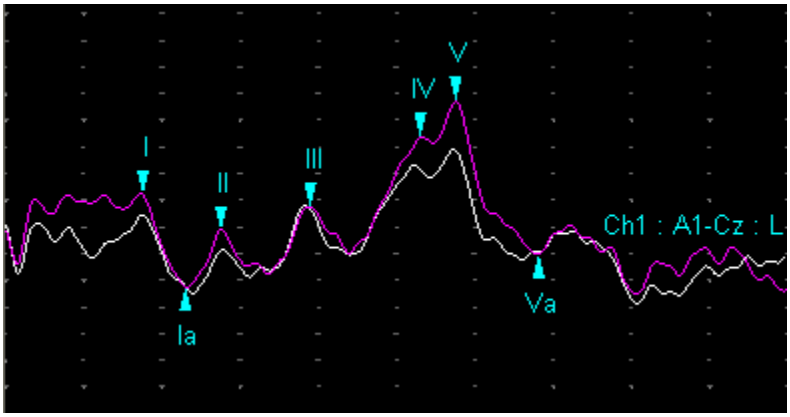
Name - click here to enter a name for the cursor, up to ten characters can be used.

Feature - click here to define the trace feature that the cursor will be searching for.

- Choose **Peak** to locate the highest point within the specified latency window.
- Choose **Trough** to locate the lowest point within the specified latency window.
- Choose **Onset** to locate the initial change from baseline before a peak.

Start / End - click here to enter the time, in milliseconds, that you want the program start and stop searching for the specified trace feature. *If the program does not find the feature within the start and end latency times it will place the cursor at the start latency position.*

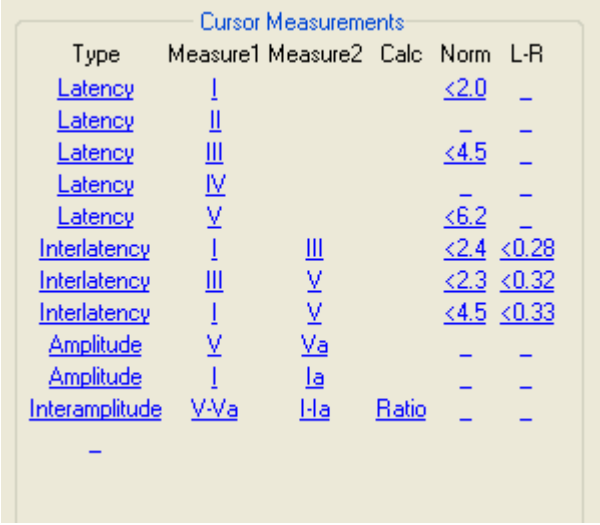
Ch - click here to assign the cursor to a specific channel. This column is only available if the **Trial Cursors** mode has been enabled.



AEP (left stimulation) with cursors placed on one trial.

Cursor Measurements

This section is used to specify the measurements that will be displayed during data acquisition and in printed reports. The Cursor Table section must be completed before any selections in this table can be made.



Type: Click here to pick the type of measurement from a pop up list.

- **Latency -** displays the **time**, in milliseconds, between stimulus delivery and the selected cursor in the Measure1 column.
- **Amplitude -** displays the **amplitude**, in microvolts, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure amplitude, the two selected cursors should be placed on the same trace.

- I**nterlatency -** displays the **time difference**, in milliseconds, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure interlatency, you must first define two latency types.
- **Interamplitude -** displays either the **amplitude Difference** or **Ratio** (see Calc column below) between the two selected amplitude types in Measure1 and Measure2. In order to measure interamplitude, you must first define two amplitude types.
- **None -** select this option to remove the line from the cursor measurements.

Measure 1 and Measure 2: Click here to select the cursor name from a pop up list. These names were defined previously in the Cursor Table section.

Calc: This column is only available for Interamplitude measurements.

- **Difference** - the difference, in microvolts, between the two selected amplitude types is displayed. (Measure1 - Measure2)
- **Ratio** - the result of dividing the first amplitude by the second amplitude is displayed. (Measure1 / Measure2)

Norm: Use this field to enter a normal value for the measurement. You can use a less than (<) or a greater than (>) symbol. The program will compare the measured value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

L-R: Use this field to enter a normal value for the left minus right difference for the measurement. The program will calculate the left minus right values for each defined measurement if cursors have been placed on one left and one right side trial. The program will compare the measured left minus right value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

Defined Measurements

	Trace	I (ms)	II (ms)	III (ms)	IV (ms)	V (ms)	I-III (ms)	III-V (ms)	I-V (ms)	V-Va (µV)	I-Ia (µV)	V-Va/I-Ia
Normal Values →	Norm	<2.0		<4.5		<6.2	<2.4	<2.3	<4.5			
Results for Right Side →	Ch2 : A2-Cz : R	1.64	2.77	3.69	4.92	5.66	2.05	1.97	4.02	0.54	0.49	1.10
Results for Left Side →	Ch1 : A1-Cz : L	1.69	2.75	3.78	4.92	6.05	2.09	2.27	4.36	0.10	0.55	0.18
L - R Normal Values →	L-R Norm						<0.28	<0.32	<0.33			
Calculated L - R Values →	L-R	0.05	0.02	0.09	0.00	0.39	0.04	0.30	**0.34**	0.44	0.06	0.92

Red Color indicates abnormal value

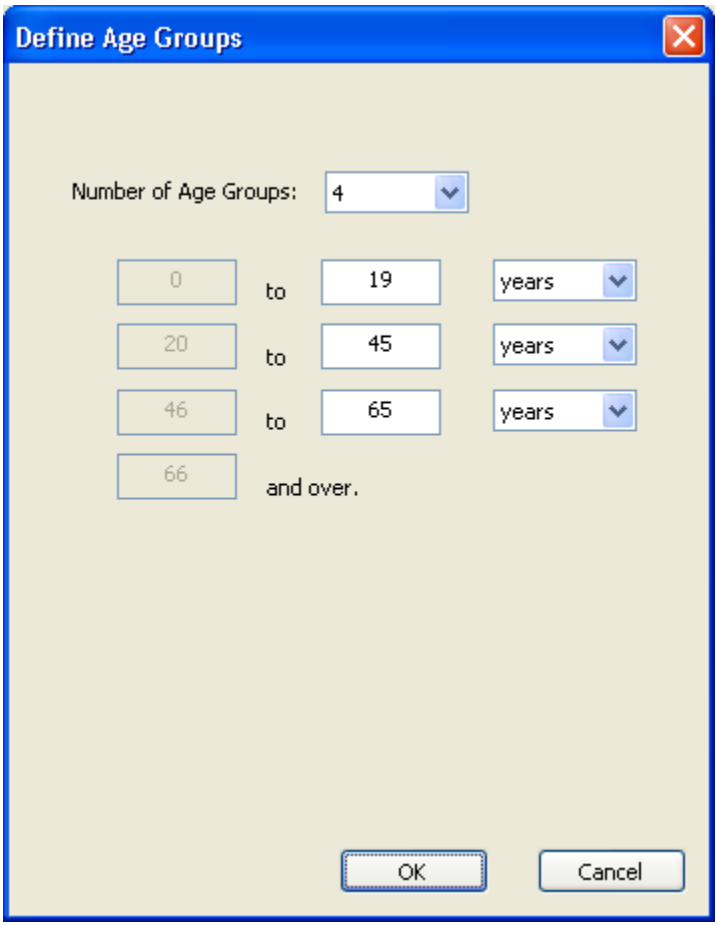
AEP cursor table example.

Age Group Norms

Up to 8 Age Groups can be defined and normal values can be entered for each group. The Sierra Wave program will compute the patient's age based on their date-of-birth and then use the appropriate age group norms.

To define the Age Groups:

1. Click on the **Define Age Groups** button.



2. Select the **number** of Age Groups, the maximum is 8.
3. Fill in the **upper age limit** for each group, select **years** or **months**, and click **OK**.
4. Check the **Use Age Groups** box. This will enable the **age groups drop-down list**.

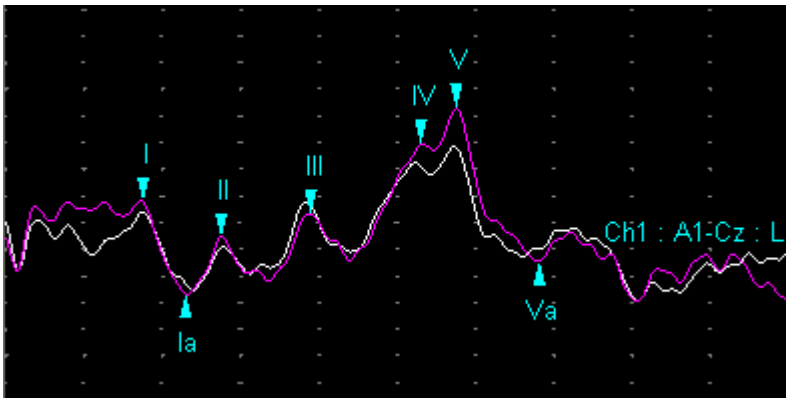
6. Enter the normal values for this age group into the **Cursor** table. Repeat for each age group in the drop-down list.

If the patient's **date-of-birth is not entered** into the patient information window, the program will use the normal values entered for the **All Ages** group.

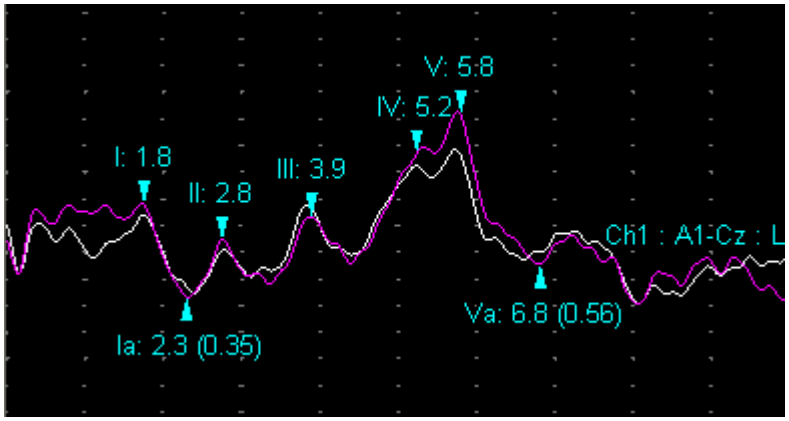
Cursor Labels

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

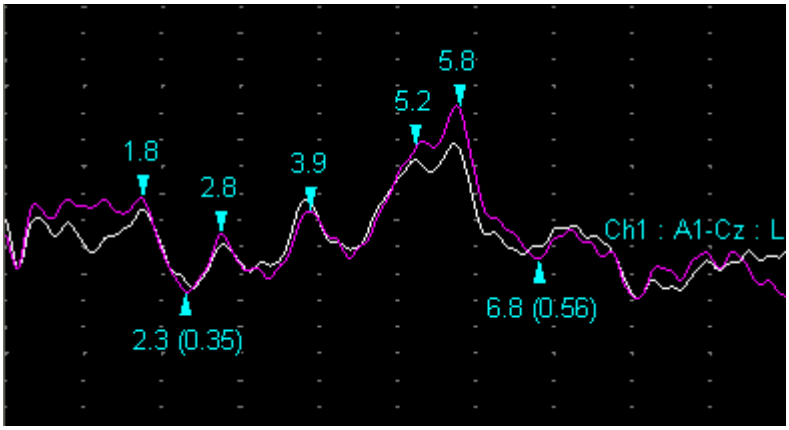
- **Show Labels** - shows the label names as entered in the auto-cursor table.



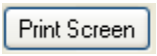
- **Labels and Values** - shows the label names mentioned above as well as the latency value (one decimal place precision) for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value (one decimal place precision) for the cursor and the amplitude values between two cursors in brackets.



Window Buttons

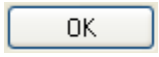


Clicking the **Print Screen** button will send an image of the screen to your default printer.

Clicking the **Save Test** button will open the Save Test window. This allows the AEP test protocol to be saved to a file.

Clicking the **Load Test** button will open the Load Test window. Use this feature to load the AEP test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the AEP settings from that file.

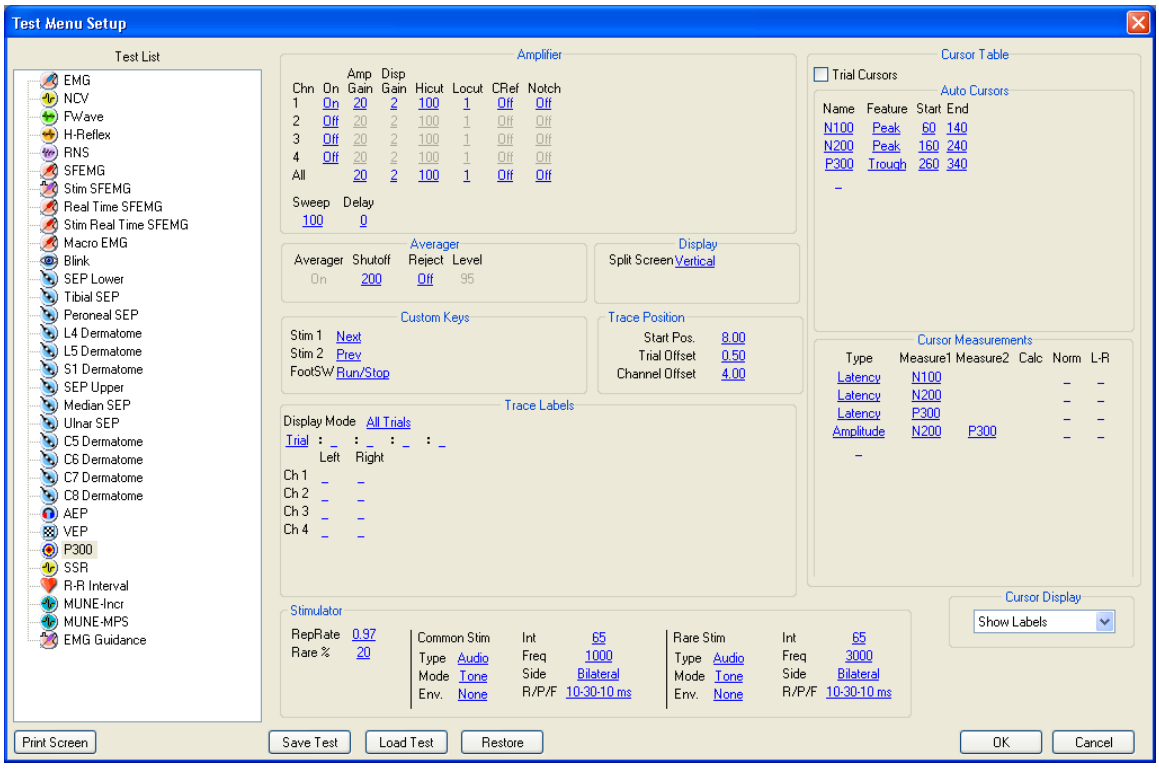


Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the AEP test protocol settings.

Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the AEP test protocol settings.

P300 Setup

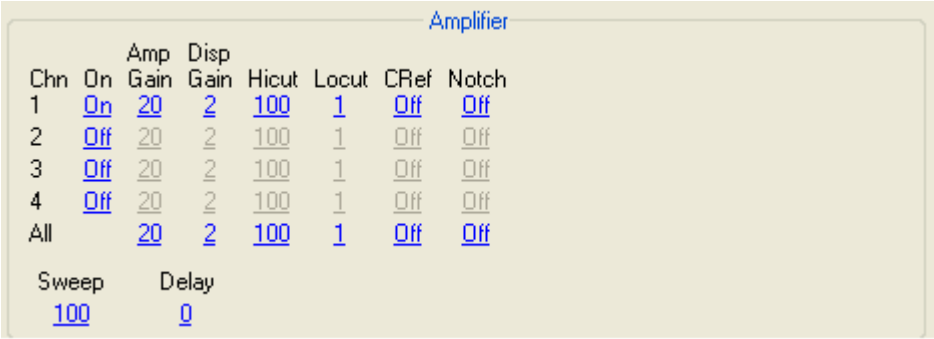
From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **P300** test protocol in the test list. The P300 test protocol settings will be displayed on the right hand side of the screen.



P300 Test Setup.

Hardware Settings

Amplifier:



On: Click here to program a channel as either On or Off.

Amp Gain: Click here to select the default Amp Gain setting in microvolts per division (uV/Div). This is also known as Live Gain and is the setting used when viewing the Live, un-averaged traces.

Disp Gain: Click here to select the default Display Gain setting in microvolts per division (uV/Div). This is the setting that is used when viewing the averaged traces.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

Locut: Click here to select the default Locut filter setting in Hertz (Hz)

CRef: Click here to enable the common reference input for the selected channel. When common reference is On the individual reference input for the channel is disabled.

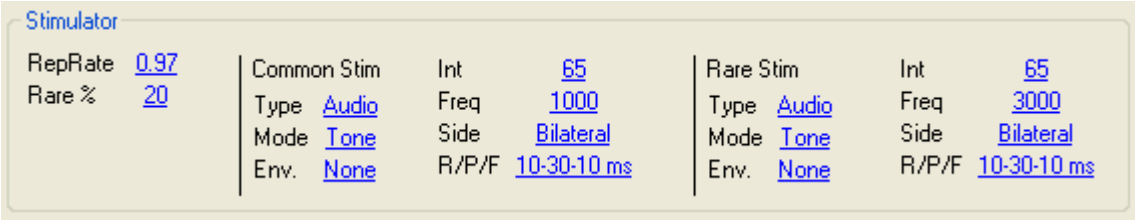
Notch: Click here to enable the 50 or 60 Hertz notch filter.

All: Provides a quick method of changing the parameters for all the channels at one time.

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

Delay: Click here to select a pre or post stimulus sweep delay of either **-1**, **0**, or **+1** division. A setting of **-1** will show one division of activity before the stimulus.

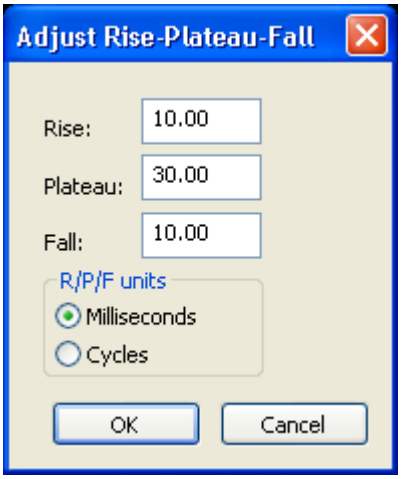
Stimulator:



Clinical recordings of the P300 are generally performed using a binaural auditory tone stimulus, commonly referred to as the auditory odd-ball paradigm. Typically, two easily discriminable tones of different pitches are presented in random order. One of the two tones occurs more often than the other and is designated the Common tone. The other tone is designated the Rare tone. This outline will assume that an auditory stimulus will be used for both the Common and Rare stimuli.

Common Stim: These settings are used to configure the Common stimulus.

- **Type** - can be set to **Audio**, **Visual**, **Electrical,** or **.Wav file**. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.
- **Frequency** - click here to select the frequency of the tone. The default setting is 1000 Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

- **Env.** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.

Rare Stim: These settings are used to configure the Rare stimulus.

- **Type** - can be set to **Audio**, **Visual**, **Electrical**, or **.Wav file**. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.
- **Frequency** - click here to select the frequency of the tone. The default setting is 3000 Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.
- **R/P/F** - same settings as for the Common stimulus.
- **Env.** - same settings as for the Common stimulus.

RepRate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). The default setting is 0.97.

Rare %: Click here to set the percentage of Rare stimuli that will be delivered. The default setting is 20 %.

Note that not all stimulus combinations are valid. The common stimulus may be set to any of the available stimulus types. The “Rare” stimulus, however; cannot be set to a stimulus type which conflicts with the choice of common stimulus. If the common stimulus is changed after setting the rare stimulus and a conflict occurs, the rare stimulus will be changed so that the conflict is resolved. See stimulator limitations below.

Stimulator Limitations

Due to hardware limitations, not all combinations of stimulus modalities are supported. The video checkerboard pattern and audio tones are generated by the same hardware device and share the same output connected on the back panel. Setting both stimuli for video checks or setting one stimulus for audio and one stimulus for video checks is not permitted. Note, however; that two audio stimuli are supported. It is also permissible to combine an audio stimulus with a visual stimulus mode other than video checks.

Averager:

Averager: Click here to set the default setting for the averager as either **On** or **Off**. For evoked potentials, the averager is **always On**.

Shutoff: Click here to set the default setting for the shutoff count, this is the total number of stimuli (Common + Rare) that will be delivered. When this number is reached stimulation will automatically be stopped. The default is 200 (160 Common, 40 Rare).

Reject: Click here to set the default setting for the artifact rejection feature as either **On** or **Off**. When this feature is turned On the program will monitor the Live un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the number of stimuli/sweeps that have been rejected for both the Common and Rare stimuli will be displayed on the screen.

Level: Click here to set the default reject sensitivity level in percent full scale. Choices are 30 to 100 % in increments of 5.

Reject is based on the Live un-averaged data and the Amp Gain setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uv/Div) with 50 uV

above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

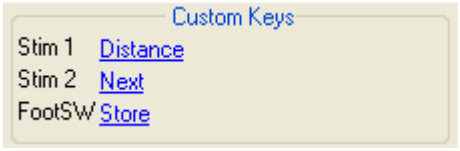
Display Settings:

Split Screen: Click here to set the default setting for how the trace window is displayed. The choices **Vertical** or **Horizontal**.

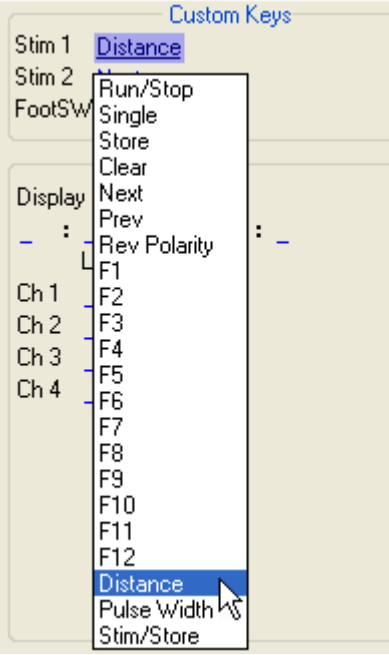
- **Vertical** - splits the trace area into two equal halves with a vertical divider. Traces for Common stimuli are displayed on the left half of the trace window. Traces for Rare stimuli are displayed on the right half of the trace window.
- **Horizontal** - splits the trace area into two equal halves with a horizontal divider. Traces for Common stimuli are displayed in the top half of the trace window. Traces for Rare stimuli are displayed in the lower half of the trace window.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.

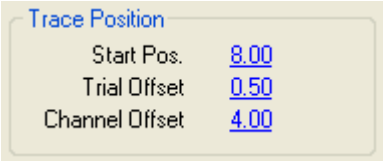


Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

Trace Position



Start Position: This is the default trace position for Channel 1 within the trace window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 8 divisions below the top of the window.

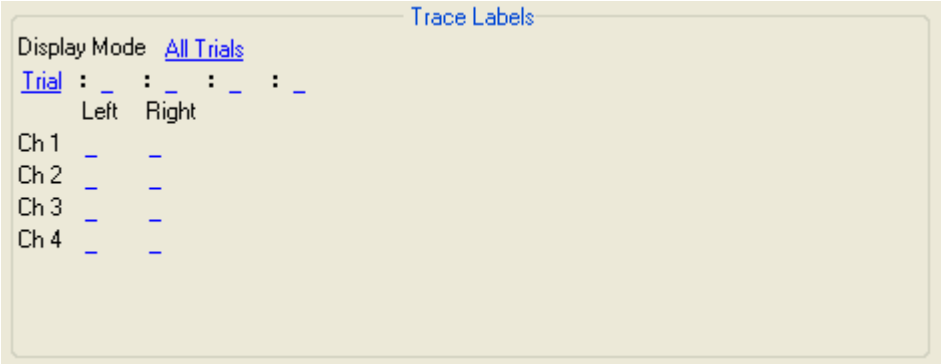
Trial Offset: This setting determines how much space will separate each stored P300 trace from both the active (white) and other stored (purple) traces. In this example the setting is 0.50 divisions, therefore the first stored P300 trace will be displayed 0.50 divisions below the active trace. If a second P300 trace is acquired and stored it will be displayed 0.50 divisions below the first stored P300 trace and so on. If you want all the traces from each channel superimposed on each other set this value to 0.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the Active (white) channels.

Trace Position settings can be changed during data acquisition by right-clicking the mouse on the trace window and selecting **Trace Position Settings** from the pop-up menu.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵).



Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.
- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.

- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., Fz-A1A2 or CZ-A1A2 montage designations).

Left / Right Custom Labels:

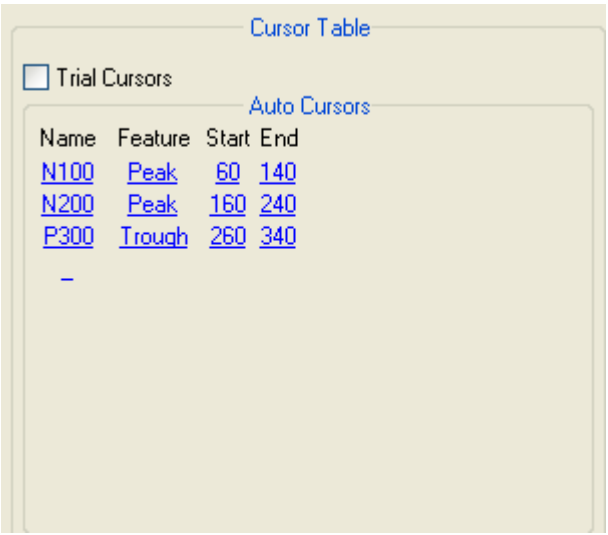
When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

Cursor Table

This section is used to configure the cursors that will be used in the evoked potential test. You can enter the name of the cursor, select its feature type (Peak, Trough, or Onset), set a latency search window for the cursor, and assign cursors to specific channels.



Trial Cursors:

When this box is checked, the program will allow you to assign the cursors to specific channels. This is most commonly done for SEP test protocols since the cursors are not all applied to the same channel. If this boxed is unchecked, the channel column is hidden.

Auto Cursors:

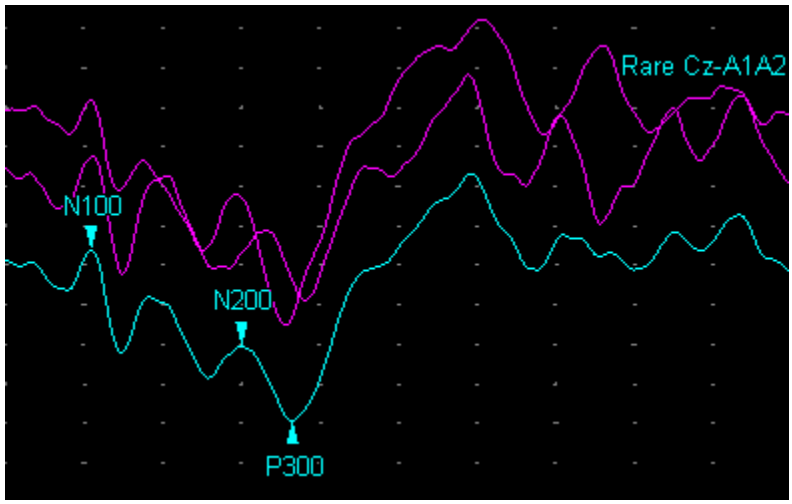
Name - click here to enter a name for the cursor, up to ten characters can be used.

Feature - click here to define the trace feature that the cursor will be searching for.

- Choose **Peak** to locate the highest point within the specified latency window.
- Choose **Trough** to locate the lowest point within the specified latency window.
- Choose **Onset** to locate the initial change from baseline before a peak.

Start / End - click here to enter the time, in milliseconds, that you want the program start and stop searching for the specified trace feature. *If the program does not find the feature within the start and end latency times it will place the cursor at the start latency position.*

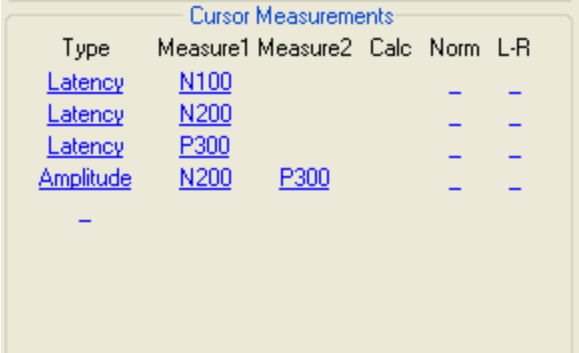
Ch - click here to assign the cursor to a specific channel. This column is only available if the **Trial Cursors** mode has been enabled.



P300 with cursors placed on the grand average of two trials.

Cursor Measurements

This section is used to specify the measurements that will be displayed during data acquisition and in printed reports. The Cursor Table section must be completed before any selections in this table can be made.



Type: Click here to pick the type of measurement from a pop up list.

- **Latency -** displays the **time**, in milliseconds, between stimulus delivery and the selected cursor in the Measure1 column.
- **Amplitude -** displays the **amplitude**, in microvolts, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure amplitude, the two selected cursors should be placed on the same trace.
- I**nterlatency -** displays the **time difference**, in milliseconds, between the two selected cursors in the Measure1 and Measure2 columns. In order to measure interlatency, you must first define two latency types.
- **Interamplitude -** displays either the **amplitude Difference** or **Ratio** (see Calc column below) between the two selected amplitude types in Measure1 and Measure2. In order to measure interamplitude, you must first define two amplitude types.
- **None -** select this option to remove the line from the cursor measurements.

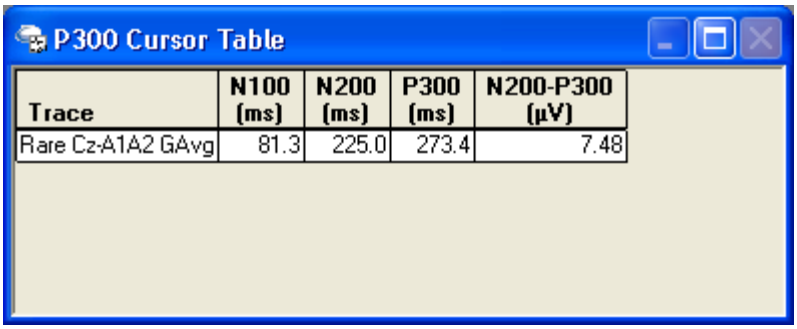
Measure 1 and Measure 2: Click here to select the cursor name from a pop up list. These names were defined previously in the Cursor Table section.

Calc: This column is only available for Interamplitude measurements.

- **Difference** - the difference, in microvolts, between the two selected amplitude types is displayed. (Measure1 - Measure2)
- **Ratio** - the result of dividing the first amplitude by the second amplitude is displayed. (Measure1 / Measure2)

Norm: Use this field to enter a normal value for the measurement. You can use a less than (<) or a greater than (>) symbol. The program will compare the measured value to the norm, if the measured value is outside normal limits it will be flagged as either **bold** or red colored text. See the topic "System Setup Options - Preferences".

L-R: these fields are not used for P300.

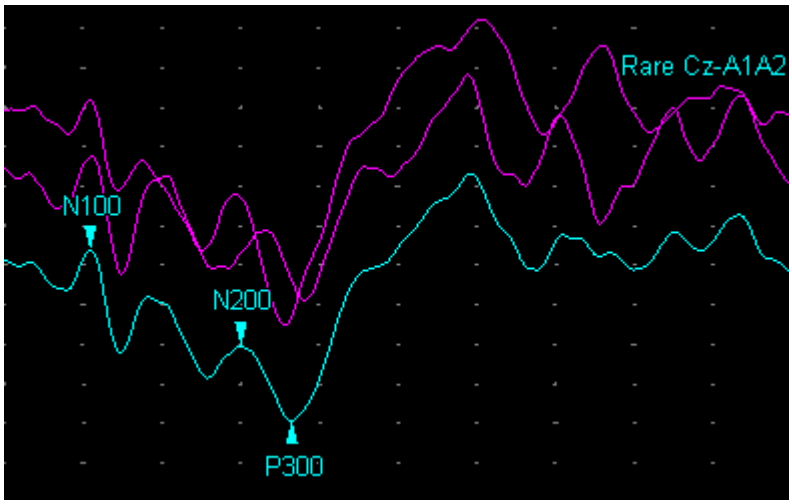


P300 Cursor Table.

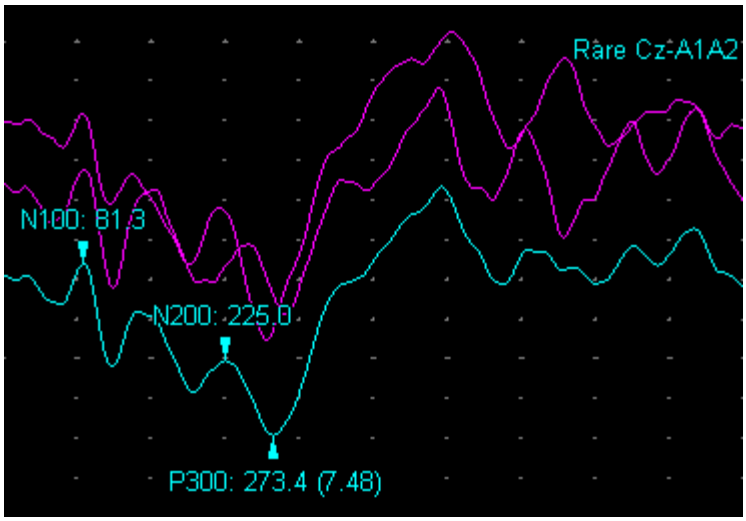
Cursor Labels

There are three options for how the cursors will appear on the traces. The factory default selection is **Show Labels**.

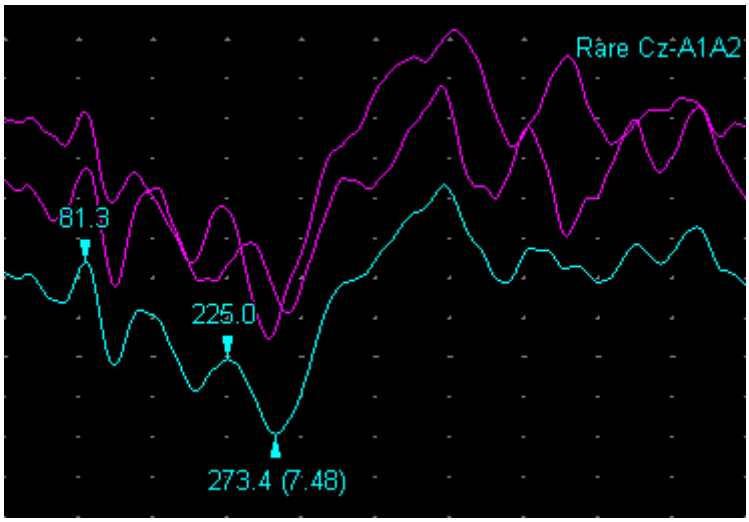
- **Show Labels** - shows the label names as entered in the auto-cursor table.



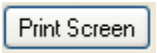
- **Labels and Values** - shows the label names mentioned above as well as the latency value (one decimal place precision) for the cursor and the amplitude value between two cursors in brackets.



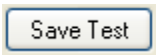
- **Show Values** - shows the latency value (one decimal place precision) for the cursor and the amplitude values between two cursors in brackets.



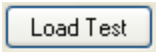
Window Buttons



Clicking the **Print Screen** button will send an image of the screen to your default printer.

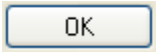


Clicking the **Save Test** button will open the Save Test window. This allows the P300 test protocol to be saved to a file.

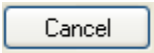


Clicking the **Load Test** button will open the Load Test window. Use this feature to load the P300 test settings that were previously stored in a file using the Save Test feature.

Clicking the **Restore** button will allow you to open a Preserve file and restore the P300 settings from that file.



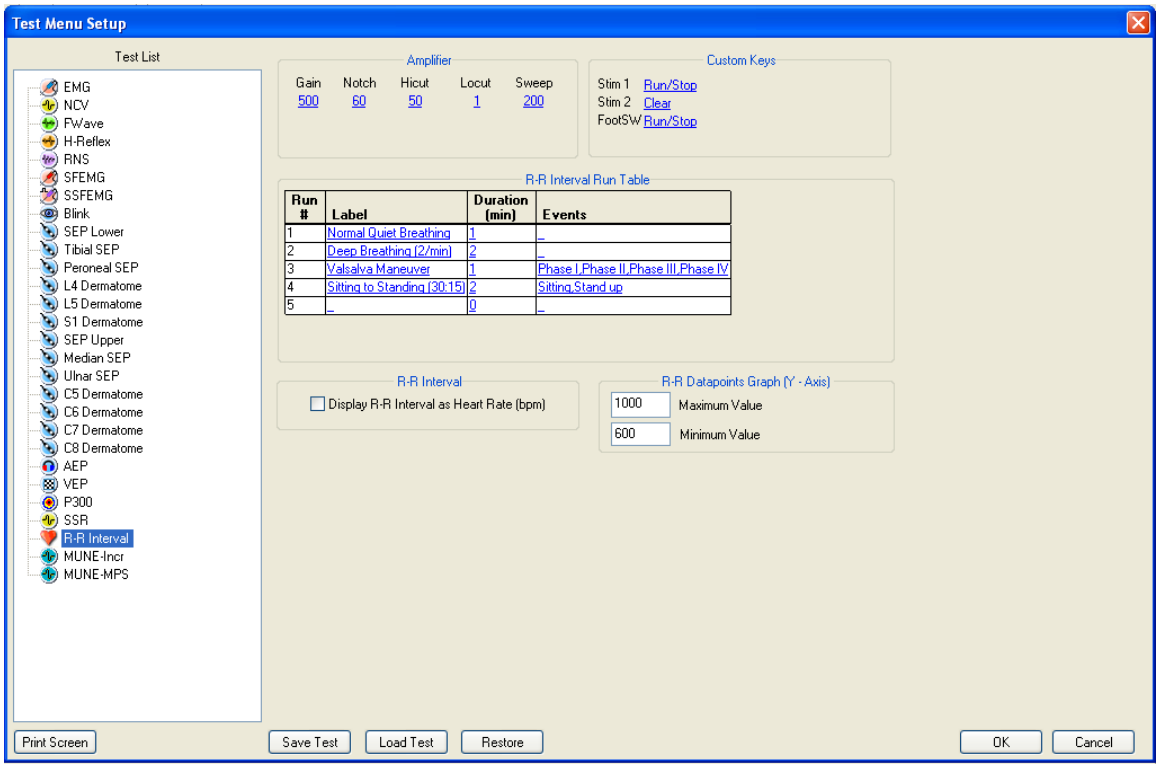
Clicking **OK** will close the Test Setup window and **will save any changes** that have been made to the P300 test protocol settings.



Clicking **Cancel** will close the Test Setup window and **will not save any changes** that have been made to the P300 test protocol settings.

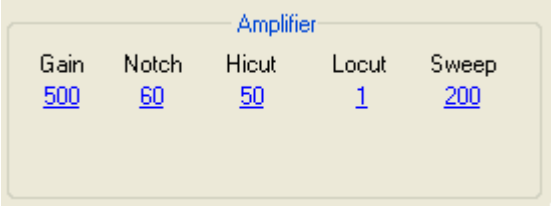
RR Interval Setup

From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **RR Interval** test protocol in the test list. The RR Interval test protocol settings will be displayed on the right hand side of the screen.



RR Interval Test Setup window.

Amplifier Settings



Gain: Click here to select the default Gain setting in microvolts per division (uV/Div).

Notch: Click here to enable the 50 or 60 Hertz notch filter.

Hicut: Click here to select the default Hicut filter setting in Hertz (Hz).

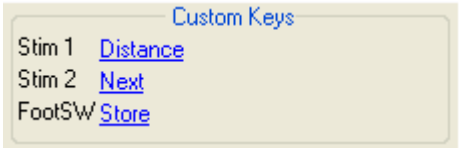
Locut: Click here to select the default Locut filter setting in Hertz (Hz)

Sweep: Click here to select the default sweep speed setting in milliseconds per division (ms/Div).

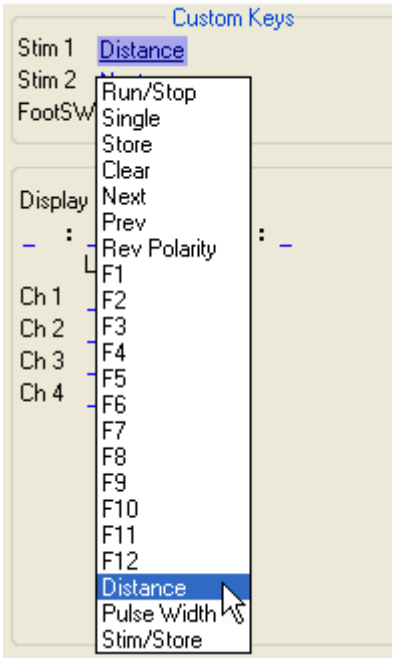
RR Interval is a single channel protocol.

Custom Keys

The **Custom Key** settings are used to program the functions of the two programmable buttons on the electrical stimulator and the footswitch.



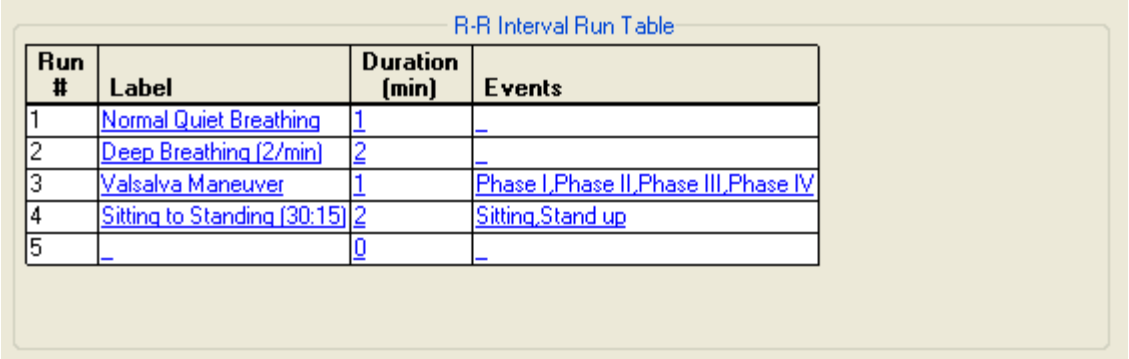
Click on the setting you want to change and a pop-up list of available choices will be displayed. Simply select the function that you want from the list.



Custom Key selection list.

RR Interval Run Table

This section is used to program the data collection runs that will be used during the test procedure.


R-R Interval Run Table

Run #	Label	Duration (min)	Events
1	Normal Quiet Breathing	1	_
2	Deep Breathing (2/min)	2	_
3	Valsalva Maneuver	1	Phase I,Phase II,Phase III,Phase IV
4	Sitting to Standing (30:15)	2	Sitting,Stand up
5	_	0	_

Run #: up to five different data collection runs can be programmed.

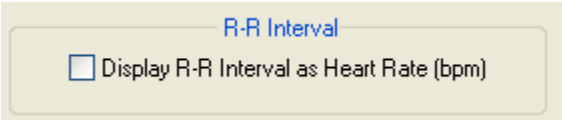
Label: this is a label that describes the run, it appears in the RR Results Table and the RR Datapoints Graph.

Duration (min): specifies how long (in minutes) the run will collect RR data.

Events: use to pre-program events that can be entered during data collection . Individual events are separated by commas.

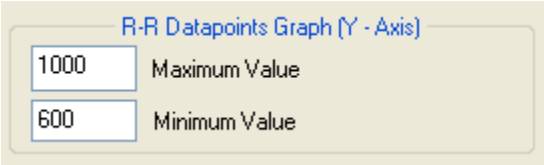
RR Interval

This check box will convert the collected RR Interval data (milliseconds) to Heart Rate data (beats per minute). The Heart Rate (bpm) will be displayed in the RR Tables and RR Datapoint Graphs.



RR Interval Datapoints Graph (Y-axis)

This section is used to set the default limits for the RR Datapoint Graph Y-axis. These values can be changed at any time during or after data collection from within the RR Datapoints Graph.

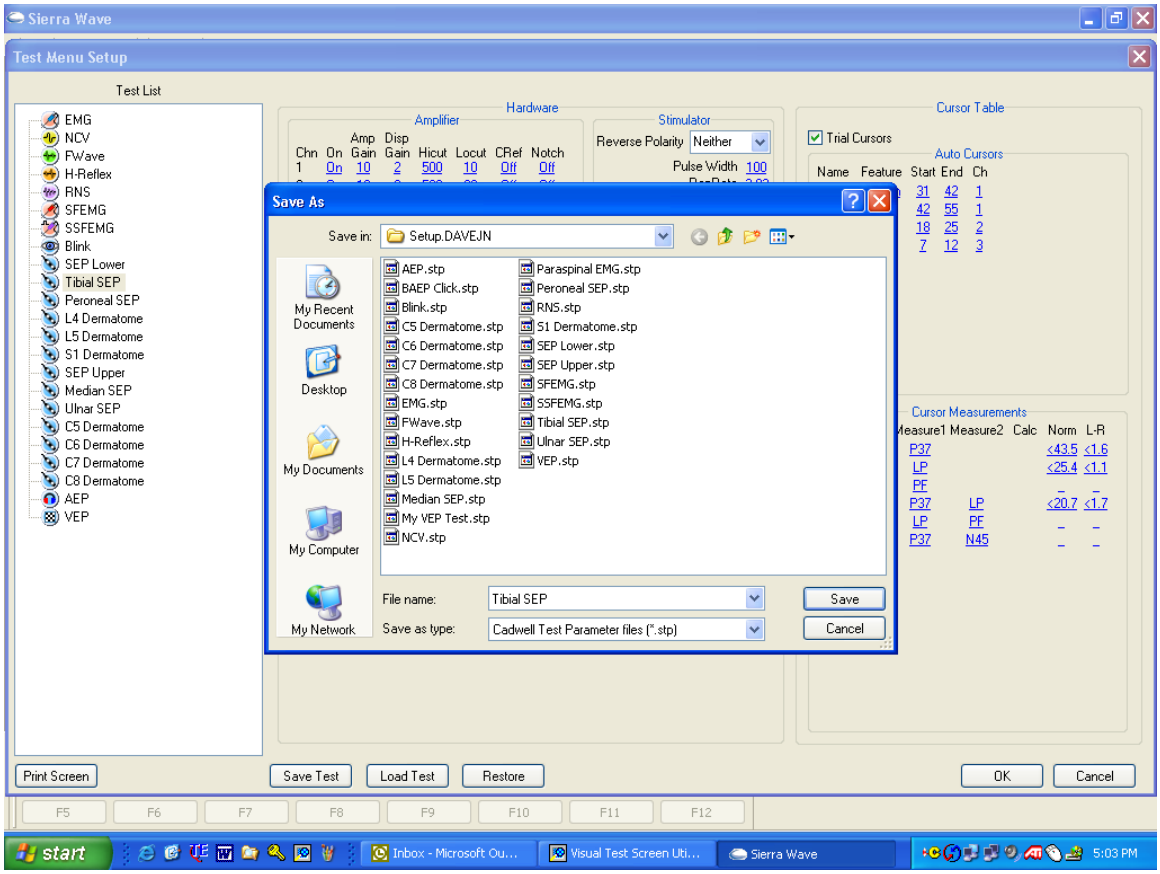


 These values are automatically converted to Heart Rate (bpm) if the preceding **RR Interval** check box is enabled.

Saving Test Setups

This feature allows the user to save a selected test protocol's settings to a file. This file can be given to other Sierra Wave users so that they can load the saved test protocol onto their own system.

Clicking the **Save Test** button will open the Save Test window.



Save Test window.

To Save a Test Protocol to a file:

1. From within the **Test Menu Editor** window, highlight the test protocol that you want to save.
2. Click on the **Save Test** button. The **Save As** window will be displayed.
3. If necessary, change the **Save In path** to the location where you want to save the file.

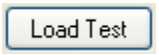
4. If necessary, change the **File Name**. The name will default to the name of the test protocol that is highlighted in the Test Menu Editor.
5. Click the **Save** button.

To Load a Test Protocol from a file:

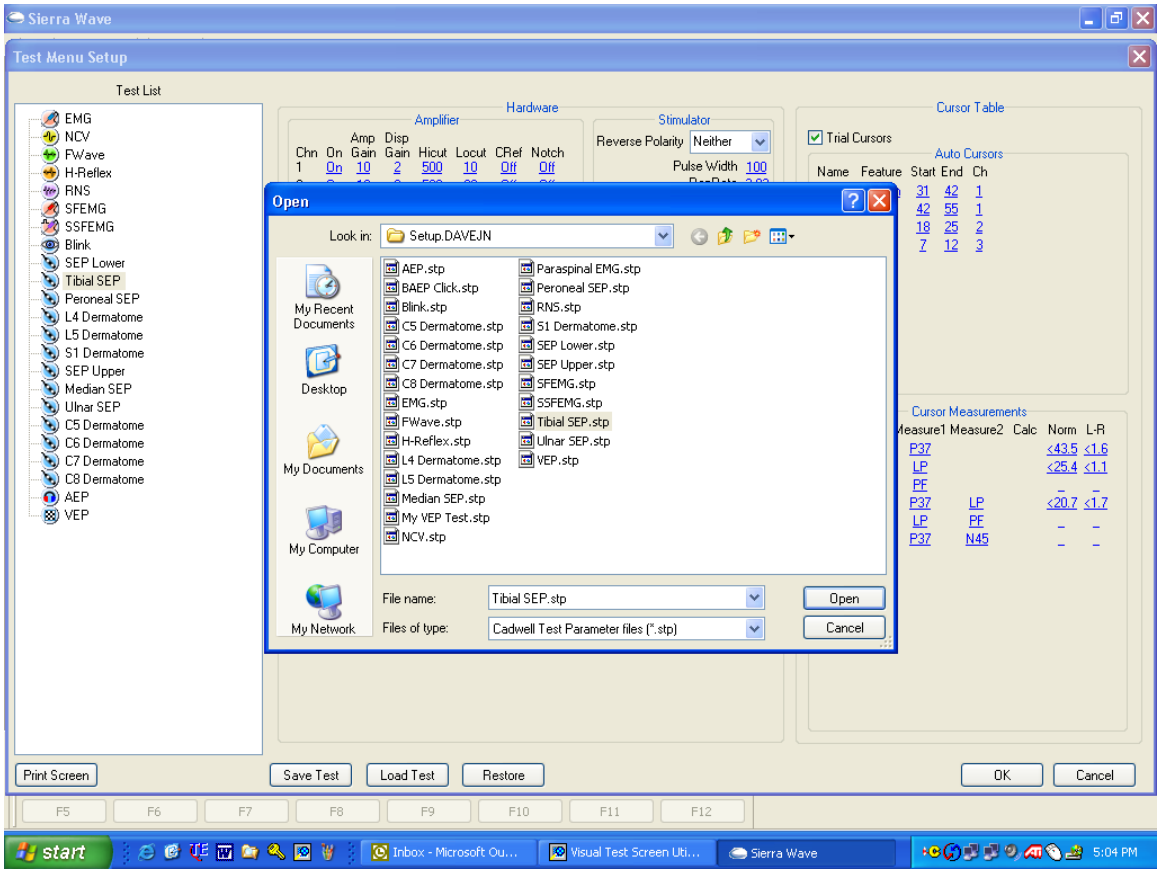
See the topic **Loading Test Setups**.

Loading Test Setups

This feature allows the user to load a test protocol's settings from a file that was created using the Save Test feature.



Clicking the **Load Test** button will open the Load Test window.



Load Test window.

To Load a Test Protocol from a file:

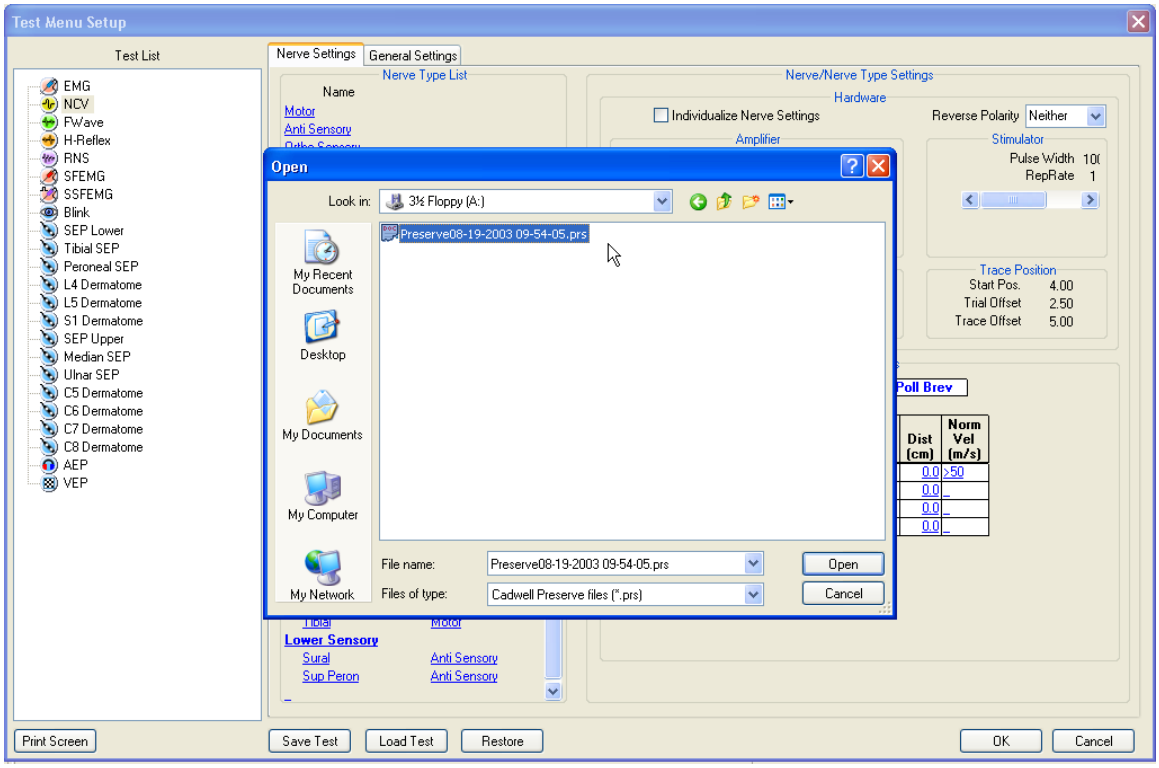
1. From within the **Test Menu Editor** window click on the **Load Test** button.
2. The **Open** window will be displayed.
3. If necessary, change the **Look In path** to the location of the test setting file.
4. Select the test setting file.
5. Click the **Open** button.

Tests that are loaded from a file are added to the bottom of the existing Test Menu list. They do not overwrite existing test protocols. If the name of the test being loaded matches a test protocol already in the Test Menu, it will be added to the bottom of the list with the number "2" after its name.

Restoring a Test Setup from a Preserve File

This feature allows you to load an individual test protocol's settings from a preserve file. For information about creating a preserve file, see the topic Preserve Settings.

Clicking the **Restore** button will allow you to open a Preserve file and load the currently selected test protocol's settings from that file.



Restore selected test protocol.

To restore the selected test protocol's settings from a preserve file:

1. In the **Test Menu Editor**, highlight a test in the **Test List**.
2. Click on the **Restore** button.
3. The **Open** window will be displayed.
4. If necessary, change the **Look In path** to the location of the preserve file.
5. Select the preserve file.
6. Click the **Open** button.

If no matching test protocol name is found within the preserve file the program will notify the user and will then terminate the restore process.

Changing Test Setup during an Exam

While performing an exam, if you make changes to the test protocol's parameters (i.e., Gain, Screen Layout, etc.) and want to save these changes as the new default settings for the test protocol, follow these steps.

- Click on the **Edit** menu
- Select **Save Test Parameters**

Changing the Test Layout

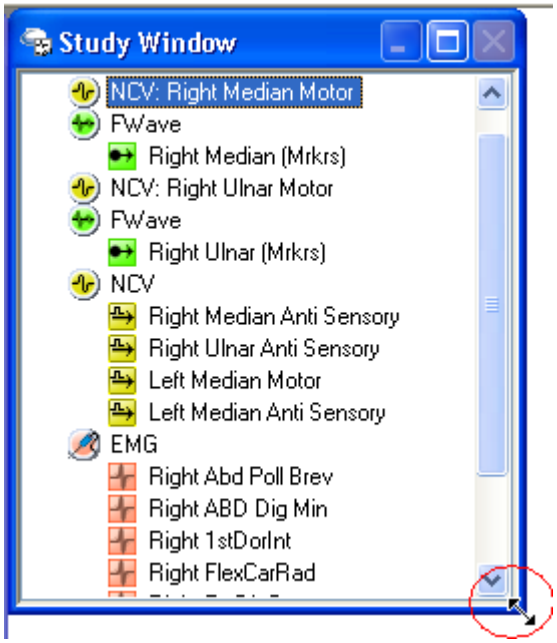
Four main windows compose the Sierra Wave screen, they are the **Trace**, **Study**, **Amplifier & Stimulator Controls**, and **Measurements / Cursor Table** windows.

The **Size** and **Position** of these windows can be changed and saved on a per test protocol basis.

The Amplifier & Stimulator controls can be configured in either a **window** or **toolbar** format. This preference can be saved on a per test protocol basis. In software version 5.5 or higher, the default format is the Controls Toolbar enabled. To turn the Controls Toolbar On or Off, select the option called **"Test Control Bar"** from the **View** menu.

To change the Size of a Window:

Move the mouse cursor until it is over the edge or corner of the window you want to resize. The cursor should turn into a **double-headed arrow**. Click the left mouse button and hold it down while you move the mouse, as the mouse moves the size of the window will change. Release the left mouse button when you have reached the size that you like.

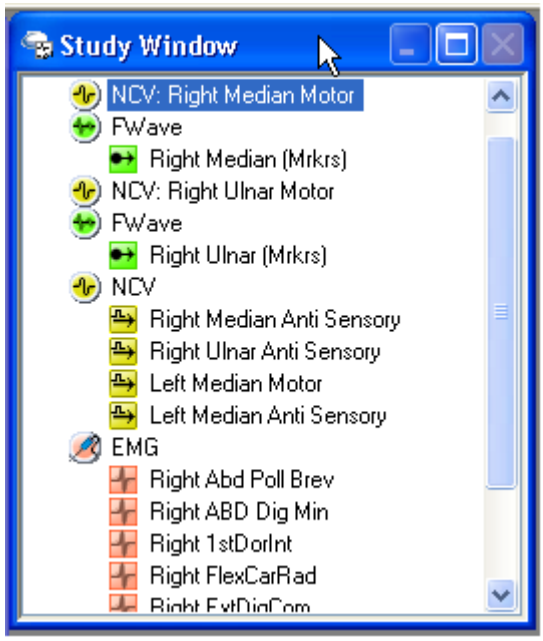


Study window with double-headed arrow in lower right corner.

To change the Position of a Window:

Move the mouse cursor over the Title Bar of the window you want to move. Click the left mouse button and hold it down while you move the mouse. The window will move with the mouse. When you reach the new position for the window release the left mouse button.

Repeat this for all the windows that you want to move.



Mouse cursor over the Study window's Title Bar.

To Save the Test Protocol's Layout:

After changing the Size and Position of the windows.

- Click on the **Edit** menu
- Select **Save Test Parameters**

The **EMG** test protocol has separate layouts for **Live** mode, **Capture** mode, and **IPA** mode. This also includes the Trace window's grid selection. When saving the layout of the EMG test protocol, first select Save Test Parameters while in Live acquisition mode, then switch to Capture mode and select Save Test Parameters a second time to save the Capture layout, and finally switch to IPA mode and select Save Test Parameters a third time to save the IPA layout.

Capture mode layout also includes **SMUA**.

Study Menu Setup

Study Menu Setup Window

From the **Edit** menu, select **Study Menu** to display the **Study Menu Setup** window. From this window you can create new study lists or modify existing study lists.

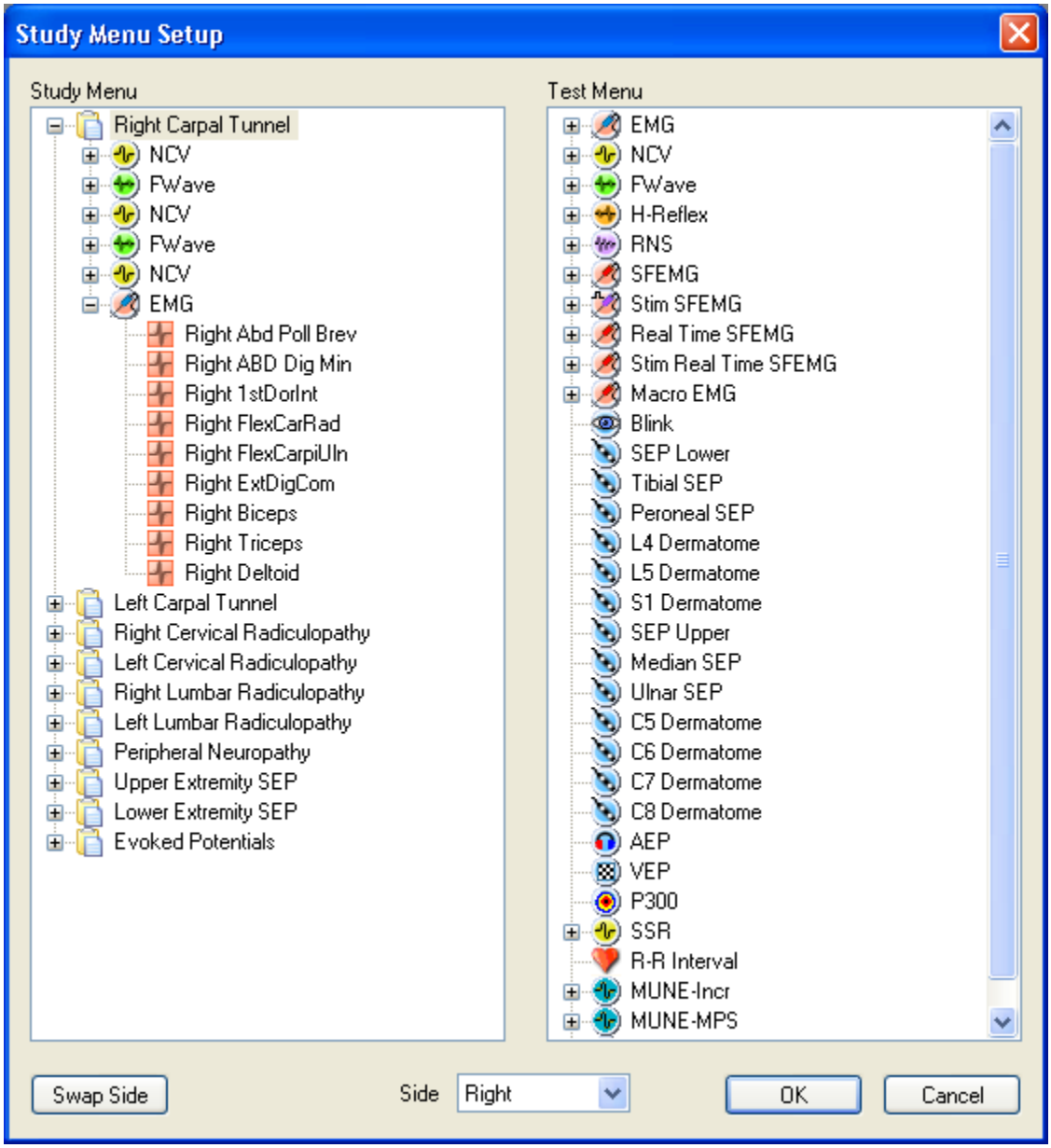
A **Study List** is simply a predefined list of test protocols. It is typically organized with the individual tests ordered in the sequence they are usually performed on the patient.

The Sierra Wave comes with several default studies that are ready to use or can be modified to suit your testing needs.

The left side of this window, labeled Study Menu, shows the existing Study Lists that are on the instrument. The right side of the window, labeled Test Menu, shows the available Test Procotols.

To expand a Study List and see what test protocols it contains, click on the plus sign **(+)** in front of the study name. To contract a Study List, click on the minus sign **(-)**.

Those test protocols which have an associated muscle or nerve list also have plus signs **(+)** in front of their names. Click on these plus signs to view the muscle or nerve list for that test protocol.

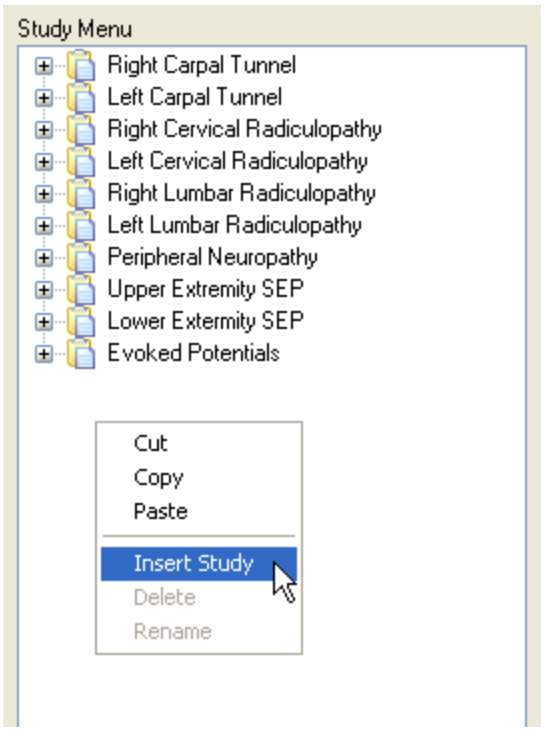


Study Menu Setup window with Right Carpal Tunnel Study expanded.

Creating a New Study

To Create a New Study List

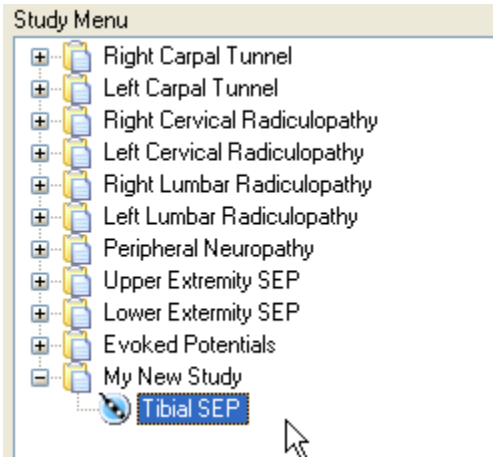
1. **Right click** the mouse in the Study Menu side of the window.
2. Select **Insert Study** from the pop-up menu.



Right click in Study Menu area to get pop-up menu.

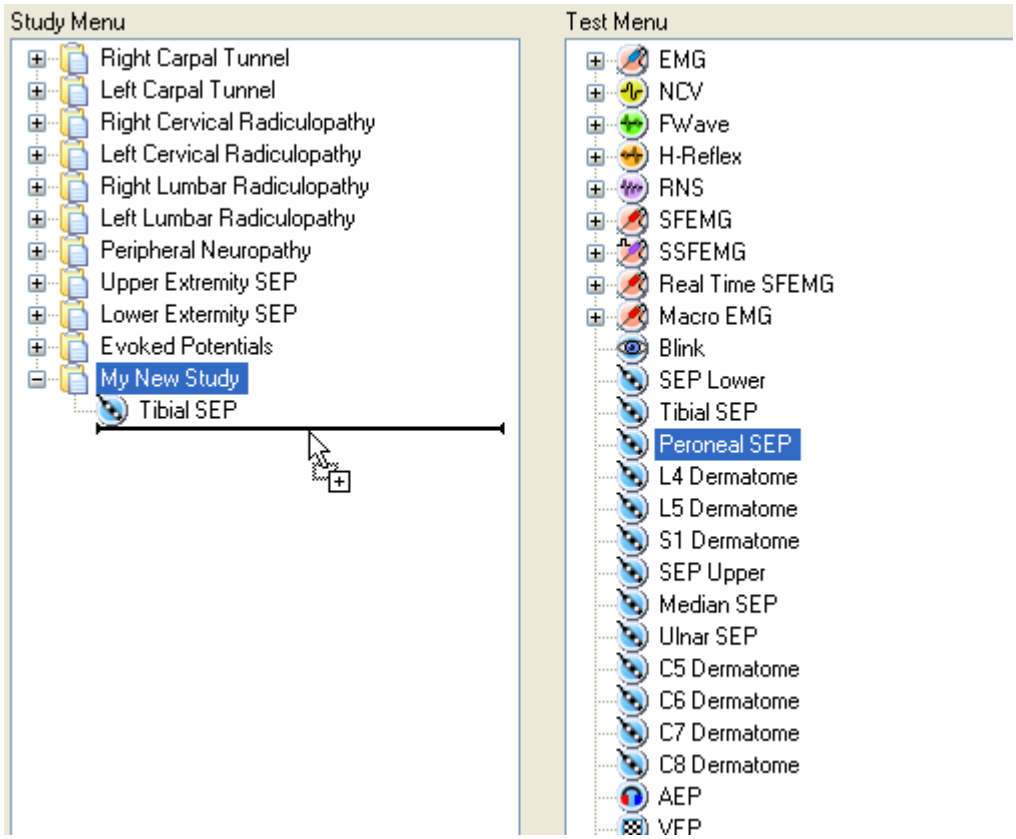
3. **Type the name** for the new study and press **Enter**.

4. Using the left mouse, **click and drag** the desired Test Protocol from the Test Menu side of the window over to the Study Menu side of the window. Drop the Test Protocol onto the name of the new study. The Test Protocol will then appear underneath the name of the study.



Result of dragging over Tibial SEP test and dropping it on My New Study.

5. Click and drag over another Test Protocol. A **black line** (see picture below) will appear which indicates where the second test will be placed when the mouse button is released.

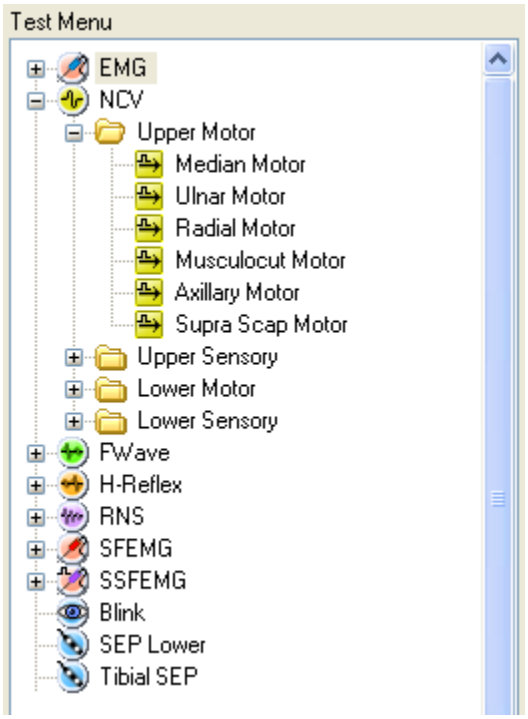


Black line indicates where second test (Peroneal SEP) will be inserted.

6. Continue to select and drag over test protocols until the Study is complete.

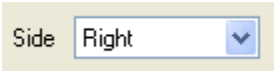
Working with Test Protocols that have a muscle or nerve list:

To view the associated nerve or muscle list for a test protocol, expand the protocol by clicking on the plus sign (+) in front of its name.



NCV test protocol expanded to show Upper Motor nerve list.

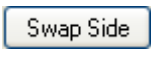
Using the Side parameter:



When you select a nerve or muscle from the Test Menu the **Side field** at the bottom of the window becomes activated. This allows you to select the side parameter for the particular nerve or muscle.

For example, if you want to add the Right Median Motor nerve to a study, first click on the Median Motor test to select it, then make sure the Side field is set to Right. Now go ahead and drag the test over to the Study List.

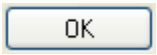
The Side field can be used with **NCV**, **EMG**, **EMG Guidance**, **F Wave**, **H Reflex**, **RNS**, **SFEMG**, **SSFEMG, Real Time SFEMG,** and **MUNE** test protocols since all these tests have either a nerve or muscle list.

Using the 

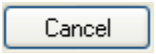
button:

If you make a mistake and drag over a test with the wrong side selected, simply highlight the test in the Study Menu and then click the **Swap Side** button. The side of that test will be reversed.

Window Buttons



Click the **OK** button to close the Study Menu Editor window and **save all your changes**.



Click the **Cancel** button to close the Study Menu Editor window **without saving any changes** that were made.

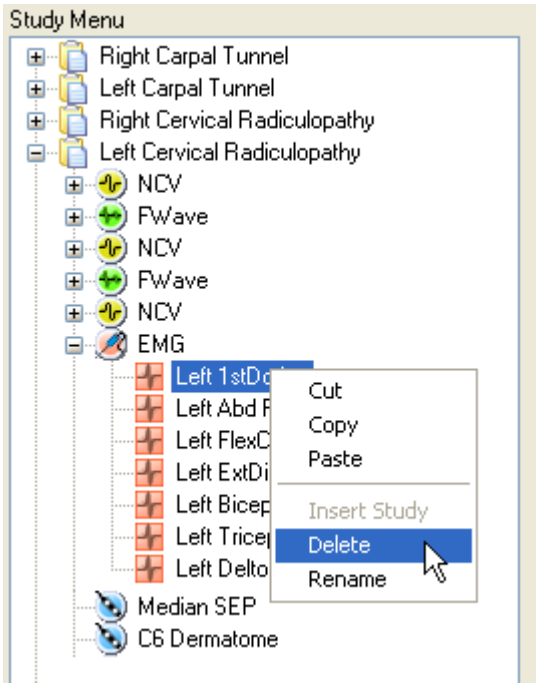
Changing an Existing Study

To change or modify and existing Study List

Click the **(+)** sign in front of the Study to be changed. This will expand the Study and show the Test Protocols contained within it.

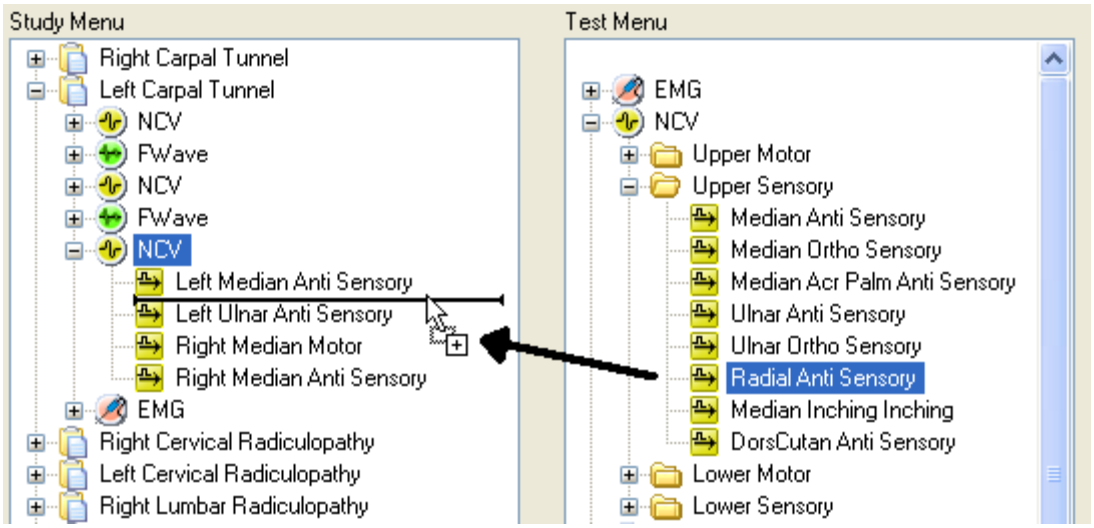
To Delete a Test from the Study:

Right click on the Test Protocol you want to remove from the Study, select **Delete** from the pop-up menu.



To Add a Test to the Study:

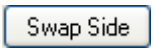
Click and drag (using the left mouse button) a Test Protocol from the Test Menu side of the window over to the Study Menu side of the window. A **black bar** will appear which indicates where the new Test Protocol will be placed when the mouse is released.



The **black bar** shows where the Radial Anti Sensory test protocol will be placed when the left mouse button is released.

To Swap Sides of a Test:

Select the Test Protocol in the Study that needs to be changed. Now, click the **Swap Sides** button at the bottom of the window. The Side parameter for the Test Protocol will be reversed, from Left to Right or Right to Left.

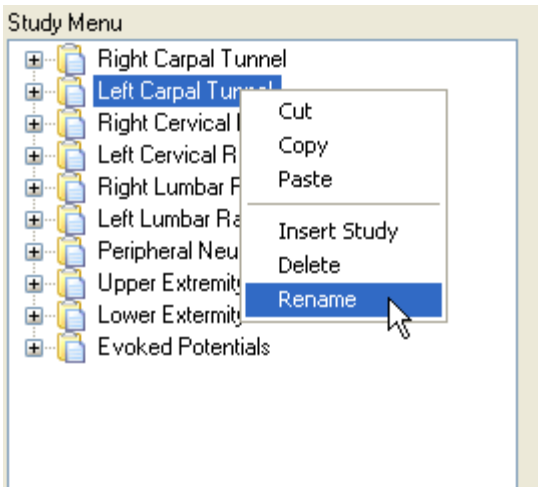


To Change the Order of the Tests in the Study:

Select the Test Protocol in the Study that you want to move. **Click and drag** (using the left mouse button) the Test Protocol up or down within the Study. A black bar will appear to indicate where the Test Protocol will be placed when the mouse is released.

To Rename a Study:

Right click over the name of the Study. From the pop-up menu select Rename. Type the new name for the Study and press Enter.



Right click on a Study and select Rename.

Window Buttons

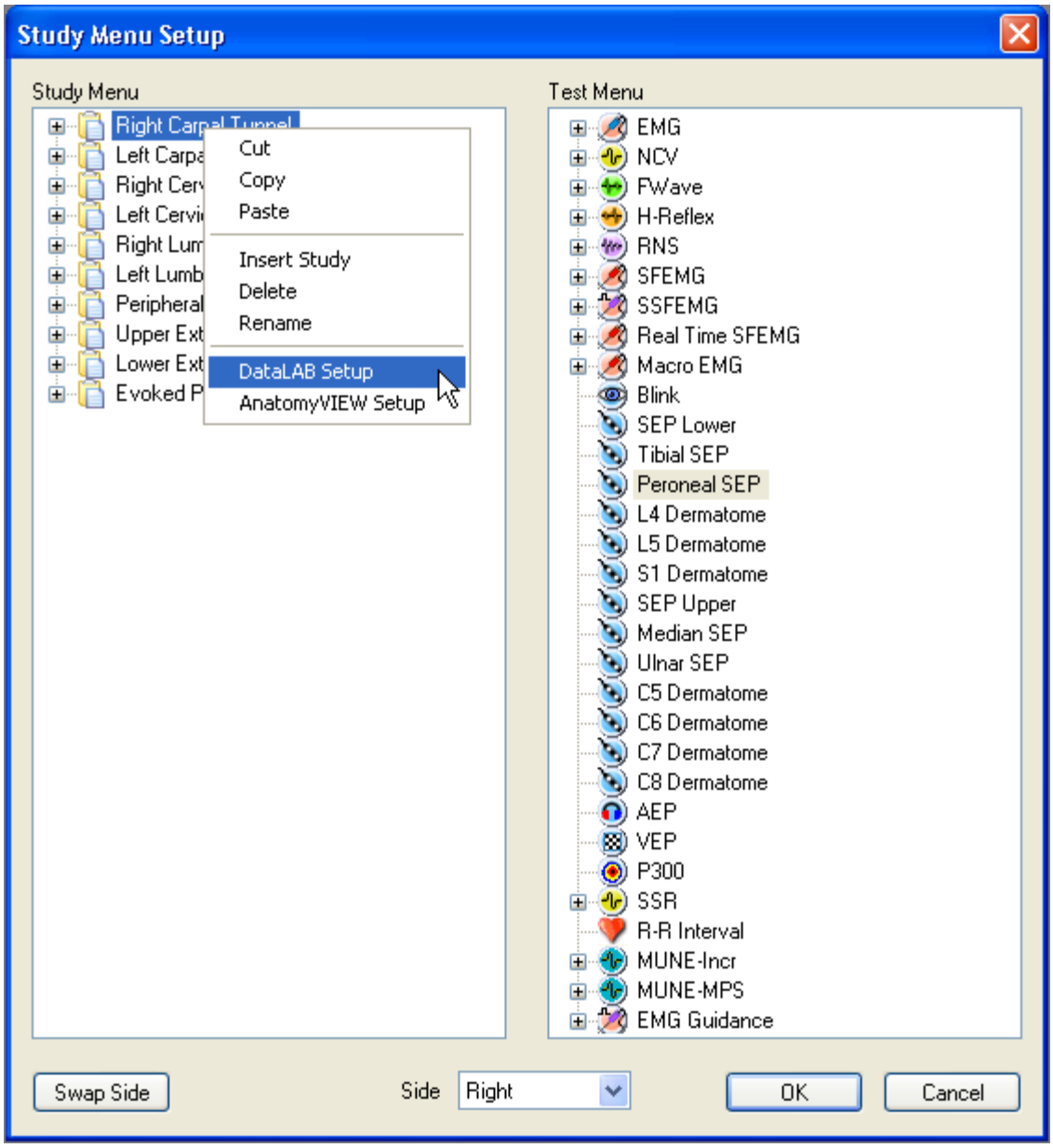
Click the **OK** button to close the Study Menu Editor window and **save all your changes**.

Click the **Cancel** button to close the Study Menu Editor window **without saving any changes** that were made.

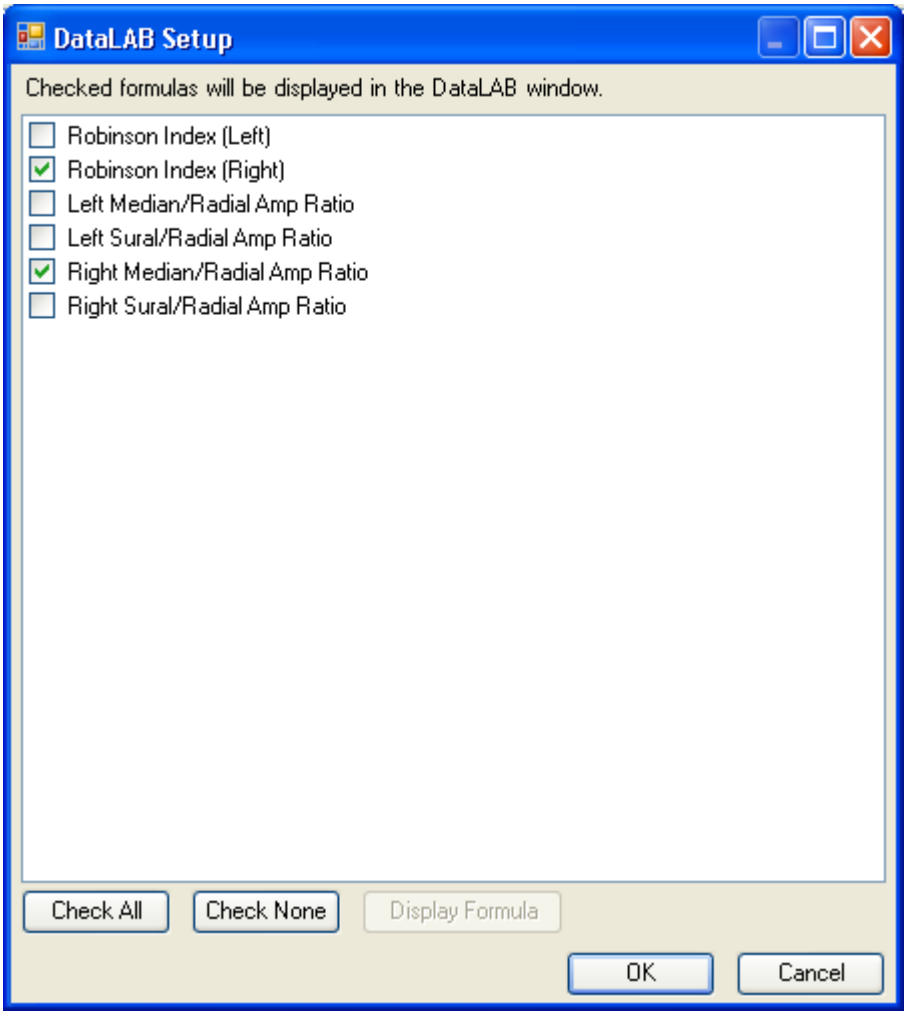
Assigning DataLAB Formulas to a Study

To Assign a DataLAB Formula to a Study:

1. From the **Edit** menu, select **Study Menu** to display the **Study Menu Setup** window.
2. **Right click** over the name of the Study and select **DataLAB Setup** from the pop-up menu. The DataLAB Setup window will be displayed.



3. Place a **check mark** next to the **formulas** you want to appear in the DataLAB window when using this Study.

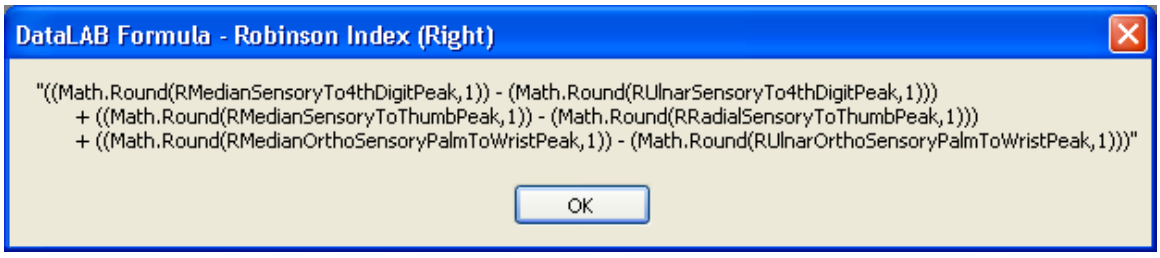


DatLAB Setup window.

4. Click **OK.**

To Display the contents of a Formula:

1. Click on the formula to highlight it.
2. Click on the **Display Formula** button.
3. The actual formula specified in the **FormulaList.xml** file will be displayed.

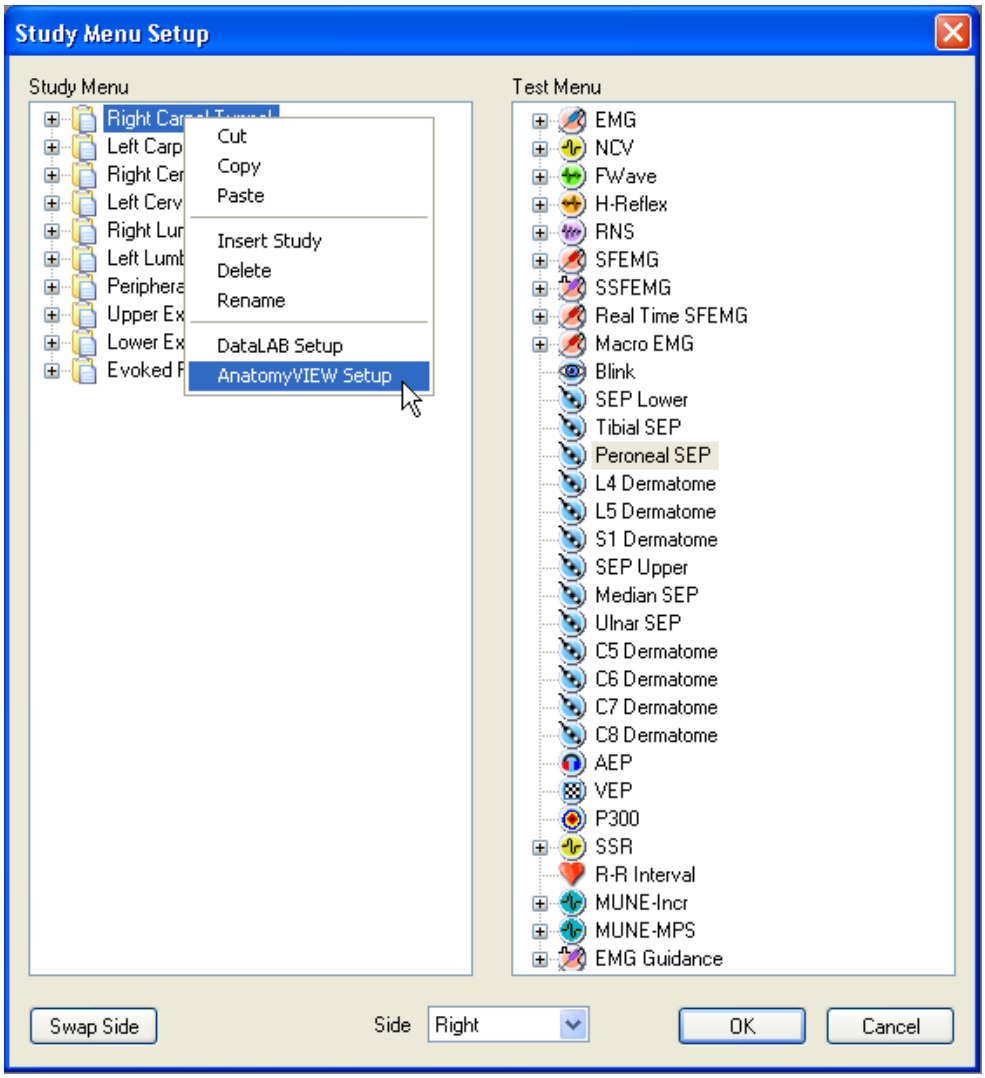


Display Formula window.

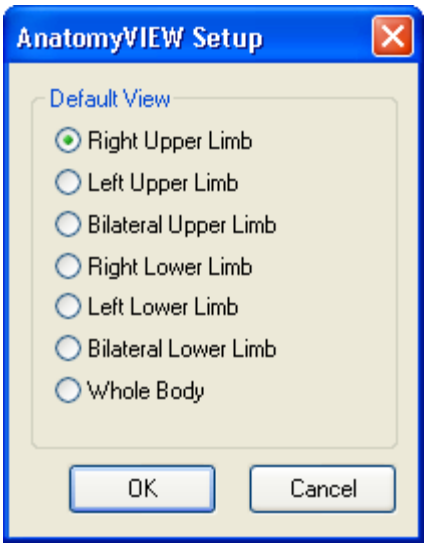
Setting the default AnatomyVIEW for a Study

To Assign the default AnatomyVIEW for a Study:

1. From the **Edit** menu, select **Study Menu** to display the **Study Menu Setup** window.
2. **Right click** over the name of the Study and select **AnatomyVIEW Setup** from the pop-up menu. The AnatomyVIEW Setup window will be displayed.



3. Select the default view and then click the **OK** button.



Menus

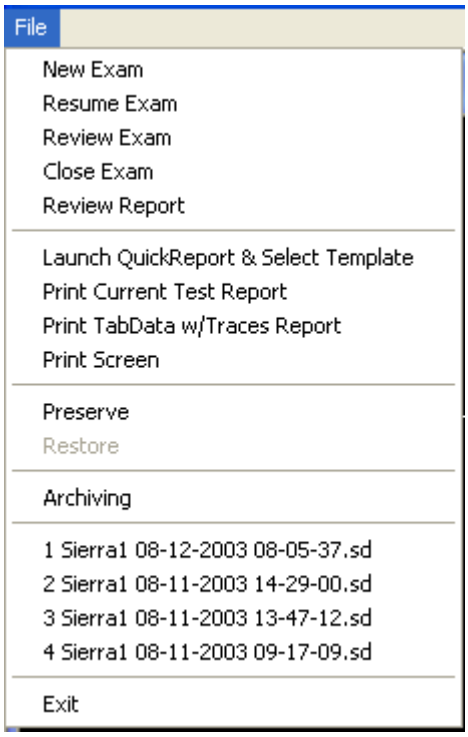
File Menu

Wave Program Menus

Pressing the **ALT** key on the PC keyboard or the **Select** key on the Wave base unit configures the base unit knobs to allow selection from the program menus. **Knob 1** moves up/down through the selected menu, **Knob 2** moves across the menus, and the **F4** function key closes the menus and returns the knobs to their original state.

Menu controls.

File Menu:

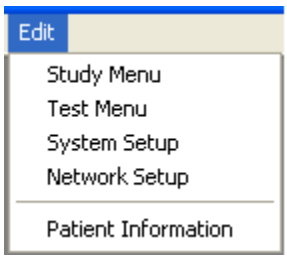


- **New Exam** – Opens the Patient Information window, after entering Last Name and First Name testing can begin.
- **Resume Exam** – Opens the Resume Exam window. Use this feature to open an existing patient file and add more test data to it.
- **Review Exam** – Opens the Review Exam window. Use this feature to review a completed patient test.
- **Close Exam** - Closes the current Patient's Exam and saves all data to their file. This function is only listed in the menu after starting an exam.
- **Review Report** - Opens the Review Report window. Use this feature to review stored report documents.
- **Enter Patient Info** – Opens the Patient Information window. Use this feature to pre-enter and save patient information for use at a later time. This feature is only listed in the menu prior to starting an exam.
- **Launch QuickReport & Select Template** - Starts the QuickReport program and allows selection of a report template. This feature is only listed in the menu after starting an exam.
- **Print *Current Test* Report** - Starts the QuickReport program and uses the report template assigned to the Print key on the base unit. In this example, the report template is called "Current Test". This feature is only listed in the menu after starting an exam.

- **Print *TabData w/Traces* Report** - Starts the QuickReport program and uses the report template assigned to the Report key on the base unit. In this example, the report template is called "TabData w/Traces". This feature is only listed in the menu after starting an exam.
- **Print Screen** - Sends an image of the current screen to the default printer. This feature is only listed in the menu after starting an exam.
- **Preserve** – Copies all test parameters, study lists and report templates to a user defined location and filename.
- **Restore**
    - **Restore All** – Restores all test parameters, study lists and report templates from a preserve file.
    - **Restore Selected** – Opens the Sierra Restore Utility and allows selected test protocols, study lists or report templates to be restored from a preserve file.
- **Archiving** – Opens the Archive Window. Which provides a convenient way to copy patient data files and stored reports to selected archive media.
- **List of last 4 studies opened.**
- **Exit** – Closes the Sierra Wave program.

Edit Menu

Edit Menu:



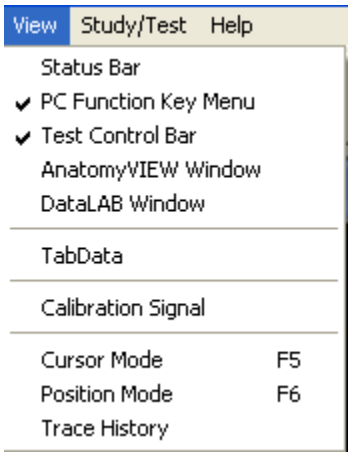
- **Study Menu** – Opens the Study Menu Setup window. Use this feature to modify and/or create customized Study Lists.
- **Test Menu** – Opens the Test Menu Setup window. Use this feature to change default test protocol, parameter settings as well as Nerve and Muscle Lists.
- **System Setup** – Opens the System Setup window. Use this feature to select Directories, Assign Study and Report Keys, set Archive

Destinations, Modify Report Header and create Custom Patient Information fields.

- **Network Setup** - Opens the Network Setup window. Use this feature to enable Automatic Copy of the patient's exam to a network location and to enabled Automatic Synchronization of test settings from a preserve file at program launch.
- **Patient Information** – Opens the Patient Information window. Use this feature to modify or add to patient info after starting exam.
- **Save Test Parameters** - Use this function to save any changes that were made to the test protocol settings and make them the new default settings for the test. *This feature is only listed in the menu after starting an exam*.
- **Current Test** - Use this function to open the Test Menu Editor window for the current test protocol. *This feature is only listed in the menu after starting an exam.*

View Menu

View Menu:



- **Status Bar** – Not used by the Wave program at this time.
- **PC Function Key Menu** – Enables the F5-F12 Function Key toolbar. This is shown at the bottom of the screen and displays additional functions that can be utilized in the test protocol. For example, F5 is used to select Cursor Mode with allows positioning of cursors using the knobs on the base unit.

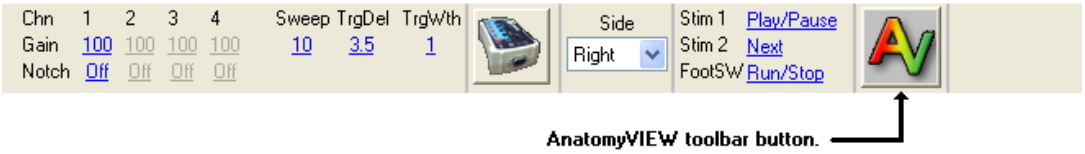
PC Function Key toolbar.

Even when the PC Function Key toolbar is disabled (unchecked) you can still use **F5** and **F6** to select the **Cursor** and **Position** functions respectively.

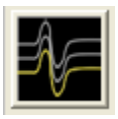
- **Test Control Bar** - This setting determines how the Amplifier & Stimulator controls are displayed. If this option is enabled, the controls are displayed in a toolbar rather than a window format.

Controls Toolbar for the NCV test protocol.

- **AnatomyVIEW Window** - Opens the AnatomyVIEW window. This window displays the EMG muscle scoring data on a 3D color-coded anatomical model. Selecting this is the same as clicking on the AnatomyVIEW toolbar button.



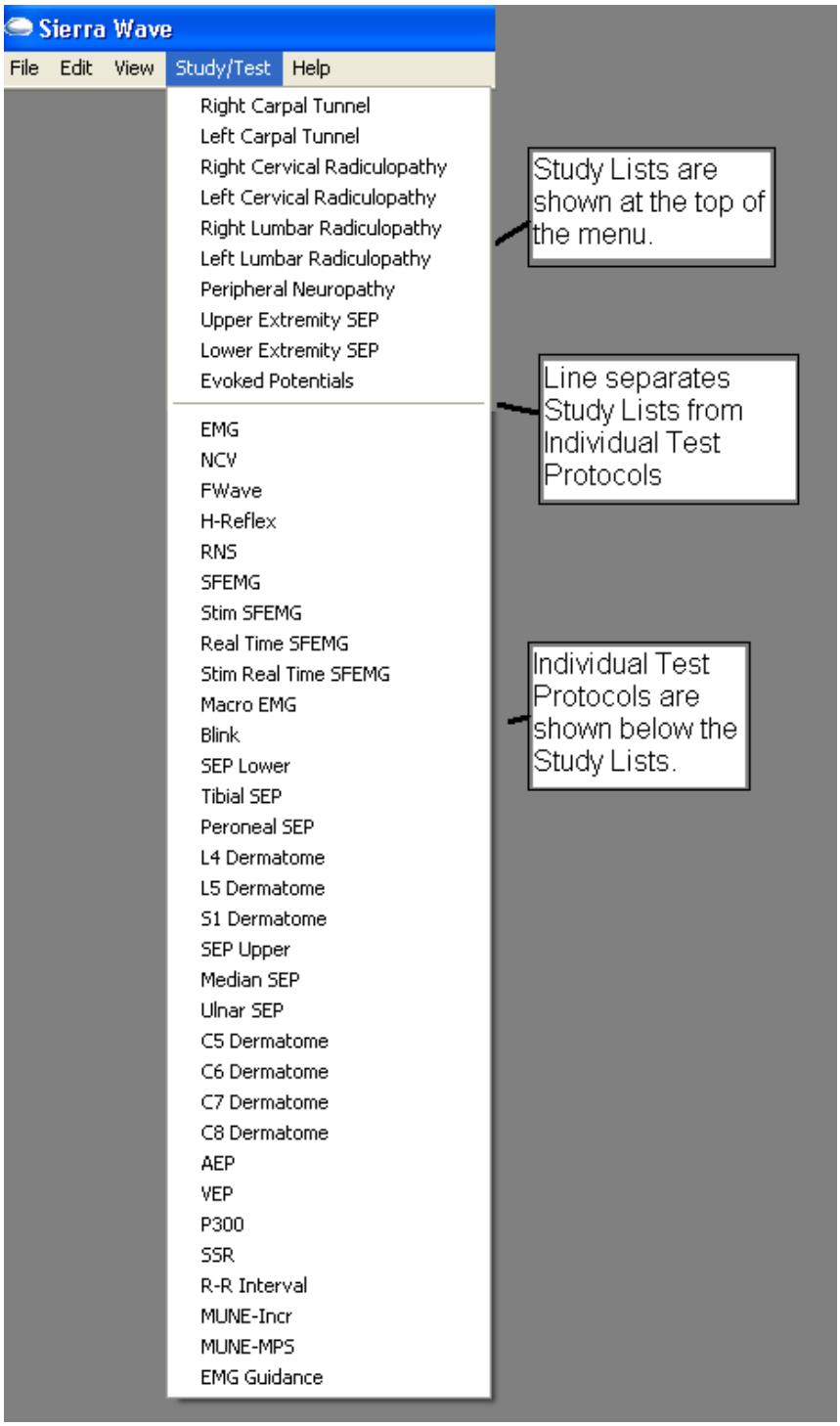
- **DataLAB Window** - Opens the DataLAB widnow. This window is used to display the results of custom formulas, such as the Robinson Index.
- **TabData** - Opens the TabData Summary window. This window is a convenient way to review all the tests that have been performed on the patient. It also displays summary tables for NCV nerve types. This function is only listed in the menu after starting an exam.
- **Calibration Signal** - Enables the built-in calibration signal. For more information see the topic Calibration Signal in the Utilities chapter.
- **Cursor Mode F5** - Selecting this is the same as pressing the F5 function key.
- **Position Mode F6** - Selecting this is the same as pressing the F6 function key.
- **Trace History** - Opens the Trace History window. This window shows the last 30 traces acquired for each stimulus site in the NCV test protocol. This window can also be opened by clicking on the Trace History Icon in the toolbar.



Trace History Icon.

Study/Test Menu

Study / Test Menu:



- The upper section lists the **Studies** available. Studies are comprised of individual Test Protocols generally arranged in the order they will be

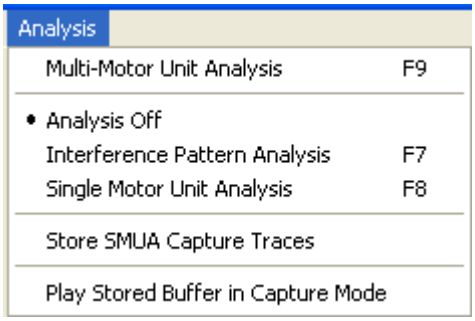
performed on the patient. For example Right Carpal Tunnel Study includes the following tests.

- Right Median Motor
- Right Ulnar Motor
- Right Median Anti Sensory
- Right Ulnar Anti Sensory
- Etc…

- The lower section lists the individual **Test Protocols** available.

Analysis Menu

Analysis Menu:



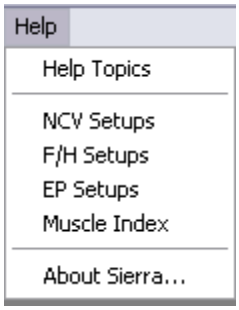
This menu is only available when the **EMG** test protocol is selected.

- **Multi-Motor Unit Analysis** - when selected, this will enable the multi-motor unit analysis mode which is utilized on live or stored EMG buffers.
- **Analysis Off** - turns off the Interference Pattern Analysis and Single Motor Unit Analysis modes. *To turn off Multi-Motor Unit Analysis, click on the Multi-Motor Unit Analysis entry a second time.*
- **Interference Pattern Analysis** - when selected, this will enable the interference pattern analysis mode and display the three available IP "cloud plots".
- **Single Motor Unit Analysis** - when selected, this will enable the single motor unit analysis mode and display the MUA table.
- **Store SMUA Capture Traces** - when selected, this will cause the program to automatically store the individual captured traces as well as the averaged MUP trace when the Store key is pressed.
- **Play Stored Buffer in Capture Mode** - when selected, this feature allows previously stored Live EMG Buffers to be played back in EMG Capture

mode. This feature is disabled if the currently selected muscle in the Study window does not have any associated stored EMG Buffers.

Help Menu

Help Menu:



- **Help Topics** – This opens the Sierra Wave Help File.
- **NCV Setups** - A shortcut to the NCV Setup Guides in the Reference Chapter.
- **F/H Setups** - A shortcut to the F/H Setup Guides in the Reference Chapter.
- **EP Setups** - A shortcut to the Evoked Potential Setup Guides in the Reference Chapter.
- **Muscle Index** - A shortcut to the list of Muscles in the Reference Chapter.
- **About Sierra** – This contains information regarding the current software version and the current versions of other components installed in the Sierra Wave Base Unit.

Protocols

EMG

EMG Basics

This topic is a repeat of the basic EMG steps found in the **Getting Started** chapter.

Select the EMG Test:

- **If a Study has already been selected**, simply click on an EMG muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the muscle name. Notice that as soon as any muscle is selected within the EMG test protocol, all the muscles are automatically added to the muscle score table.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG test protocol from the Study/Test menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that as soon as any muscle is selected, it is displayed within the Study window and is automatically added to the muscle score table.


The **Automatic Muscle Scoring** feature can be disabled in the **EMG Test Setup** window. When this feature is disabled the muscles in the Study window are not automatically added to the muscle score table. You will need to use the **F2 (Muscle Sel/Score)** knob or the **Left mouse button** to manually add the appropriate muscles to the scoring table.

Once the muscle has been selected. Follow these steps for performing routine EMG data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate.

   Typical Settings for EMG

   Gain = 100 or 200 uV/Div

   Hicut = 10k Hz

   Locut = 10 - 30 Hz

   Sweep Speed = 10.0 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Insert the Needle Electrode**

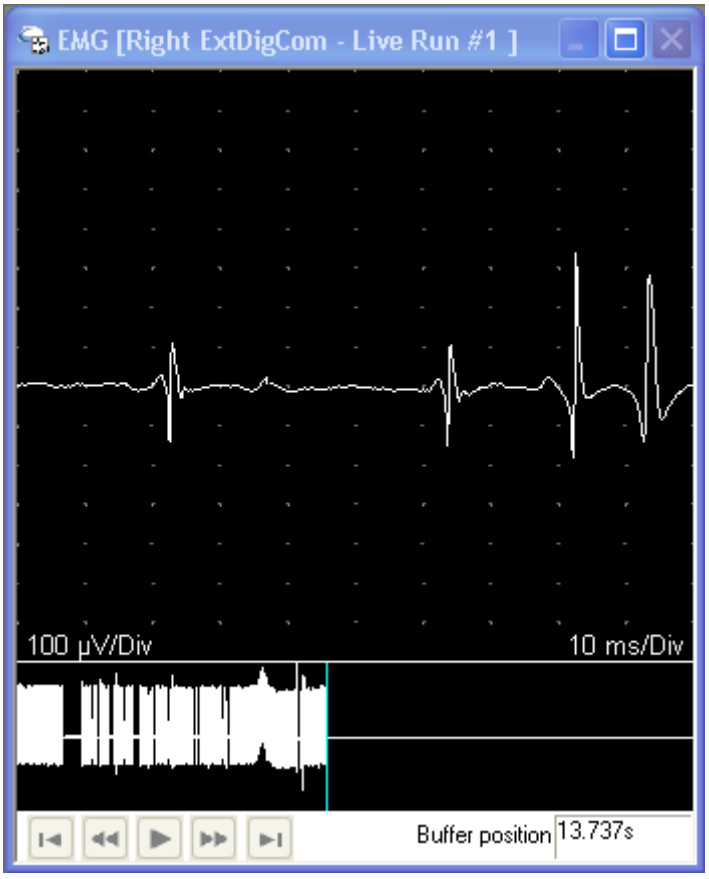
4. **Adjust Volume**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume Knob** on the left hand side of the base unit.

5. **Select Live or Capture Acquisition Mode**

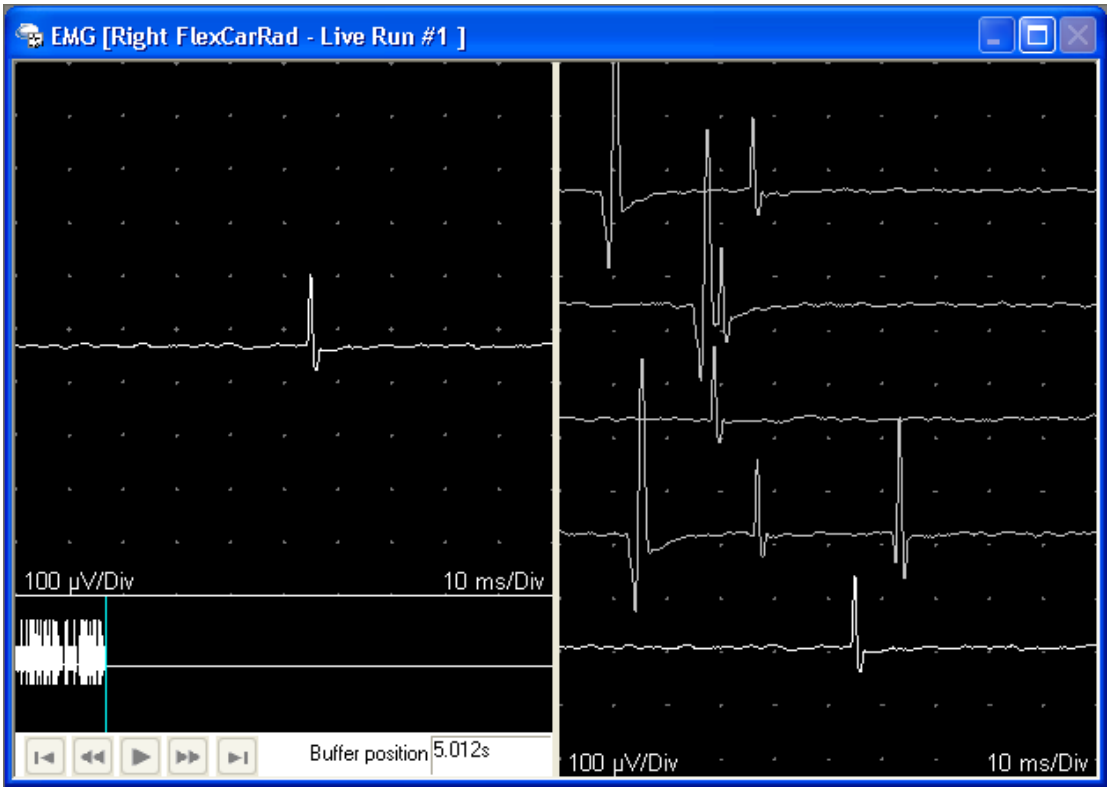
   Use the **F1 (Live / Capture)** function key to toggle between these two acquisition modes.

   Live Mode: In Live mode free-running EMG is displayed in the Trace window and a compressed view of the EMG Live Buffer is displayed below this. A moving blue marker shows the current position within the buffer. At any time data acquisition can be stopped and the data in the Live Buffer can be reviewed or played back (see step #7 below). The EMG protocol always defaults to the Live data acquisition mode.



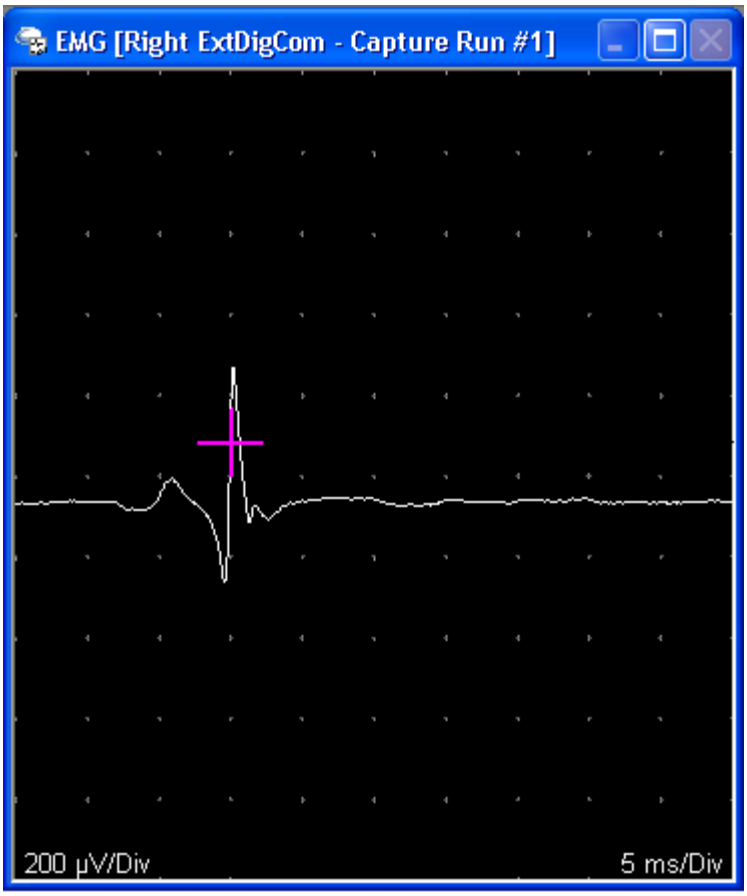
EMG - Live mode

Live Mode with Raster Display: An optional Raster Display can be enabled by pressing the **F11 (Raster)** function key. When this feature is enabled the Trace window is split into two equal sections; the left half showing the live EMG data and the compressed buffer, the right half showing consecutively rastered EMG traces. Click here for more information on the Raster Display option.



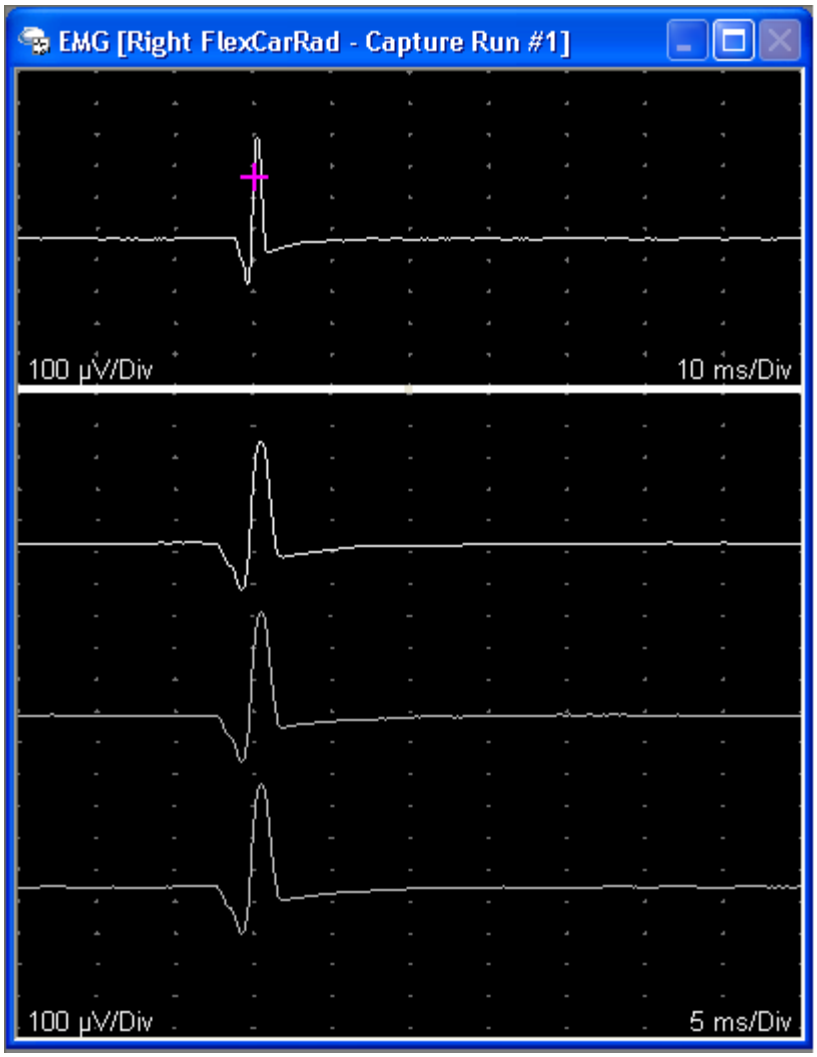
Live EMG mode with Raster Display enabled.

Capture Mode: In Capture mode a voltage level trigger and delay marker are displayed within the Trace window. The level of the voltage trigger can be adjusted using **Knob #3 (Trigger Lvl)**. When EMG activity exceeds the trigger level (in either the negative or positive direction) the sweep is captured momentarily and is repositioned with the crossing point at the delay marker. This allows for easier visualization of motor unit potentials. At any time data acquisition can be stopped and up to 50 captured sweeps can be reviewed (see step #7 below).



EMG - Capture mode

Capture Mode with Capture Window: An optional Capture Window can be enabled by pressing the **F11 (Cap Wnd)** function key. When this feature is enabled the trace window is split into two sections; the top section shows the live EMG trace and the trigger level and delay indicator, the bottom section shows a rastered display of the most recently captured traces. Click here for more information on the Capture Window option.



Capture Mode with Capture Window enabled.

6. **Adjust Gain & Sweep**

   During EMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

   You can also use the mouse to change these settings in the **EMG Controls window** or **Controls Toolbar**.

7. **Stop Data Acquisition and Review (optional)**

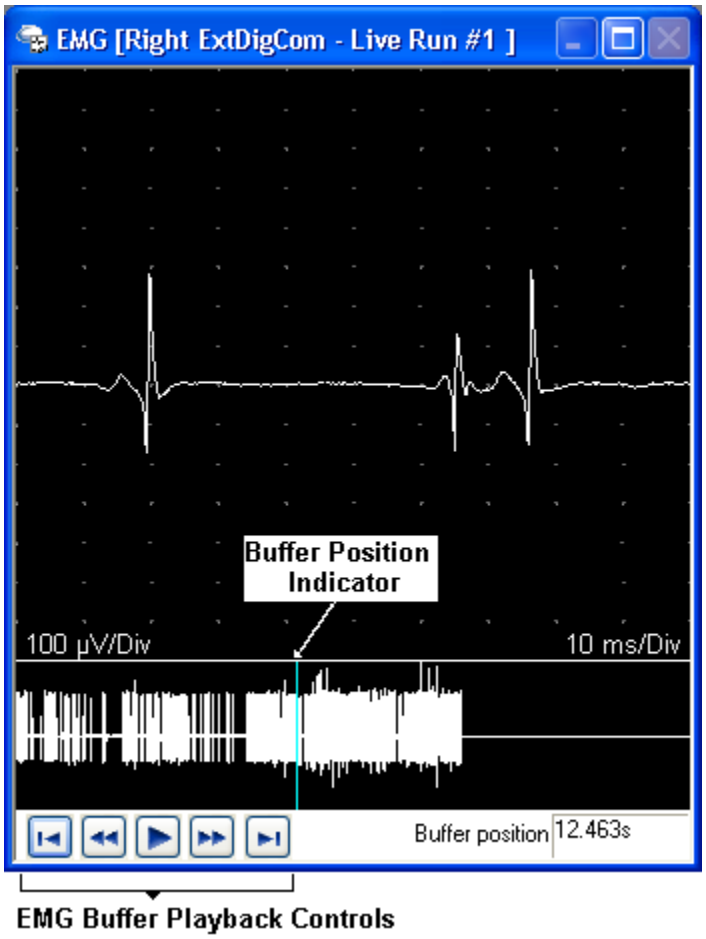
   To stop data acquisition perform one of the following actions;

   - Press the **Run/Stop key** on the **Sierra Wave base unit.**
   - Press the **Stim button** on the **Electrical Stimulator handle**.

- Press the **Footswitch** pedal.
- Click on the **Stop button** in the **EMG Controls** window.

Stopped Live EMG:

Review the Live Buffer - move backwards and forwards in the Live EMG buffer by turning **Knob #1 (Review / Play-Stop)**, press the knob to replay the buffer. You can also review by dragging the blue marker back and forth within the compressed buffer area using the mouse.



EMG - Stopped Live mode

Store a Snapshot - press the **F1 (Store Snap Shot)** function key or the **Store key** on the Sierra Wave base unit to store the currently displayed sweep. The stored sweep will be displayed in purple.

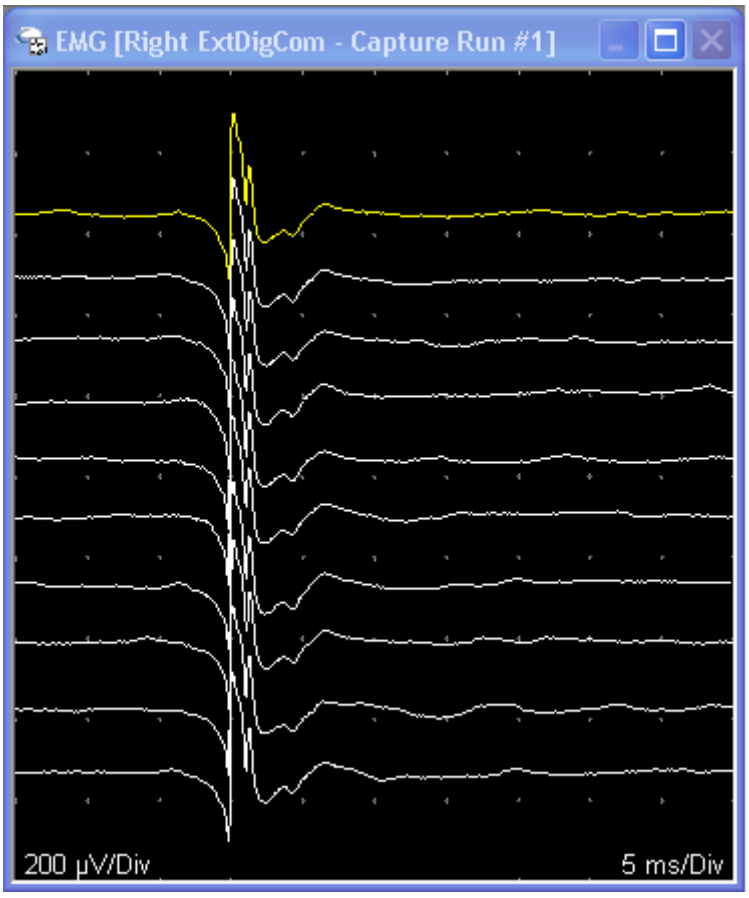
Store the entire Live Buffer - press the **F2 (Store Live Buffer)** function key. The trace will be displayed in blue indicating that the entire buffer has been stored.

Manual MUP Tool - **right click** the mouse over the motor unit potential (MUP) of interest, then select **MUP Tool** from the pop-up menu. The

motor unit potential is shown centered within a MUP window and quantitative measurements are shown in the table below. Click **OK** to save the MUP and include it in the final report, click **Cancel** to discard the MUP.

Stopped Capture EMG:

Review Captured Sweeps - use **Knob #4 (Trace Sel /Delete)** to review through the captured traces, press the knob to delete the selected trace (selected trace is displayed in yellow color). Press the **F2 (Raster / Overlay)** function key to superimpose all the captured traces.

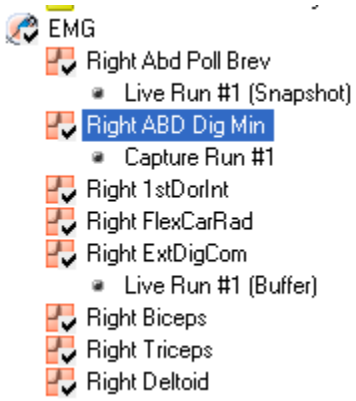


EMG - Stopped Capture mode

Store Captured Sweeps - press the **Store key** on the Sierra Wave base unit or click on the **Store button** within the EMG Controls window. The stored traces will be displayed in purple.

Prior to storing any EMG traces, Use **Knob #2 (Muscle Sel)** to highlight the correct muscle name in the Study window. This will ensure that the EMG data will be stored with the correct muscle name.

As EMG is stored, you will see a new **node** appear in the Study window below the muscle name. This indicates what has been stored for this muscle. The example below shows a Snapshot stored for the Right Abd Poll Brev muscle, a Capture run stored for the Right ABD Dig Min muscle, and a Live Buffer stored for the Right ExtDigCom muscle.



Example of stored EMG nodes in the Study window.

8. Return to Data Acquisition Mode

If you stopped either Live or Captured data acquisition, perform one of the following actions to resume data acquisition;

- Press the **Run/Stop key** on the **Sierra Wave base unit**.
- Press the **Stim button** on **Electrical Stimulator handle**.
- Click the **Run button** in the **EMG Controls** window.

9. Modify Muscle Scoring

With the **Automatic Muscle Scoring** feature enabled, as soon as a muscle is selected in the Study window, or added to the Study window using the **F3 (Muscle List)** function key, it is automatically added to the **Muscle Scoring Table** and is scored as normal.

To change the muscle scoring for a muscle:

- Turn **Knob #3 (Score Table / Modify)** until the highlight is over the scoring field that you want to change, press the knob to pop up a list of choices, turn the knob to highlight one of the choices and press again to select it.
- Using the **left mouse button**, click on the scoring field that you want to change. From the pop up list of choices click again to make a selection.

Muscle Scoring Table

Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Right	Abd Poll Brev	Median	C8-T1	Incr	2+	1+	Nml	Nml	0	Nml	Nml	_
Right	ABD Dig Min	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	ExtDigCom	Radial (Post Int)	C7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_

Muscle Scoring Table

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. Select Next Muscle

Turn **Knob #2 (Muscle Sel / Delete Score)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the muscle from the list.

Move the Needle Electrode to the new muscle and repeat the above steps as necessary.

It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

11. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected tests traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

12. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the Sierra Wave base unit and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (EMG)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in **Live vs. Capture** acquisition mode and on whether the EMG is **running or stopped**. The functions will also change when either the **Cursor** or **Position** modes are enabled.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Live EMG Acquisition Mode:

Live EMG

(Knobs)

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Muscle Sel / Delete Score - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window. If the

muscle has been scored you can press the knob to remove it from the Muscle Scoring Table.

ScoreTable / Modify - turn this knob to move the highlight within the Muscle Scoring Table window. Press this knob to change the scoring choice for a muscle, for example to change Fibs from Nml to +3.

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the EMG trace. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the EMG trace.

The Gain and Sweep will automatically reset to default values when a new muscle is selected in the Study window.

(F Keys)

Live / Capture - press this function key to switch back and forth between **Live** or **Capture** acquisition modes.

Fibs / Recrt - press this function key to switch back and forth between **Fibs** and **Recrt** parameter settings. You can program different Gain and Sweep Speed parameters for these two modes and use this function key to easily toggle between the two.

This function key will automatically reset to the Fibs mode when a new muscle is selected in the Study window.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Live EMG - Data Acquisition Stopped

(Knobs)

Review / Play-Stop - turn this knob to move backward and forward within the EMG buffer. Press the knob to start & stop playback of the EMG buffer.

Muscle Sel / Delete Score - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window. If the muscle has been scored you can press the knob to remove it from the Muscle Scoring Table.

Score Table Modify - turn this knob to move the highlight within the Muscle Scoring Table window. Press this knob to change the scoring choice for a muscle, for example to change Fibs from Nml to +3.

Gain / Sweep - turn the knob to change the gain of the EMG trace. Press the knob, then turn to change the sweep speed of the EMG trace.

(F Keys)

Store Snap Shot - press this function key to store the currently displayed EMG trace.

Store Live Buffer - press this function key to store the entire EMG buffer.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Cursor mode (F5)

(Knobs)

Lat 1 / Lat 2 - turn this knob to move latency marker number one. Press this knob, then turn to move latency marker number two. The latency values are displayed at the top left of the Trace window.

Amp 1 / Amp 2 - turn this knob to move amplitude marker number one. Press this knob, then turn to move amplitude marker number two. The amplitude value is displayed at the top left of the Trace window.

Sel. Trial - turn this knob to select a stored snapshot trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected snapshot trace.

(F Keys)

Raster / Overlay - press this function key to toggle between displaying stored snapshot traces in raster or overlay (i.e., superimposed) modes.

AmpMrk On / Off - press this function key to toggle the amplitude markers On or Off within the Trace window.

LatMrk On / Off - press this function key to toggle the latency markers On or Off within the Trace window.

Position mode (F6)

(Knobs)

Sel. Trial / Move - turn this knob to select a stored EMG snapshot trace. When selected, the trace will be displayed in yellow. Press the knob, then turn to move the selected trace up or down within the Trace window.

Move Active - turn this knob to move the active (white colored) trace up or down within the Trace window.

Sel. Trial / Delete - turn this knob to select a stored EMG snapshot trace. When selected, the trace will be displayed in yellow. Press the knob to delete the selected trace.

Gain - turn this knob to change the Gain of the selected trace.

(F Keys)

Raster / Overlay - press this function key to toggle between displaying stored snapshot traces in raster or overlay (i.e., superimposed) modes.

Capture EMG Acquisition Mode:

Capture EMG - During Data Acquisition

(Knobs)

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Muscle Sel / Delete Score - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window. If the muscle has been scored you can press the knob to remove it from the Muscle Scoring Table.

Trigger Lvl / Dual Trig - turn this knob to move the trigger level indicator up or down within the Trace window. Press this knob to activate the Dual Trigger mode. In Dual Trigger mode the trace will be captured if it falls between the two trigger level indicators (useful for capturing small amplitude motor units in the presence of large amplitude motor units)

Gain / Sweep - turn the knob to change the gain of the EMG trace. Press the knob, then turn to change the sweep speed of the EMG trace.

(F Keys)

Live / Capture - press this function key to switch back and forth between **Live** or **Capture** acquisition modes.

Fibs / Recrt - press this function key to switch back and forth between **Fibs** and **Recrt** parameter settings. You can program different Gain and Sweep Speed parameters for these two modes and use this function key to easily toggle between the two.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Capture EMG - Data Acquisition Stopped

(Knobs)

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Muscle Sel / Delete Score - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window. If the muscle has been scored you can press the knob to remove it from the Muscle Scoring Table.

Start Trace / Trace Cnt - this knob effects how the traces in the EMG capture buffer are displayed. Turn the knob to change the starting trace number. Press the knob, then turn to change the trace count number.

Trace Sel / Delete - turn this knob to select an EMG Capture trace. When selected, the trace will be displayed in yellow. Press the knob to delete the selected trace from the capture buffer.

(F Keys)

Raster / Overlay - press this function key to toggle between displaying captured EMG traces in raster or overlay (i.e., superimposed) modes.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Cursor Mode (F5)

(Knobs)

Lat 1 / Lat 2 - turn this knob to move latency marker number one. Press this knob, then turn to move latency marker number two. The latency values are displayed at the top left of the Trace window.

Amp 1 / Amp 2 - turn this knob to move amplitude marker number one. Press this knob, then turn to move amplitude marker number two. The amplitude value is displayed at the top left of the Trace window.

Sel. Trial - turn this knob to select a captured EMG trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected trace.

(F Keys)

Raster / Overlay - press this function key to toggle between displaying captured EMG traces in raster or overlay (i.e., superimposed) modes.

AmpMrk On / Off - press this function key to toggle the amplitude markers On or Off within the Trace window.

LatMrk On / Off - press this function key to toggle the latency markers On or Off within the Trace window.

Position Mode (F6)

- this feature is disabled in EMG Capture.

EMG Test Setup

EMG test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

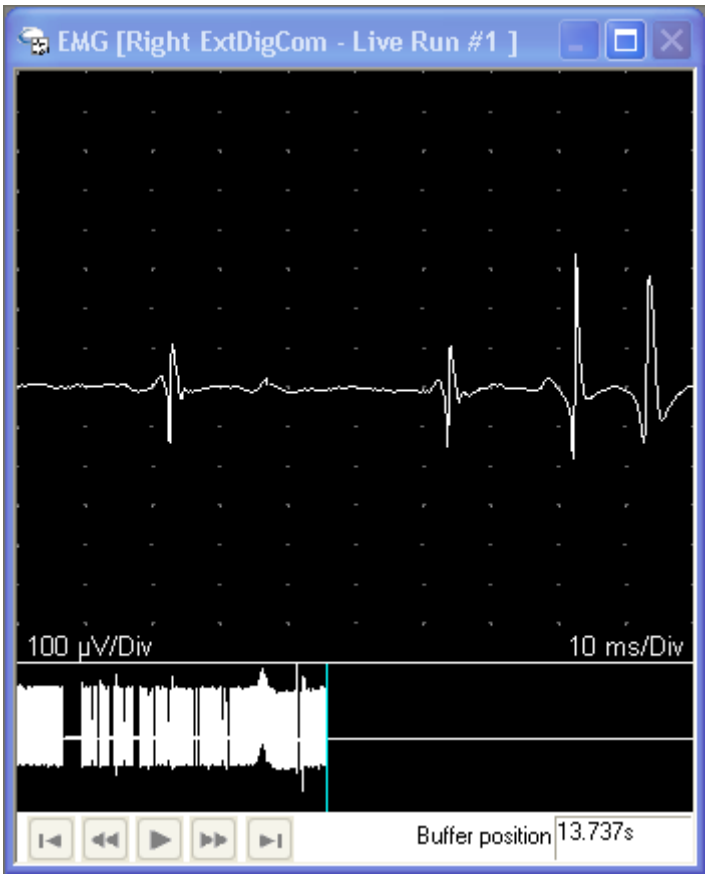
Live vs. Capture Mode

The EMG test protocol has two basic data acquisition modes, **Live** and **Capture**. Live mode is also known as "Free Running EMG" mode and Capture mode is also known as "Trigger" mode.

Use the **F1 (Live / Capture)** function key to toggle between these two acquisition modes.

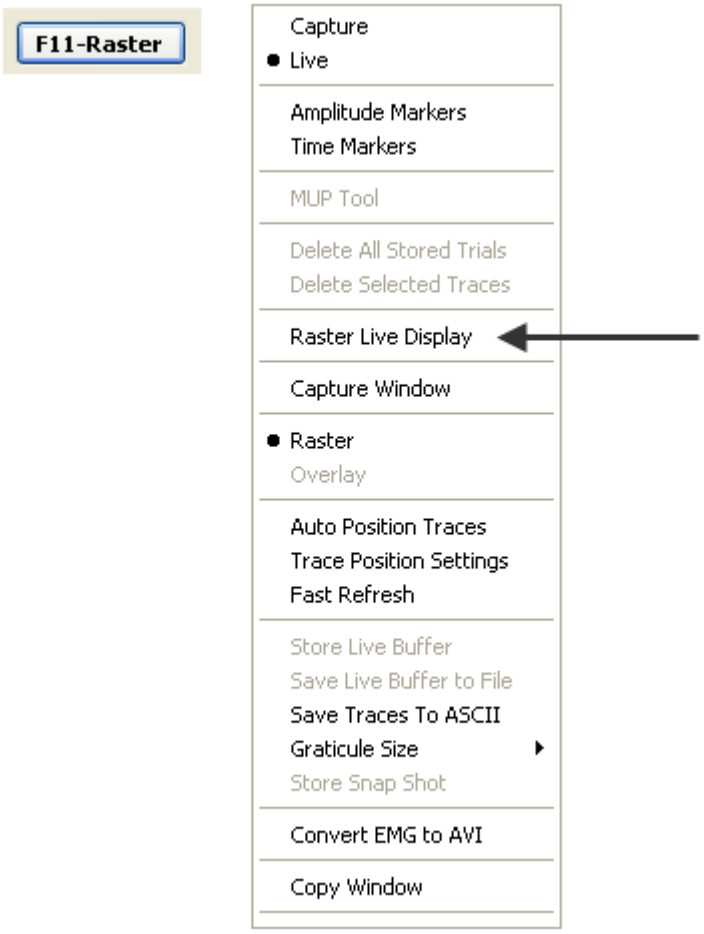
Live Mode

Live Mode: In Live mode "free-running" EMG is displayed in the Trace window and a compressed view of the EMG Live Buffer is displayed below this. A moving blue marker shows the current position within the buffer. At any time data acquisition can be stopped and the data in the Live Buffer can be reviewed or played back. The EMG test protocol always defaults to the Live data acquisition mode when it is first loaded.

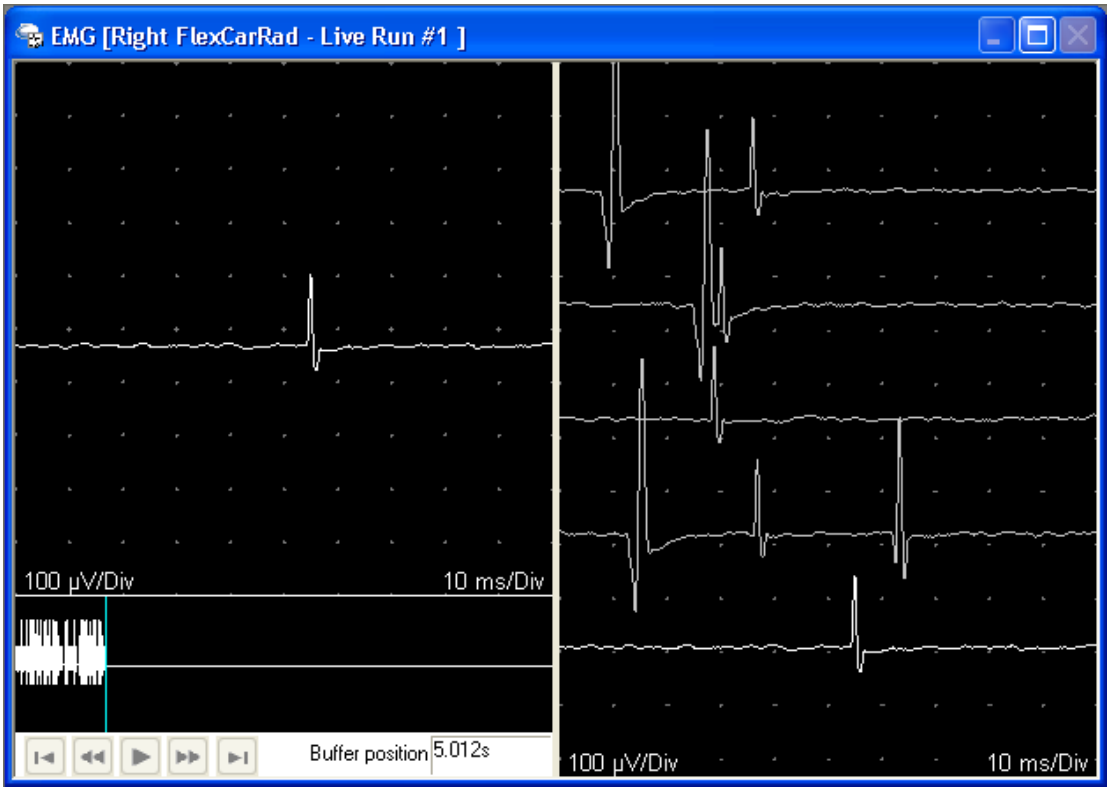


EMG - Live mode

Live Mode with Raster Display: While in EMG Live mode, click or press the **F11-Raster** function key, or right click within the EMG trace window and select **Raster Live Display** from the pop-up menu.



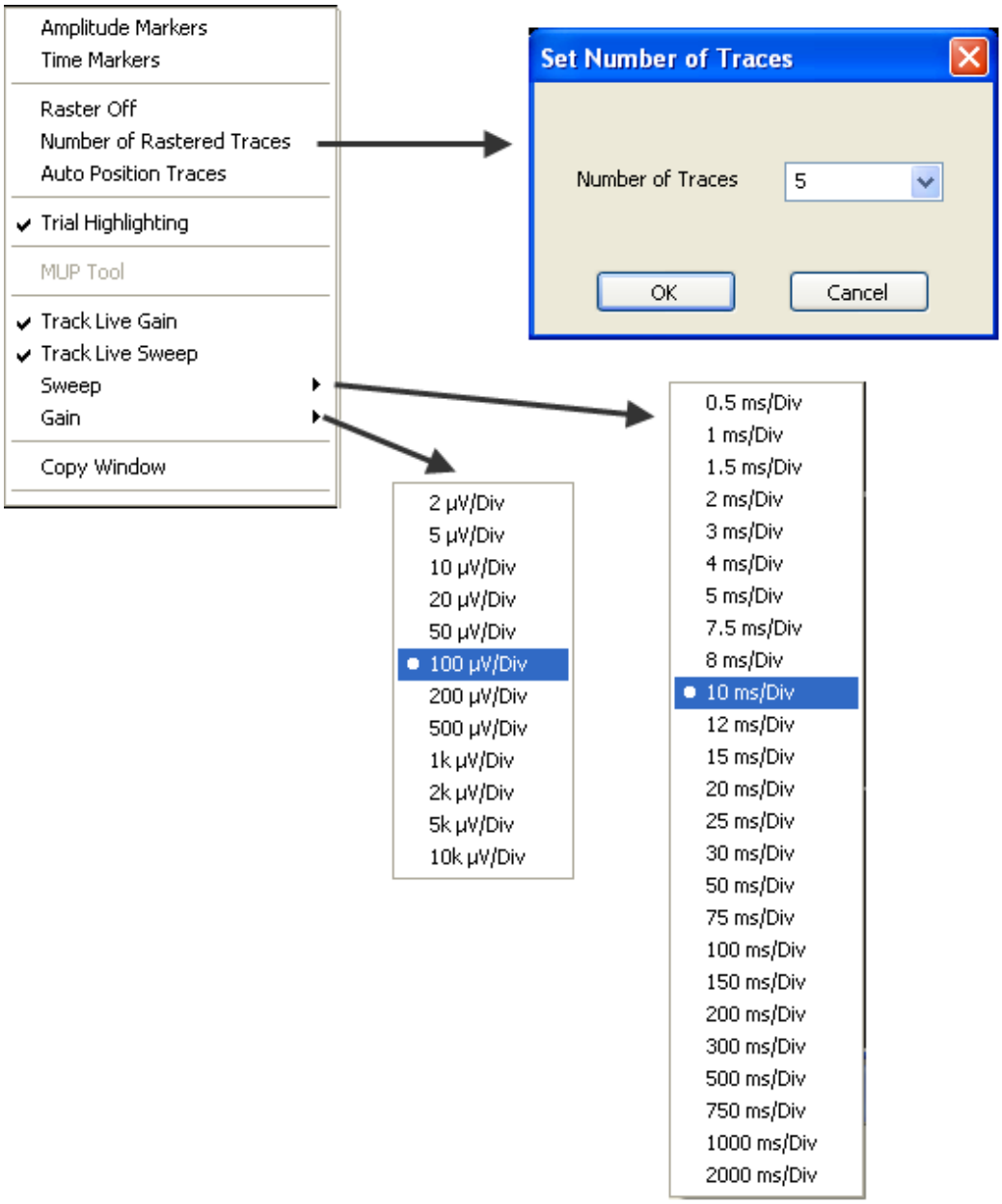
When this feature is enabled the Trace window is split into two equal sections; the left half showing the live EMG data and the compressed buffer, the right half showing consecutively rastered EMG traces.



Live EMG mode with Raster Display enabled.

Raster Display Options.

Right clicking within the raster trace area will display a pop-up menu of raster display options.



- **Amplitude Markers** – enables amplitude markers within the raster display area.
- **Time Markers** – enables time markers within the raster display area.
- **Raster Off** – turns off the raster display feature.
- **Number of Rastered Traces** – changes the number of traces displayed in the raster area. Select 3, 5, or 10 from the drop down list or type in any number between 2 and 100.

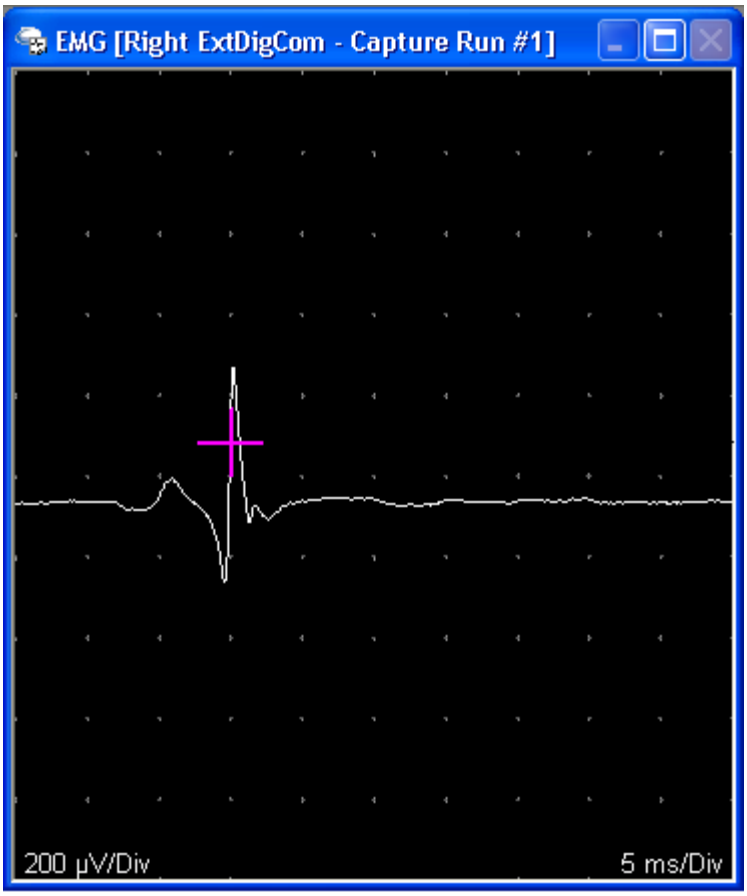
- **Auto Position Traces** – if traces have been moved up/down within the raster area, this option will return the traces to their original positions.
- **Trial Highlighting** - enables the alternating white/gray coloring of the rastered traces.
- **MUP Tool** - this feature is only available when EMG acquisition has been stopped. For more information on the MUP Tool, click here.
- **Track Live Gain** - when enabled the rastered traces will always be displayed at the same gain setting as the Live EMG trace.
- **Trace Live Sweep** - when enabled the rastered traces will always be displayed at the same sweep speed setting as the Live EMG trace.
- **Sweep** - changes the sweep speed of the rastered traces. Select a sweep speed value from the list. The black dot indicates the current setting.
- **Gain** - changes the gain of the rastered traces. Select a gain value from the list. The black dot indicates the current setting.
- **Copy Window** - copies the contents of the EMG trace window to the clipboard.

Enabling the Raster Display as your default setting for EMG.

The status of the Raster display feature, and the number of rastered traces, can be saved as part of the default settings for the EMG test protocol. With the feature enabled, simply select **Save Test Parameters** from the **Edit** menu.

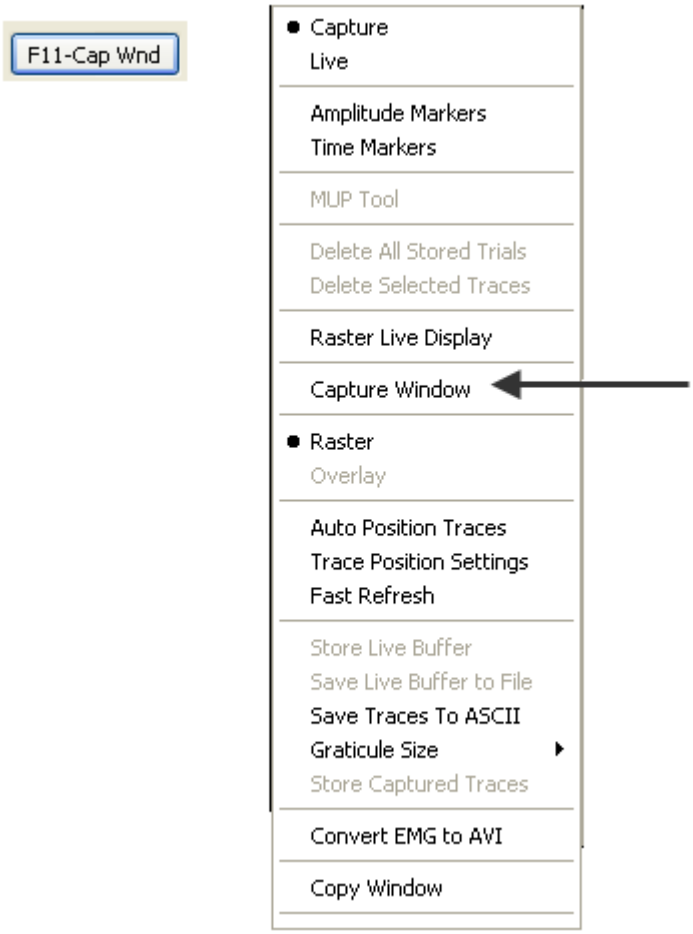
Capture Mode

Capture Mode: In Capture mode a voltage level trigger and delay marker are displayed within the Trace window. The level of the voltage trigger can be adjusted using **Knob #3 (Trigger Lvl)**. When EMG activity exceeds the trigger level (in either the negative or positive direction) the sweep is captured momentarily and is repositioned with the crossing point at the delay marker. This allows for easier visualization of motor unit potentials. At any time data acquisition can be stopped and up to 50 captured sweeps can be reviewed.

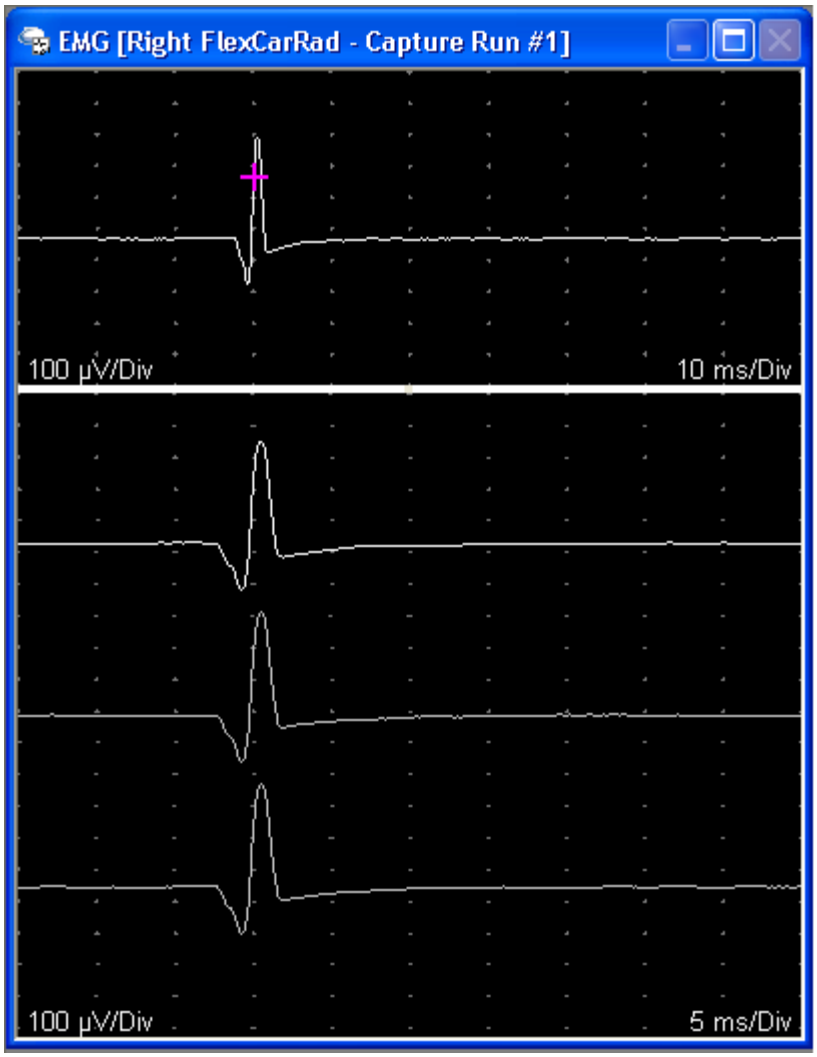


EMG - Capture mode

Capture Mode with Capture Window: While in EMG Capture mode, click or press the **F11-Cap Wnd** function key, or right click within the EMG trace window and select **Capture Window** from the pop-up menu.



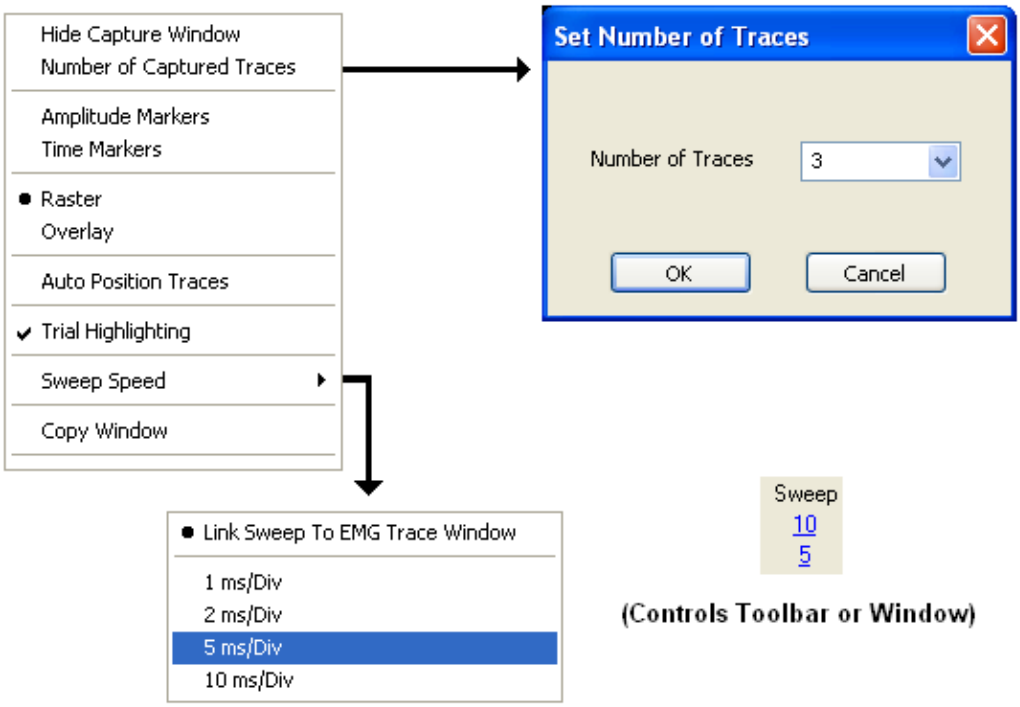
When this feature is enabled the trace window is split into two sections; the top section shows the live EMG trace and the trigger level and delay indicator, the bottom section shows a rastered display of the most recently captured traces.



Capture Mode with Capture Window enabled.

Capture Window Options.

Right clicking within the capture window trace area will display a pop-up menu of display options.



- **Hide Capture Window** – turns off the capture window.
- **Number of Captured Traces** - changes the number of traces displayed in the captured window trace area. Select 3, 5, or 10 from the drop down list or type in any number between 2 and 100.
- **Amplitude Markers** – enables amplitude markers in the captured window area.
- **Time Markers** – enables time markers in the captured window area.
- **Raster / Overlay** – sets the position of the captured window traces as either rastered or overlayed (i.e., superimposed).
- **Auto Position Traces** - if captured window traces have been moved up/down using the mouse, this option will return the traces to their original positions.
- **Trial Highlighting** - enables the alternating white/gray coloring of the captured traces.
- **Sweep Speed** – the sweep speed of the Live and Capture Window areas can be set independently.

    - **Link Sweep to EMG Trace Window** – automatically sets the captured window trace area to the same sweep speed as the Live trace.
    - **1, 2, 5, 10 ms/Div** – sets the captured window trace sweep speed to the selected value. Dual sweep values are displayed in the Controls Toolbar or Amplifier Controls window when the captured window sweep speed is set differently than the Live trace sweep speed.
- **Copy Window** - copies the contents of the EMG Trace window to the clipboard.

Enabling the Capture Window Display as your default setting for EMG.

The status of the Capture Window display feature and the number of traces displayed within the window can be saved as part of the default settings for the EMG test protocol. With the feature enabled, simply select **Save Test Parameters** from the **Edit** menu.

Live Buffer Review & Playback

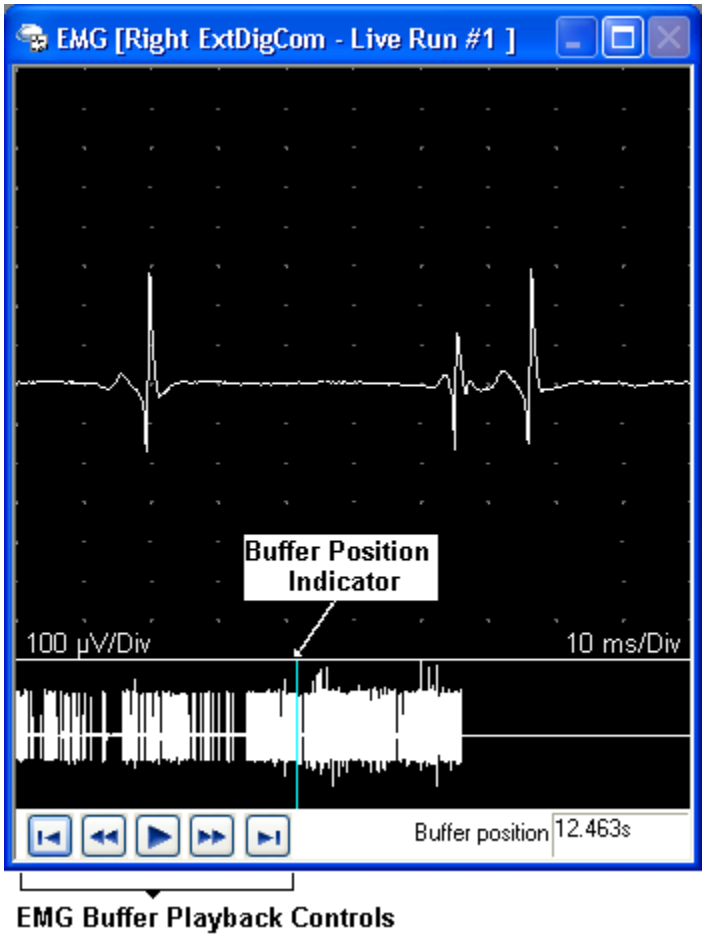
Before you can review the Live EMG Buffer you need to stop data acquisition. To stop Live EMG data acquisition perform one of the following,

- Press the **Run/Stop key** on the **Sierra Wave base unit**.
- Press the **Stim button** on the **Electrical Stimulator handle**.

Data acquisition will be stopped and the last complete sweep of EMG data will be displayed.

To Move Backwards & Forwards within the buffer:

Turn **Knob #1 (Review / Play-Stop)** counter-clockwise to move backward in the buffer, turn the knob clockwise to move forward. You can also turn the **Intensity Wheel** on the electrical stimulator handle to move within the buffer. Another method is to **use the mouse** to click and drag the blue marker back and forth within the compressed buffer area.



EMG - Stopped Live mode

To Start EMG Playback:

Press **Knob #1 (Review / Play-Stop)** and the EMG buffer will begin to playback. Playback begins at the current location of the buffer position indicator (blue line). As the EMG is played back the buffer position indicator will move from left to right across the compressed buffer area. The EMG's audio signal is played back through the PC's speakers, not through the speaker in the Sierra Wave base unit, therefore, if the audio is not loud enough, adjust the volume controls on your PC's speakers.

Review & Playback can also be accomplished by clicking on the **EMG Buffer Playback Controls.**

Buffer Playback Controls.

 Go back one page.

 Go forward one page.

 Go back one division.

 Go forward one division.

 Start EMG playback.

 Stop EMG playback.

To Set the Length of the EMG Buffer:

The length of the Live EMG Buffer can be preset to be 30, 60, 120, 240, 360, or 600 seconds.

- Select **Edit Current Test** from the **Edit** menu.
- Change the setting labeled **EMG Buffer (secs)**, then click the **OK** button.

To save these changes as the new **default** settings for the EMG Test protocol.

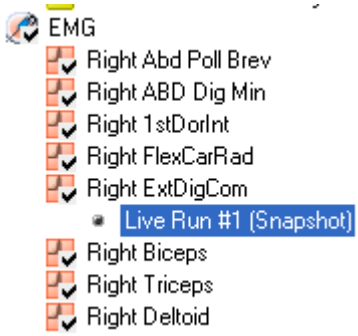
- Select **Save Test Parameters** from the **Edit** menu.

Storing a Live Snapshot

1. Stop Live EMG data acquisition by performing one of the following,
   - Press the **Run/Stop key** on the **Sierra Wave base unit**.
   - Press the **Stim button** on the **Electrical Stimulator handle**.

   Data acquisition will be stopped and the last complete sweep of EMG data will be displayed.
2. Move backward or forward within the EMG buffer until the trace that you want to store is displayed.

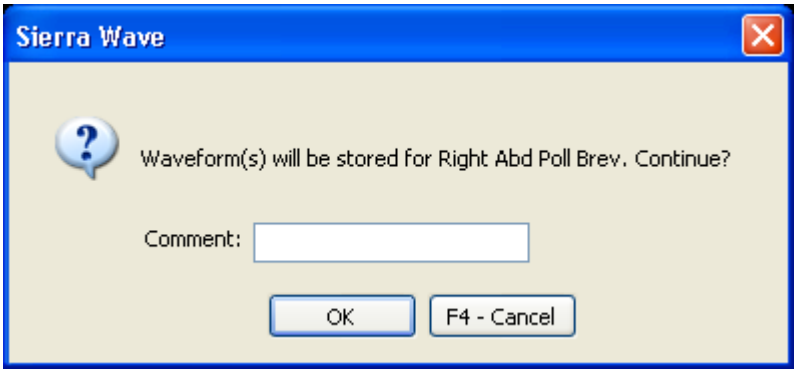
3. Verify that the correct muscle name is highlighted in the Study window. If necessary, use **Knob #2 (Muscle Sel / Delete Score)** to highlight a different muscle name.
4. Store the snapshot by performing one of the following actions,
    - Press the **F1 (Store Snap Shot)** function key on the **Sierra Wave base unit**.
    - Press the **Store key** on the **Sierra Wave base unit**.
    - Press the **Store button** on the **Electrical Stimulator handle**.
    - **Click** the **Store button** in the EMG Controls window on the screen.
5. The stored EMG snapshot will be displayed in purple color and an entry will appear underneath the currently selected muscle name in the Study window.



Study window showing stored EMG snapshot for the Right ExtDigCom muscle.

6. Return to Live EMG data acquisition mode by performing one of the following,
    - Press the **Run/Stop key** on the **Sierra Wave base unit**.
    - Press the **Stim button** on the **Electrical Stimulator handle**.
    - **Click** on the **Run button** in the EMG Controls window on the screen.

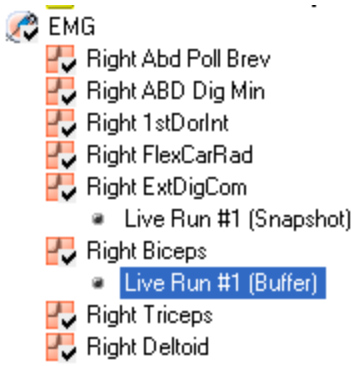
If the **Confirm Store Commands** option is enabled for the EMG test protocol, the program will display a confirmation window whenever a Live Snapshot, Live Buffer, or Captured traces are stored. This ensures that the data is stored with the correct muscle name and side and provides a place for a comment to be entered as well.



Storing a Live Buffer

1. Stop Live EMG data acquisition by performing one of the following,
    - Press the **Run/Stop key** on the **Sierra Wave base unit**.
    - Press the **Stim button** on the **Electrical Stimulator handle**.

    Data acquisition will be stopped and the last complete sweep of EMG data will be displayed.
2. Verify that the correct muscle name is highlighted in the Study window. If necessary, use **Knob #2 (Muscle Sel / Delete Score)** to highlight a different muscle name.
3. Store the Live EMG Buffer by pressing the **F2 (Store Live Buffer)** function key on the **Sierra Wave base unit**.
4. The EMG trace color will change from white to light blue to indicate that the buffer has been stored and an entry will appear underneath the currently selected muscle name in the Study window.

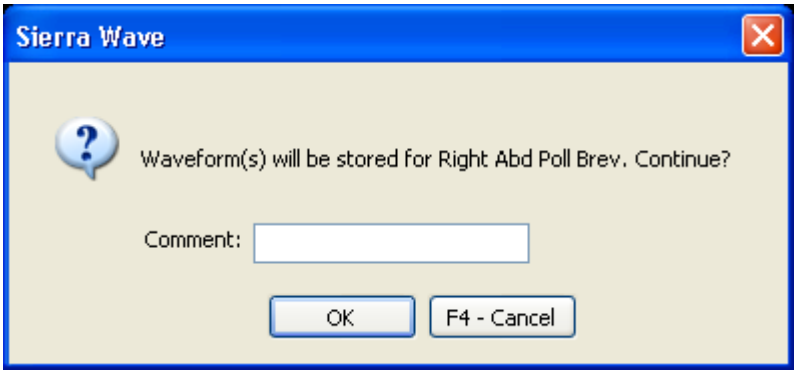


Study window showing stored buffer for Right Biceps muscle.

5. Return to Live EMG data acquisition mode by performing one of the following,
    - Press the **Run/Stop key** on the **Sierra Wave base unit**.

- Press the **Stim button** on the **Electrical Stimulator handle**.
- **Click** on the **Run button** in the EMG Controls window on the screen.

If the **Confirm Store Commands** option is enabled for the EMG test protocol, the program will display a confirmation window whenever a Live Snapshot, Live Buffer, or Captured traces are stored. This ensures that the data is stored with the correct muscle name and side and provides a place for a comment to be entered as well.

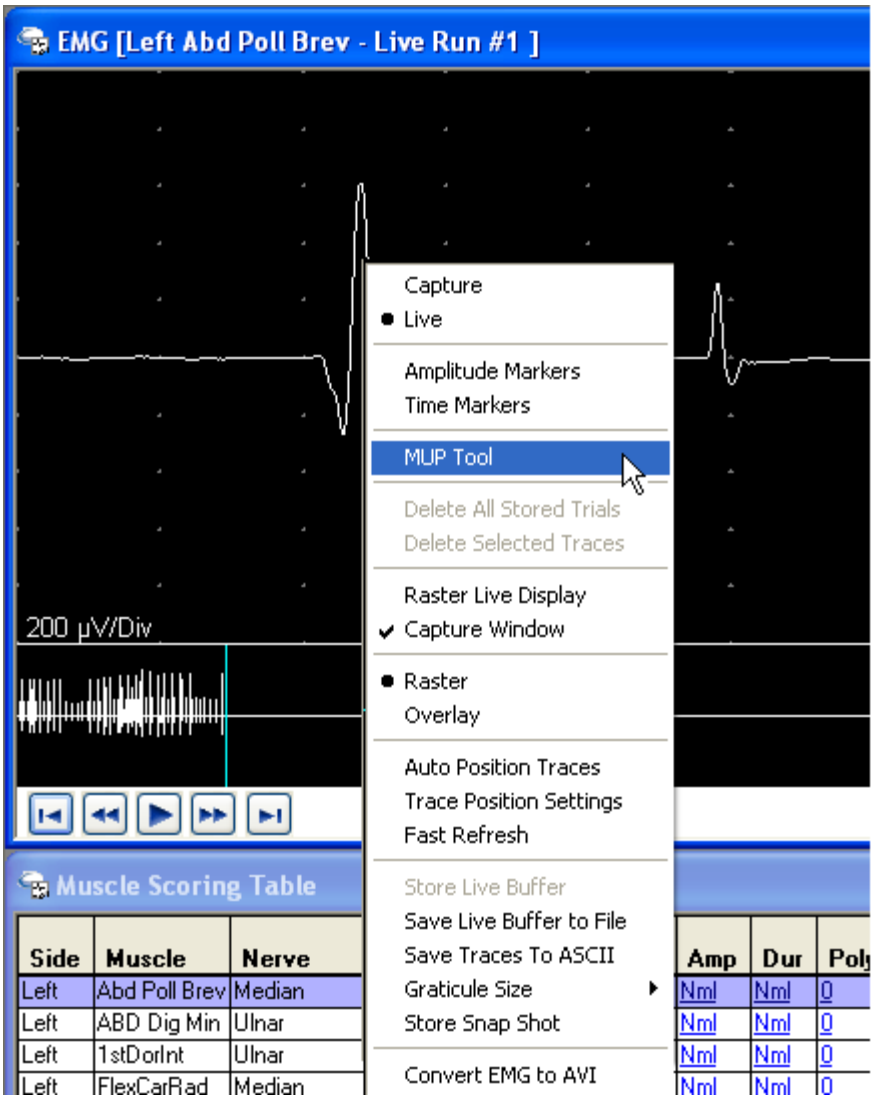


MUP Tool

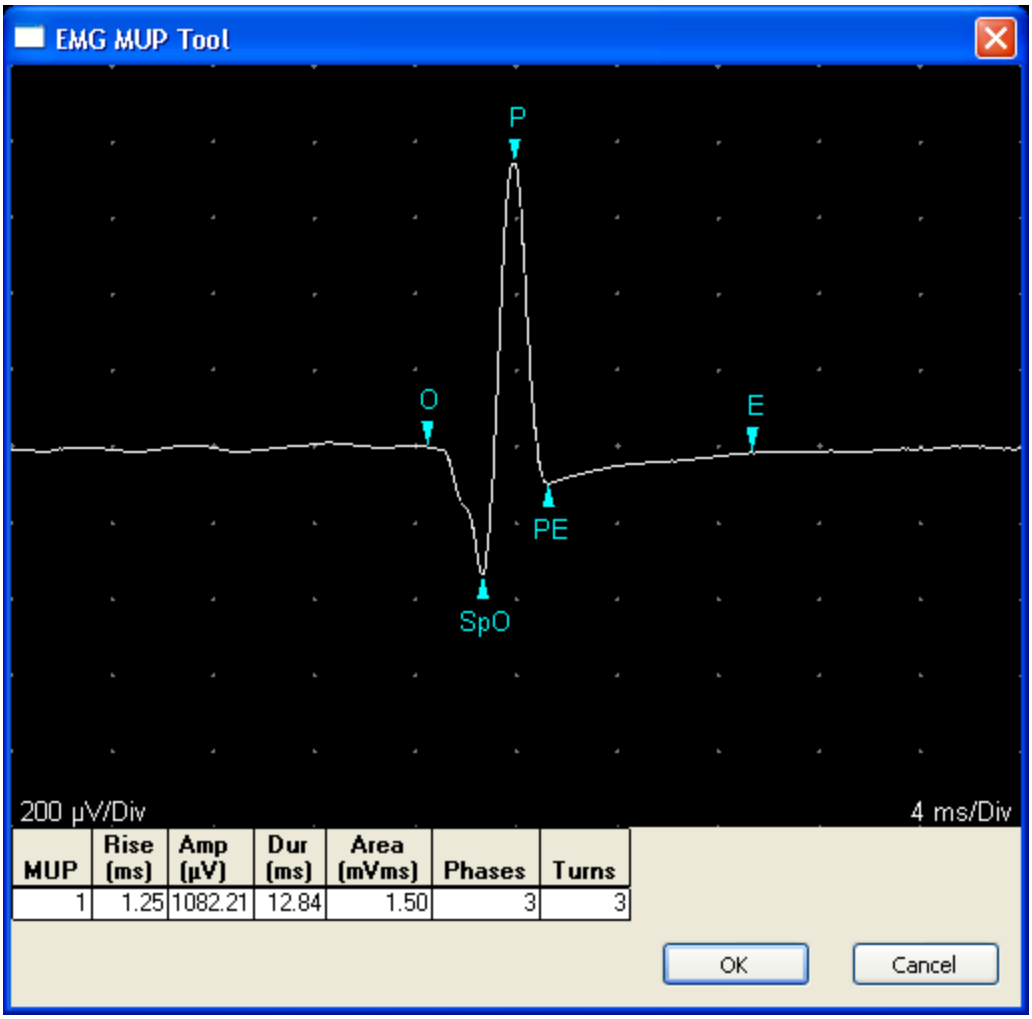
The MUP Tool gives the user the ability to quickly select and document motor unit potentials without having to use special software techniques like SMUA or MMUA.

Using the MUP Tool:

1. **Stop** the Live EMG. *The MUP Tool is only available when the EMG is stopped.*
2. **Right-click** the mouse over the motor unit potential (MUP) of interest, then select **MUP Tool** from the pop-up menu.



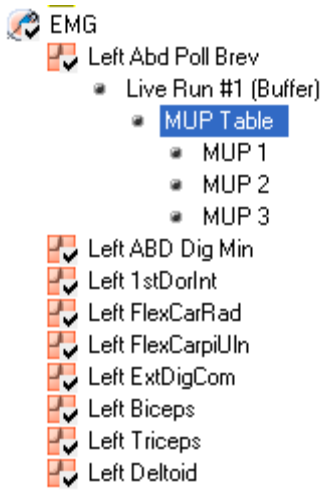
3. The motor unit potential is shown centered within a **MUP window** and is displayed at a sweep speed of 4 ms/Div. Cursors are automatically placed on the potential and the resulting measurements are shown in a table at the bottom of the window. The positions of the cursors can be adjusted using the mouse.



MUP window.

4. Clicking the **OK button** closes the MUP window and creates a new node in the Study window called **MUP Table** with a sub-node called **MUP #1**. The program also automatically stores the Live EMG Buffer. Clicking the **Cancel button** closes the MUP window and discards the MUP without adding it to the Study window.

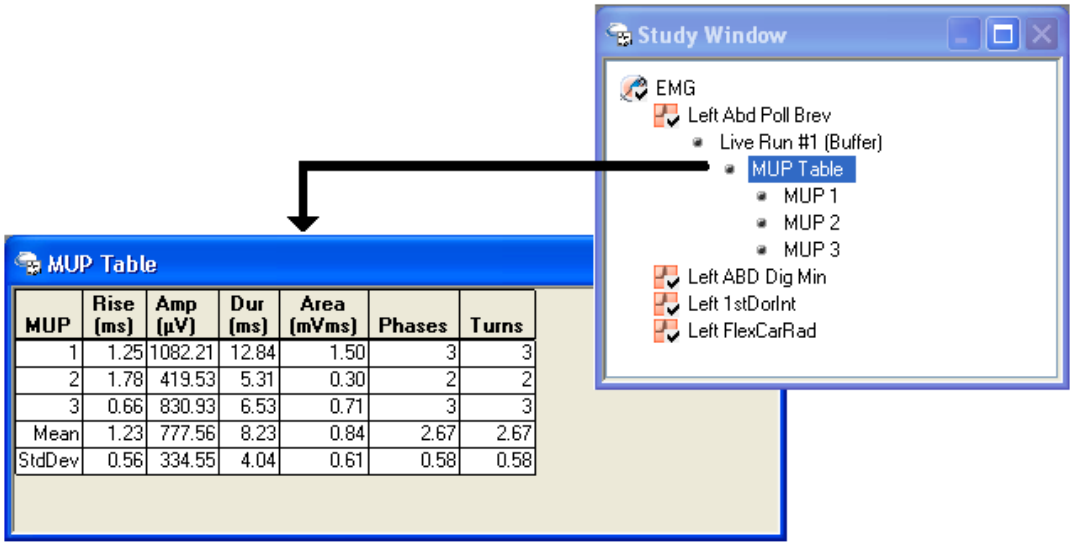
This process can be repeated any number of times. The program will automatically increment the MUP # as each additional MUP is stored. MUPs can be saved for each muscle shown in the Study window and are stored separately for each buffer.



MUP Table created in Study window for the Left Abd Poll Brev with three MUPs stored from the buffer.

Study window behavior:

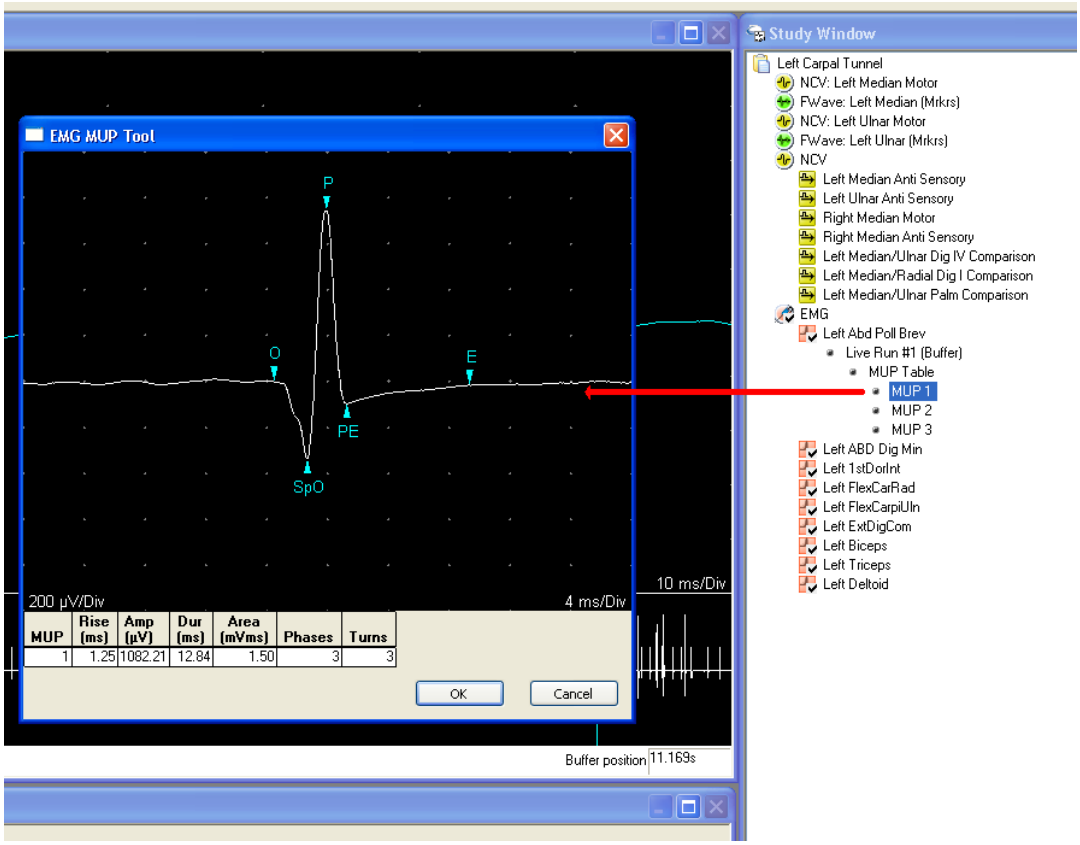
- Clicking on the **MUP Table node** in the Study window displays a **MUP Table window** in place of the Muscle Score Table window. This table includes the measurements for all MUPs selected using the MUP Tool.



MUP	Rise (ms)	Amp (µV)	Dur (ms)	Area (mVms)	Phases	Turns
1	1.25	1082.21	12.84	1.50	3	3
2	1.78	419.53	5.31	0.30	2	2
3	0.66	830.93	6.53	0.71	3	3
Mean	1.23	777.56	8.23	0.84	2.67	2.67
StdDev	0.56	334.55	4.04	0.61	0.58	0.58

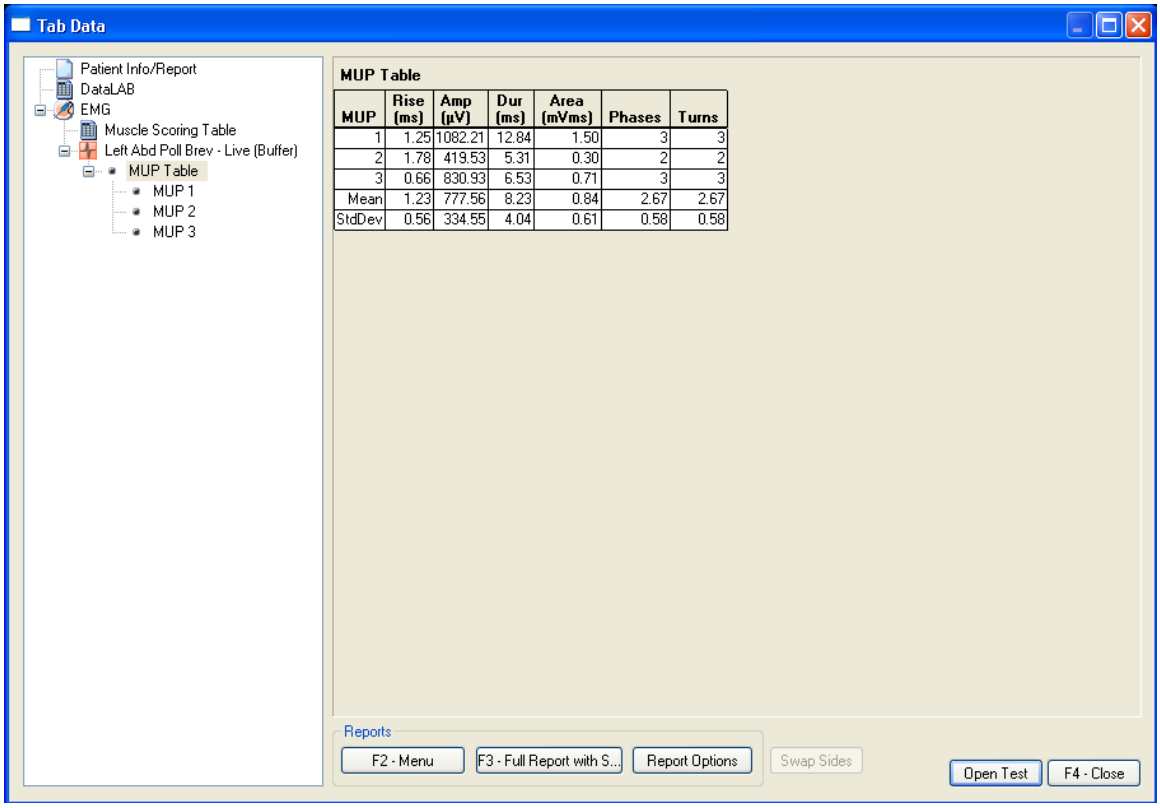
- Clicking on an **individual MUP # node** in the Study window displays the individual **MUP window** once again. This is also true if a row is selected within the MUP Table window. At this point clicking OK simply

closes the MUP window , clicking Cancel also closes the window and would 'undo' any changes made to the cursor positions.

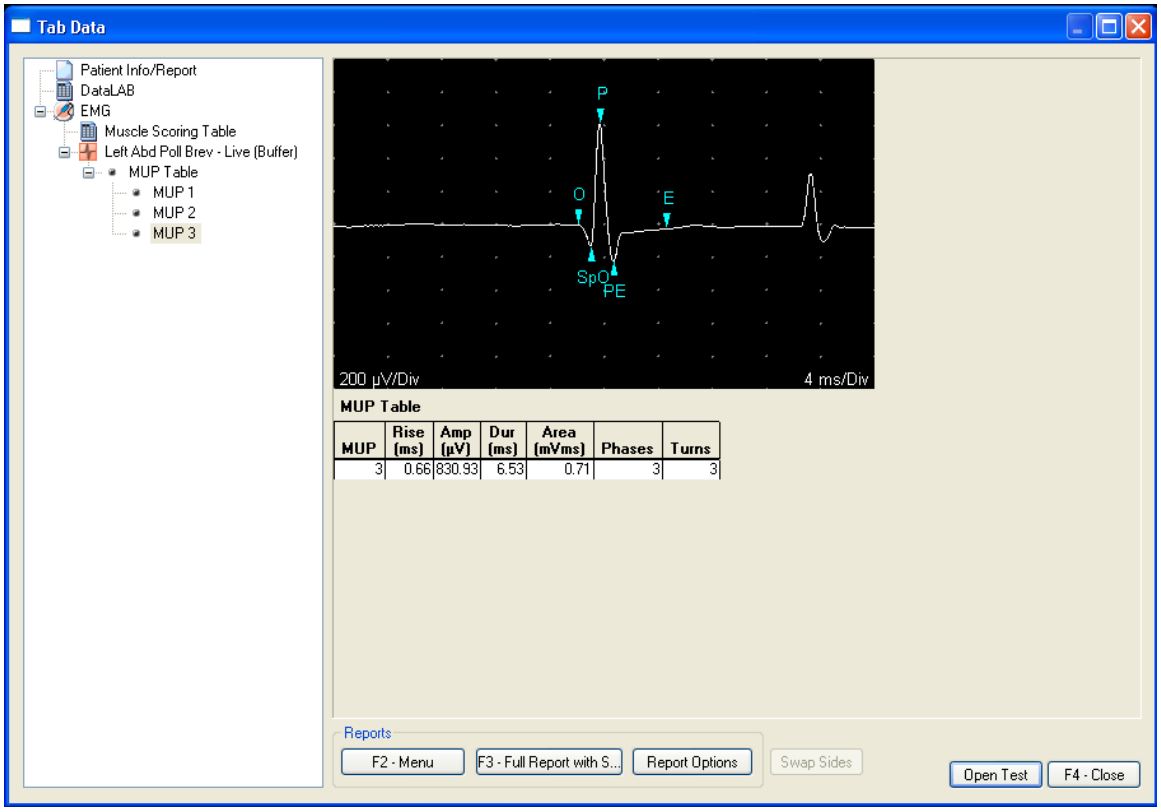


TabData window behavior:

- Clicking on the **MUP Table node** displays the summary MUP Table.



- Clicking on an **individual MUP # node** displays the waveform for the MUP and its results table.



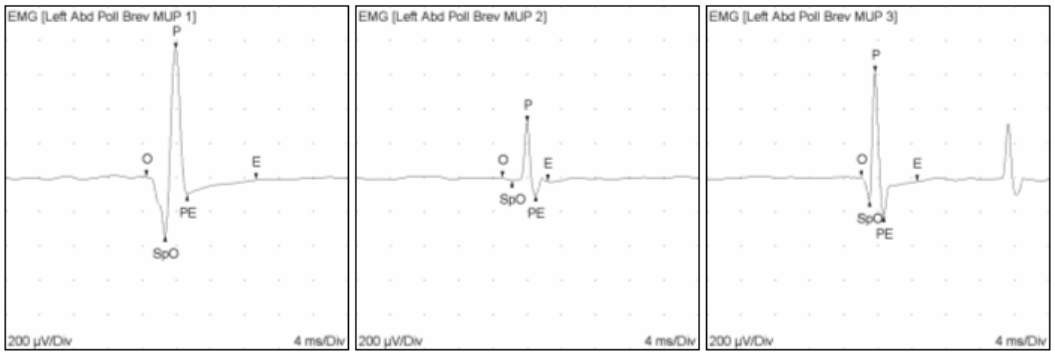
Reports:

MUP traces and the tabulated measurements are included in reports.

MUP Table [Left Abd Poll Brev]

MUP	Rise (ms)	Amp (µV)	Dur (ms)	Area (mVms)	Phases	Turns
1	1.25	1082.21	12.84	1.50	3	3
2	1.78	419.53	5.31	0.30	2	2
3	0.66	830.93	6.53	0.71	3	3
Mean	1.23	777.56	8.23	0.84	2.67	2.67
StdDev	0.56	334.55	4.04	0.61	0.58	0.58

Waveforms:

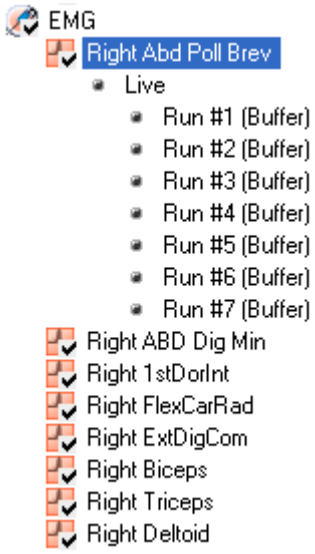


Buffer Playback in Capture Mode

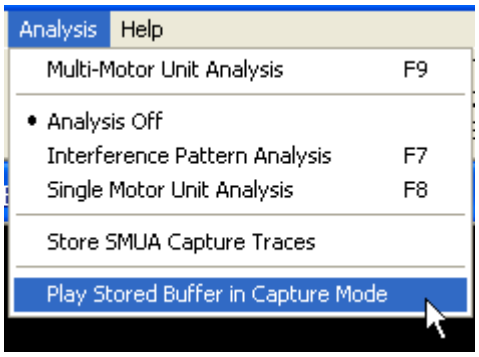
This feature allows a previously stored Live EMG Buffer to be played back in Capture Mode. All of the typical functions of Capture Mode are available during playback (i.e., adjusting Trigger & Delay, stop and review of capture buffer).

To playback a stored EMG Buffer in Capture Mode, follow these steps:

1. **Select a muscle** in the **Study window** that has one or more stored EMG Buffers.

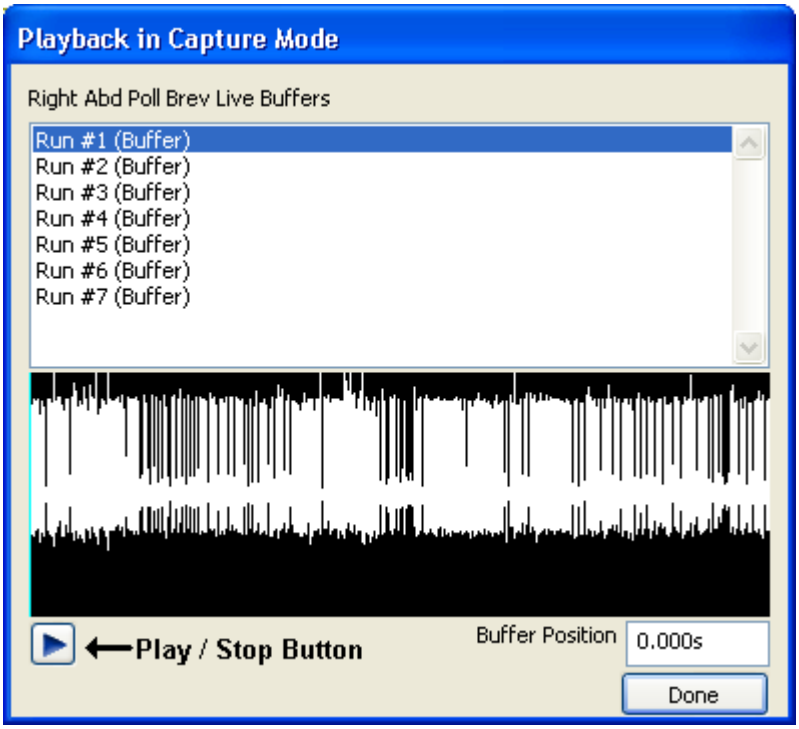


2. Enable the playback feature by selecting **Play Stored Buffer in Capture Mode** from the **Analysis** menu.

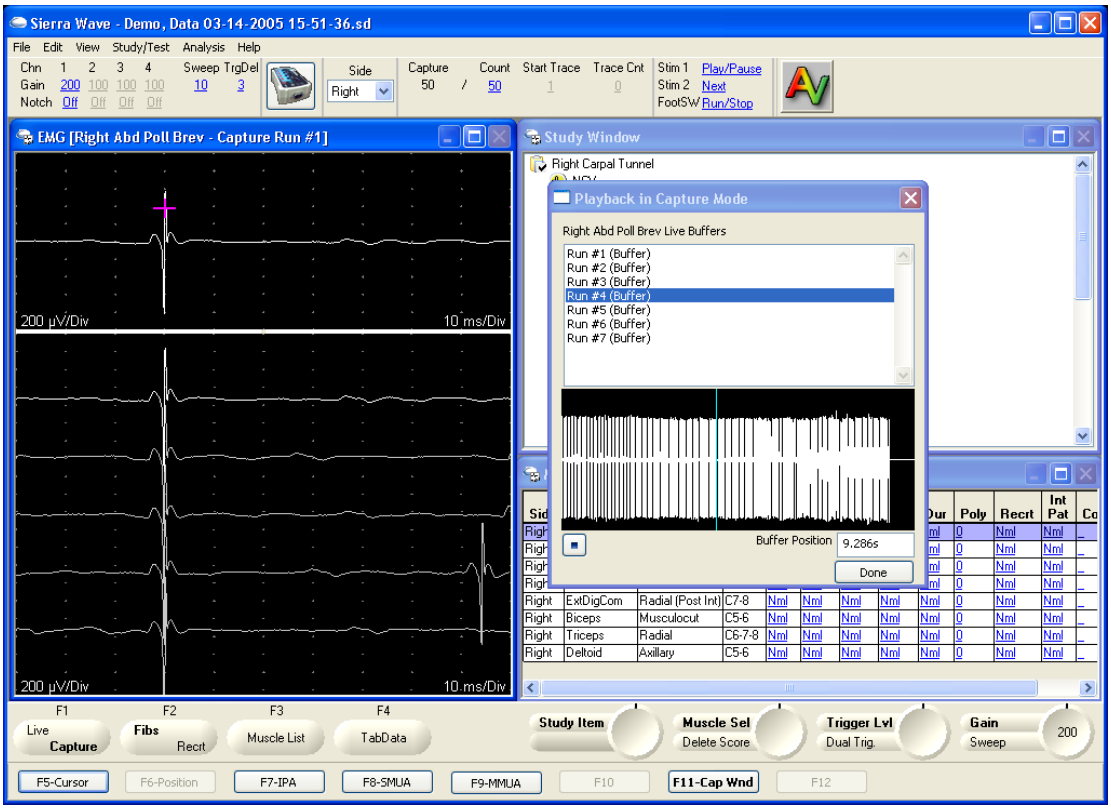


3. The **Capture Playback** window is displayed and the first stored buffer is automatically selected. This window lists all the stored buffers for the

selected muscle. It contains the compressed buffer trace, a position marker, and a Play/Stop button.



4. Pressing the **Play** button causes the selected buffer to be played within the EMG Capture trace window.



Stored EMG Buffer being played back in Capture Mode

5. During playback in Capture Mode the following controls are available.
   a. **Knob 4** (Gain/Sweep) can be utilized.
   b. **Knob 3** (Trigger Lvl/Dual Trig) can be utilized.
   c. **Clear** key can be used to reset the Capture Count.
   d. **Trg Dly** control can be utilizied.

6. Clicking the **Stop** button will show all the traces in the Capture buffer. To save these traces, press the **Store** key on the Sierra Wave base unit.

7. To select a different EMG buffer, simply click on it in the list.

8. Click the **Done** button to close the Capture Playback window.

Reviewing Captured Traces

1. Stop Capture EMG data acquisition by performing one of the following,

    - Press the **Run/Stop key** on the **Sierra Wave base unit**.
    - Press the **Stim button** on the **Electrical Stimulator handle**.

    Data acquisition will be stopped and the contents of the captured trace buffer will be displayed. Up to 50 traces can be held in the capture buffer.

2. Use **Knob #3 (Start Trace / Trace Cnt)** to set the **Trace Cnt** number, typically this defaults to the total number of traces in the capture buffer. Changing this to 5, for example, would display only five traces at a time in the trace window rather than all the traces at once.

3. If necessary, use **Knob #3 (Start Trace / Trace Cnt)** to set the **Start Trace** number, typically this defaults to 1 and can't be changed until the Trace Cnt has been changed first. A setting of 1 means that the first trace in the capture buffer is displayed at the top of the Trace window.

    Here's an example of how to use the **Trace Cnt** and **Start Trace** settings to view subsets of the capture buffer:

    Assume there are 50 total traces in the capture buffer. The Trace Cnt will default to 50 and the Start Trace number will default to 1. Therefore all 50 traces (1 to 50) are displayed in the Trace window. Now, change the Trace Cnt to 20 and leave the Start Trace number at 1. You will see traces 1-20 displayed in the Trace window. You can now change the Start Trace number to 21, now you can view traces 21-40. Change the Start Trace number again and it goes to 41, now you can view traces 41-50.

4. If necessary, use **Knob #4 (Trace Sel / Delete)** to select and delete any unwanted traces from the capture buffer. A selected trace is displayed in yellow color on the screen. As traces are deleted the total Trace Cnt will decrease.

5. For instructions on how to store the captured traces, go to the next topic in the Help system.

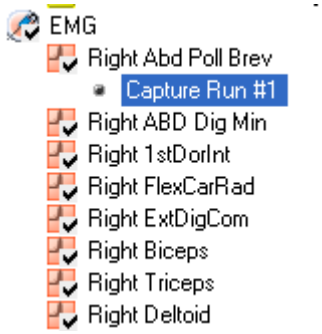
Storing Captured Traces

1. Stop Capture EMG data acquisition by performing one of the following,

    - Press the **Run/Stop key** on the **Sierra Wave base unit**.
    - Press the **Stim button** on the **Electrical Stimulator handle**.

Data acquisition will be stopped and the contents of the captured trace buffer will be displayed.

2. If necessary, use **Knob #4 (Trace Sel / Delete)** to select and delete any unwanted traces from the capture buffer.
3. Verify that the correct muscle name is highlighted in the Study window. If necessary, use **Knob #2 (Muscle Sel / Delete Score)** to highlight a different muscle name.
4. Store the captured traces by performing one of the following,
    - Press the **Store key** on the **Sierra Wave base unit**.
    - Press the **Store button** on the **Electrical Stimulator handle**.
    - **Click** the **Store button** in the EMG Controls window on the screen.
5. The captured trace color will change from white to purple indicating the traces have been stored. You will also see an entry appear underneath the currently selected muscle name in the Study window.

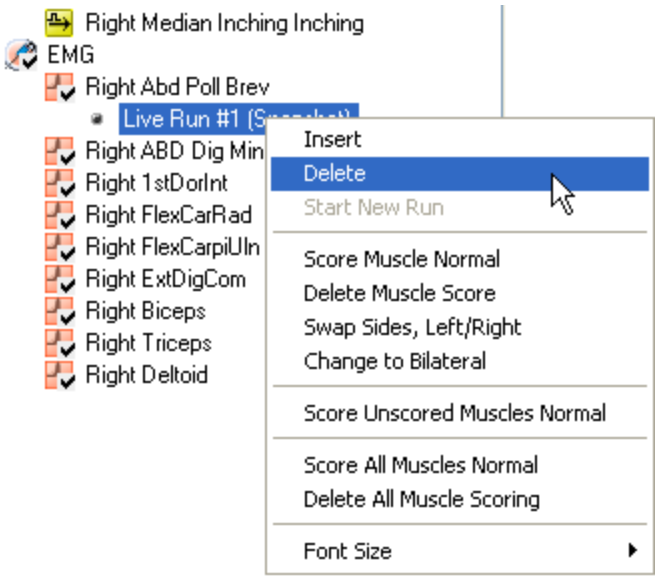


Study window showing a stored set of captured traces for the Right Abd Poll Brev muscle.

6. Return to Capture EMG data acquisition mode by performing one of the following,
    - Press the **Run/Stop key** on the **Sierra Wave base unit**.
    - Press the **Stim button** on the **Electrical Stimulator handle**.
    - **Click** on the **Run button** in the EMG Controls window on the screen.

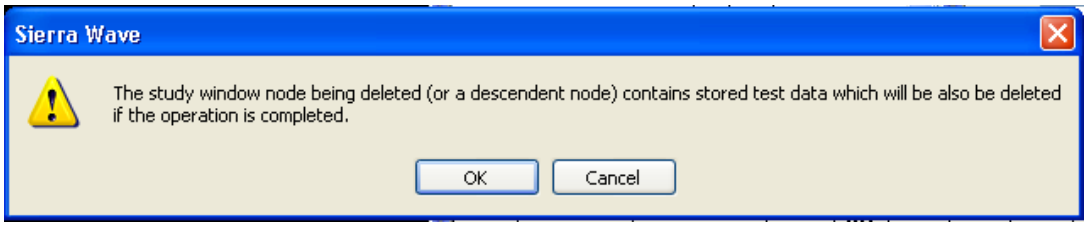
Deleting a Snapshot, Buffer, or Capture

1. **Right click** the mouse over the stored **Snapshot**, **Live Buffer**, or **Capture run** in the Study window.
2. From the pop-up menu select **Delete**.



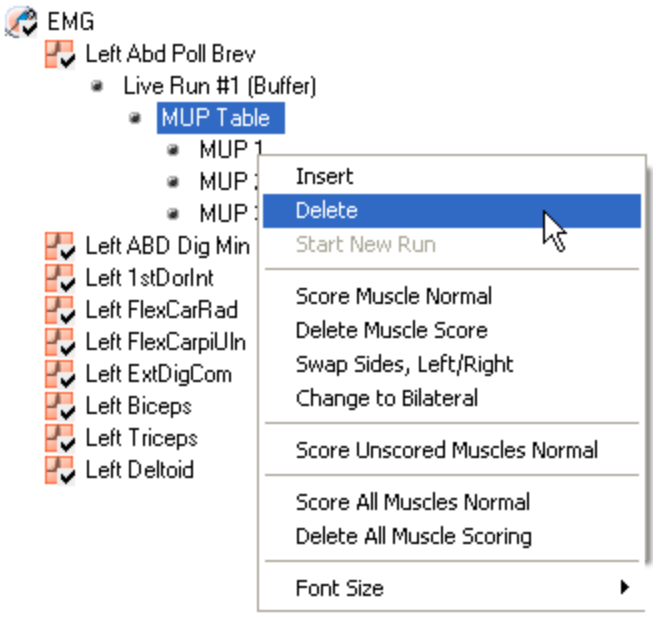
Right click and select Delete.

3. A confirmation message will be displayed, select **OK**.



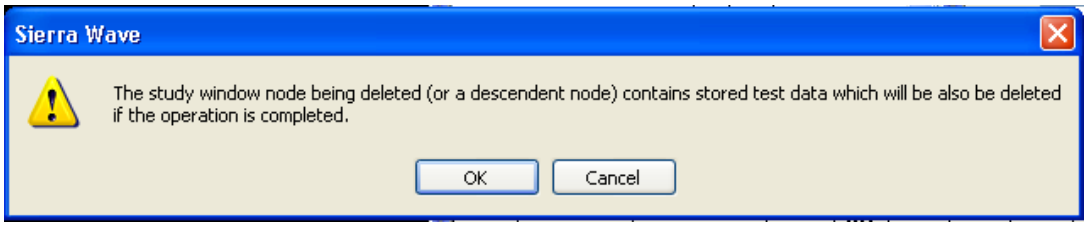
Deleting a Manual MUP

1. **Right click** the mouse over the stored **MUP #** in the Study window.
2. From the pop-up menu select **Delete**.



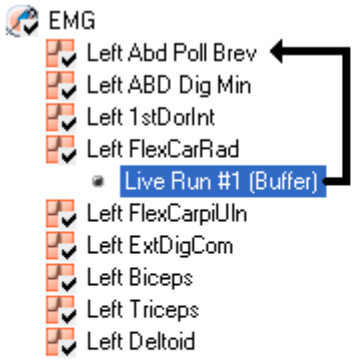
Right click and select Delete.

3. A confirmation message will be displayed, select **OK**.

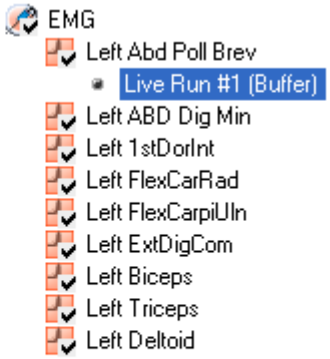


Moving a Stored Buffer or Snapshot

To move a Stored EMG Buffer or Snapshot to a different muscle in the Study window, simply left click on the stored Snapshot or Buffer and drag it to the appropriate muscle name in the Study window. When you release the left mouse button the snapshot or buffer will be moved to that muscle.



Click on stored buffer or snapshot and drag to a different muscle.



Upon releasing the mouse button the buffer or snapshot will be moved to that muscle.

Muscle Scoring

EMG Muscle Scoring

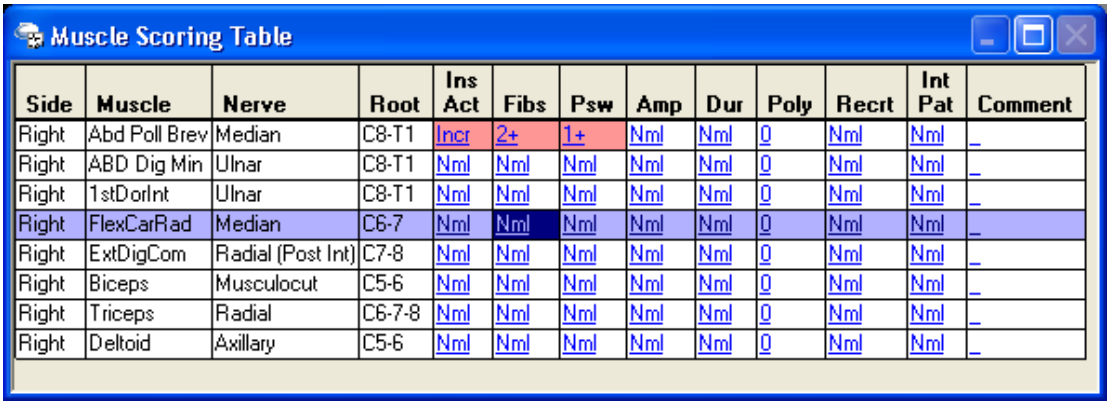
With the **Automatic Muscle Scoring** feature enabled, as soon as **any EMG muscle** is selected within the Study window, or is added to the Study window using the **F3 (Muscle List)** function key, it is automatically scored as "normal" and is added to the **Muscle Score Table**.

The **Automatic Muscle Scoring** feature can be disabled in the **EMG Test Setup** window. When this feature is disabled the muscles in the Study window are not automatically added to the muscle score table. You will need to use the **F2 (Muscle Sel/Score)** knob to manually add the appropriate muscles to the scoring table.

Modifying Muscle Scoring

To change the muscle scoring for a muscle,

- Turn **Knob #3 (Score Table / Modify)** until the highlight is over the scoring field that you want to change, **press the knob** to pop up a list of choices, **turn the knob** to highlight one of the choices and press again to select it.
- Using the **left mouse button**, click on the scoring field that you want to change. From the pop up list of choices click again to make a selection.

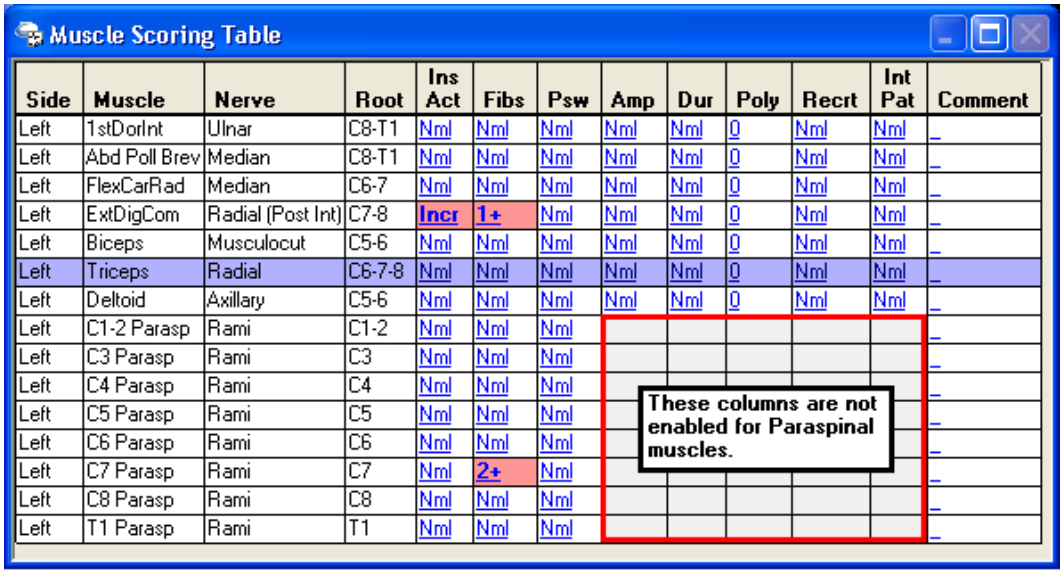


Muscle Scoring Table

Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Right	Abd Poll Brev	Median	C8-T1	Incr	2+	1+	Nml	Nml	0	Nml	Nml	_
Right	ABD Dig Min	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	ExtDigCom	Radial (Post Int)	C7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Right	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_

Depending on your preferences in System Setup, abnormal selections can be flagged with a red background color, as bold text, or as bold text & background color red.

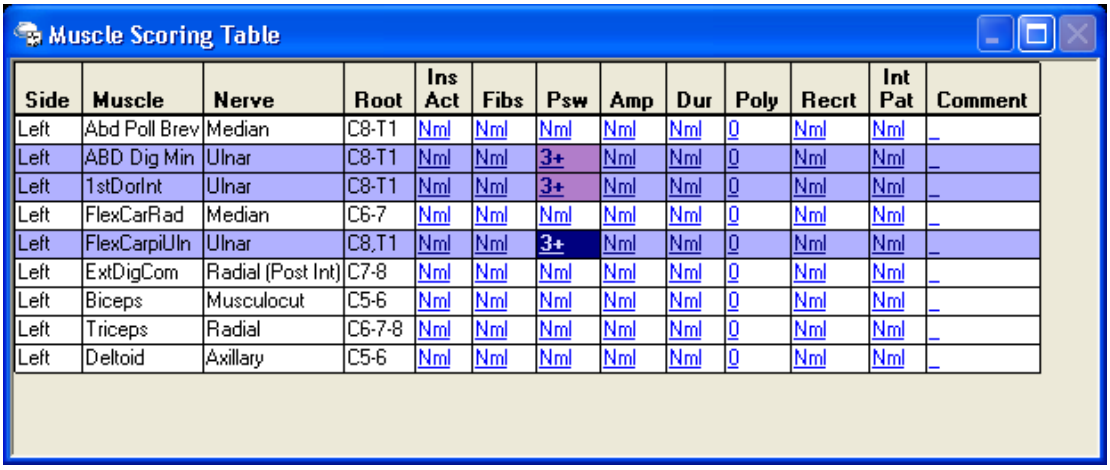
Muscles with the **Is Paraspinal** flag enabled will not use all the columns in the muscle scoring table.



Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Left	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Abd Poll Brev	Median	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	ExtDigCom	Radial (Post Int)	C7-8	Incr	1+	Nml	Nml	Nml	0	Nml	Nml	_
Left	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	C1-2 Parasp	Rami	C1-2	Nml	Nml	Nml						_
Left	C3 Parasp	Rami	C3	Nml	Nml	Nml						_
Left	C4 Parasp	Rami	C4	Nml	Nml	Nml						_
Left	C5 Parasp	Rami	C5	Nml	Nml	Nml						_
Left	C6 Parasp	Rami	C6	Nml	Nml	Nml						_
Left	C7 Parasp	Rami	C7	Nml	2+	Nml						_
Left	C8 Parasp	Rami	C8	Nml	Nml	Nml						_
Left	T1 Parasp	Rami	T1	Nml	Nml	Nml						_

Scoring Multiple Muscle Abnormalities

To score the same abnormality on multiple muscles, simply hold down the **Control key** while left clicking on each row in the Muscle Scoring Table. Once the appropriate muscles (i.e., rows) have been selected you can then change the scoring choices on any one of the selected rows and your selections will be applied to all the selected rows. To deselect the rows, click in a blank area outside the table.



Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Left	Abd Poll Brev	Median	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	ABD Dig Min	Ulnar	C8-T1	Nml	Nml	3+	Nml	Nml	0	Nml	Nml	_
Left	1stDorInt	Ulnar	C8-T1	Nml	Nml	3+	Nml	Nml	0	Nml	Nml	_
Left	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	FlexCarpiUln	Ulnar	C8,T1	Nml	Nml	3+	Nml	Nml	0	Nml	Nml	_
Left	ExtDigCom	Radial (Post Int)	C7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Biceps	Musculocut	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Triceps	Radial	C6-7-8	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	Deltoid	Axillary	C5-6	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_

Muscle Scoring Table with three muscles selected and scored with 3+ Psw.

Deleting a Row from the Muscle Score Table

To delete a row from the Muscle Score Table, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Delete Score)** until the muscle you want to remove from the Muscle Score Table is **highlighted** in the Study window, then **press the knob** and the corresponding row in the table will be deleted.
- **Right click** the mouse over **the row** you want to delete, then select **Delete Row** from the pop-up menu.

When a muscle is deleted from the Muscle Score Table the checkmark next to the muscle name in the Study window is also removed.

Deleting all Rows from the Muscle Score Table

To delete all rows from the Muscle Score Table, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Delete Score)** until the muscle name you want to remove from the Muscle Score Table is **highlighted** in the Study window, then **press the knob** to delete the row. Repeat this process until all the rows are deleted.
- **Right click** the mouse over any row in the Muscle Score Table, then select **Delete All Rows** from the pop-up menu. A confirmation message will be displayed, select **OK**.

When a muscle is deleted from the Muscle Score Table the checkmark next to the muscle name in the Study window is also removed.

Re-Scoring a Muscle that has been deleted from the Muscle Score Table

To re-score one muscle, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Score)** to **highlight** the **muscle name** in the Study window. **Press the knob** to score the muscle with its normal defaults.
- **Right click** the mouse over the **muscle name** in the Study window. From the pop-up menu select **Score Muscle Normal**.

To re-score all muscles.

- **Right click** the mouse over any **muscle name** in the Study window. From the pop-up menu select **Score All Muscles Normal**.

Sorting the Muscle Score Table

Initially, the muscles are added to the score table in the same order that they are listed in the Study window.

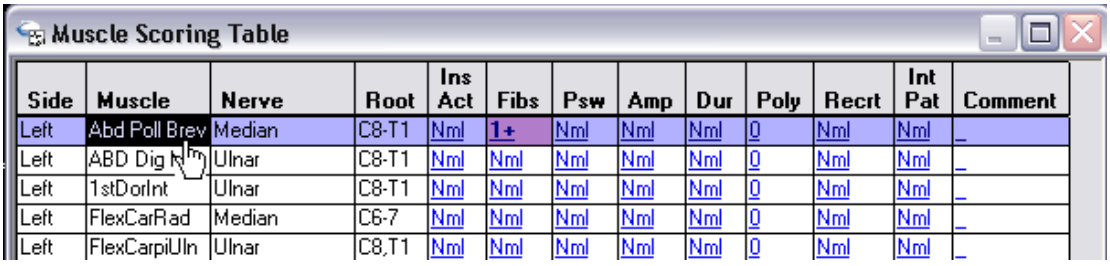
Single click on the **column heading** (e.g. Fibs) to sort the table by the entries in that column. Sorting priority is first by number (0-9), then alphabetically (a-z).

Restoring Original Sort Order

Right click the mouse on any row in the Muscle Score Table and select **Original Sort Order** from the pop-up menu.

Manually changing the Sort Order

Left click & hold over muscle name, pointer turns into a ‘hand’. Drag to the location where you want to move this row and release the mouse button.



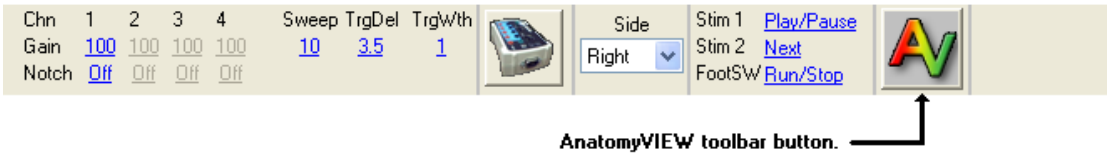
Side	Muscle	Nerve	Root	Ins Act	Fibs	Psw	Amp	Dur	Poly	Recrt	Int Pat	Comment
Left	Abd Poll Brev	Median	C8-T1	Nml	1+	Nml	Nml	Nml	0	Nml	Nml	_
Left	ABD Dig M	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	1stDorInt	Ulnar	C8-T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	FlexCarRad	Median	C6-7	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_
Left	FlexCarpiUln	Ulnar	C8,T1	Nml	Nml	Nml	Nml	Nml	0	Nml	Nml	_

AnatomyVIEW - EMG

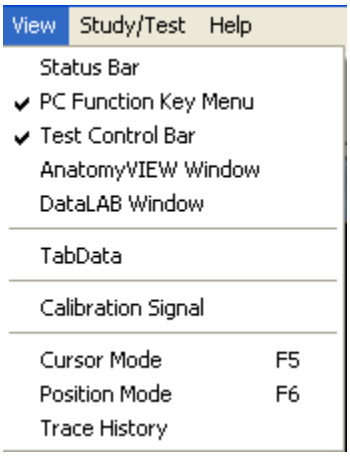
The AnatomyVIEW feature allows the EMG muscle scoring data to be displayed on a 3D color-coded anatomical model. The AnatomyVIEW window can be included in reports.

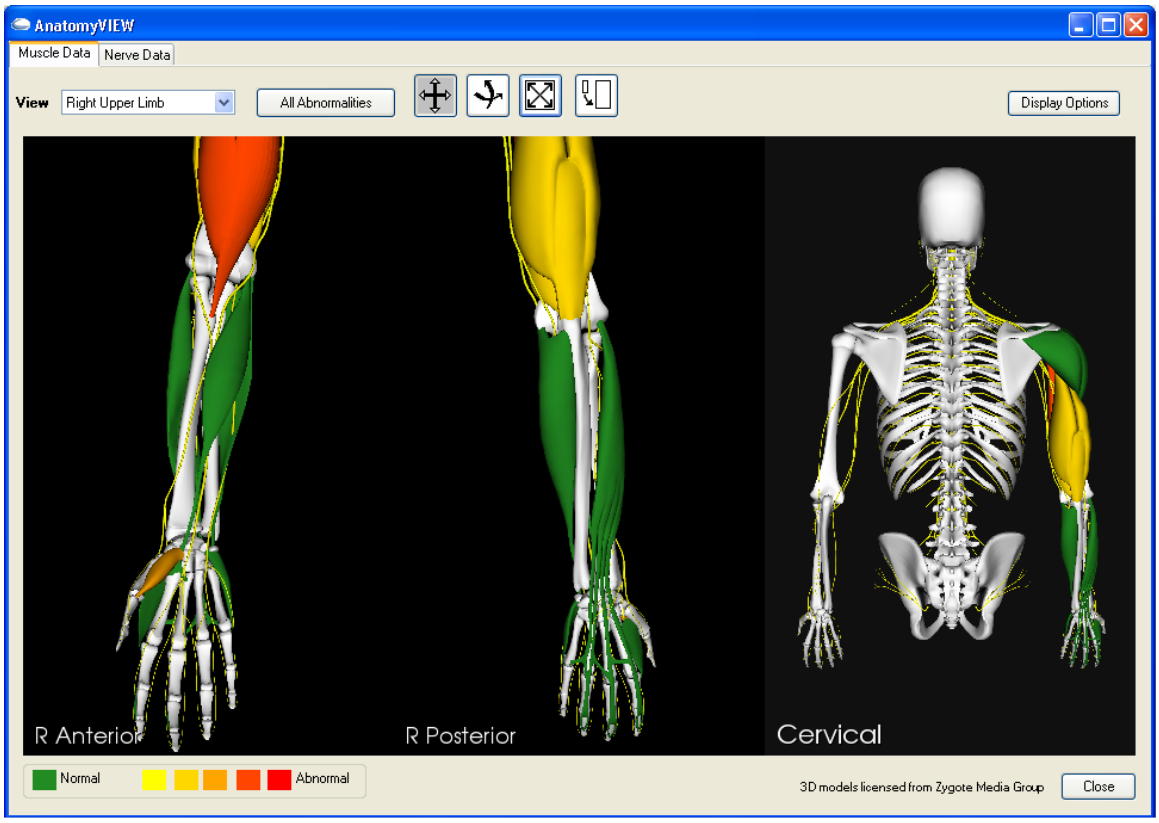
To open the AnatomyVIEW window, perform one of the following:

- Click on the **AnatomyVIEW button** in the EMG test controls toolbar.



- Select **AnatomyVIEW** from the **View menu**.



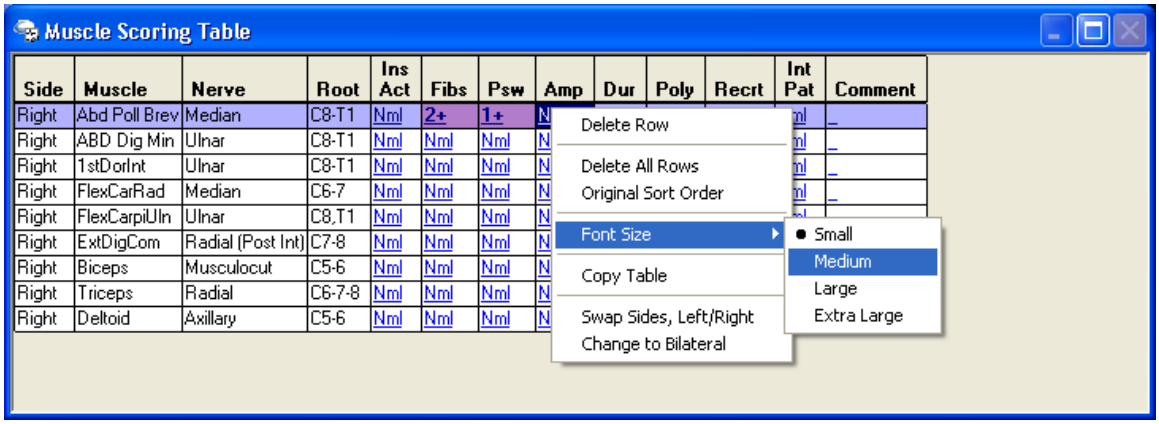


AnatomyVIEW window.

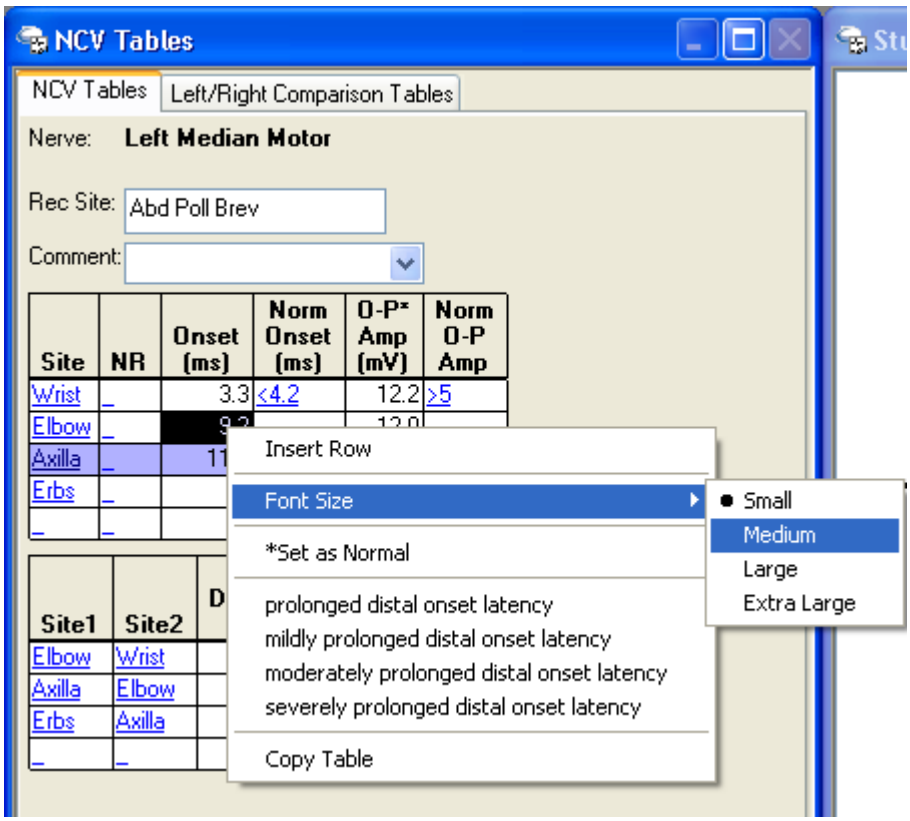
For additional AnatomyVIEW topics, Click here.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

Swap Sides

To swap the side parameter on a muscle, perform one of the following.

- **Right click** the mouse over the **muscle name** in the **Study window**. From the pop-up menu select **Swap Sides, Left/Right**.
- **Right click** the mouse over the corresponding **row in the Muscle Score Table**. From the pop-up menu select **Swap Sides, Left /Right**.

 If the muscle was listed only **once** in the Study window, then it will be swapped to the opposite side.

 If the muscle was listed in the Study window **twice**, as a right sided muscle and as a left sided muscle, then both the entries will have their side parameter swapped. You can never have more than one Right or Left sided muscle in the Study window.

 If the muscle being swapped contains stored data (i.e., a snapshot, buffer, or capture runs), the data is also moved to the opposite side.

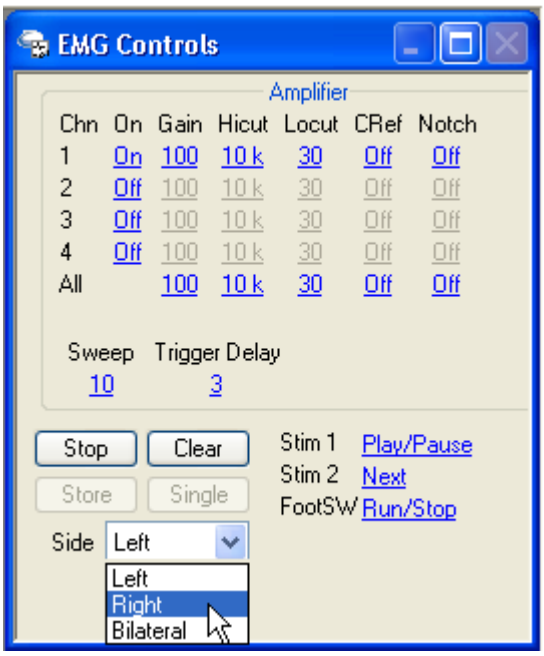
Change Sides

Changing the Side parameter for a muscle is different than Swapping Sides. When you change sides, the highlight moves from the currently selected muscle in the Study window (e.g. Right Abd Poll Brev) to the same muscle but with the opposite side (e.g., Left Abd Poll Brev).

If the muscle corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **EMG Controls Window**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



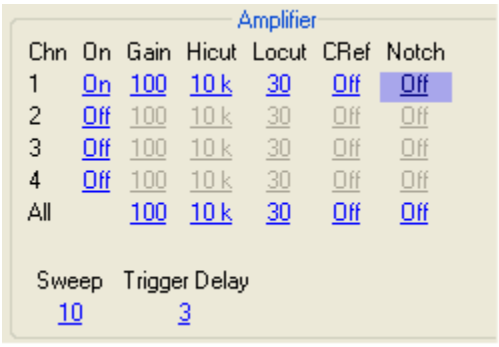
Or, in the **EMG Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.

Notch Filter

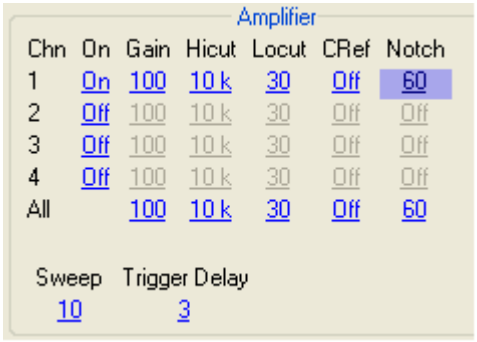
A 50 or 60 Hz Notch Filter can be enabled for each channel. The default frequency of the filter is set within the System Setup preferences.

To enable the Notch Filter

In the **EMG Controls** window, click on the **Notch** setting for the appropriate channel. The setting will toggle from **Off** to **50** or **60** Hz.



Notch Off



Notch ON (60 Hz)

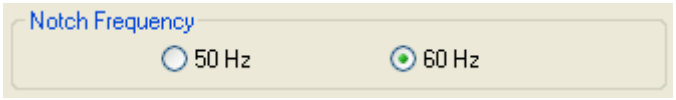
In the **Controls Toolbar**, click on the **Notch** setting for the appropriate channel. The setting will toggle from **Off** to **50** or **60** Hz.

Notch Off

Notch On

To set the default Notch Filter Frequency

1. From the **File** menu, select **System Setup**.
2. Select either **50 Hz** or **60 Hz** in the **Notch Frequency** section.



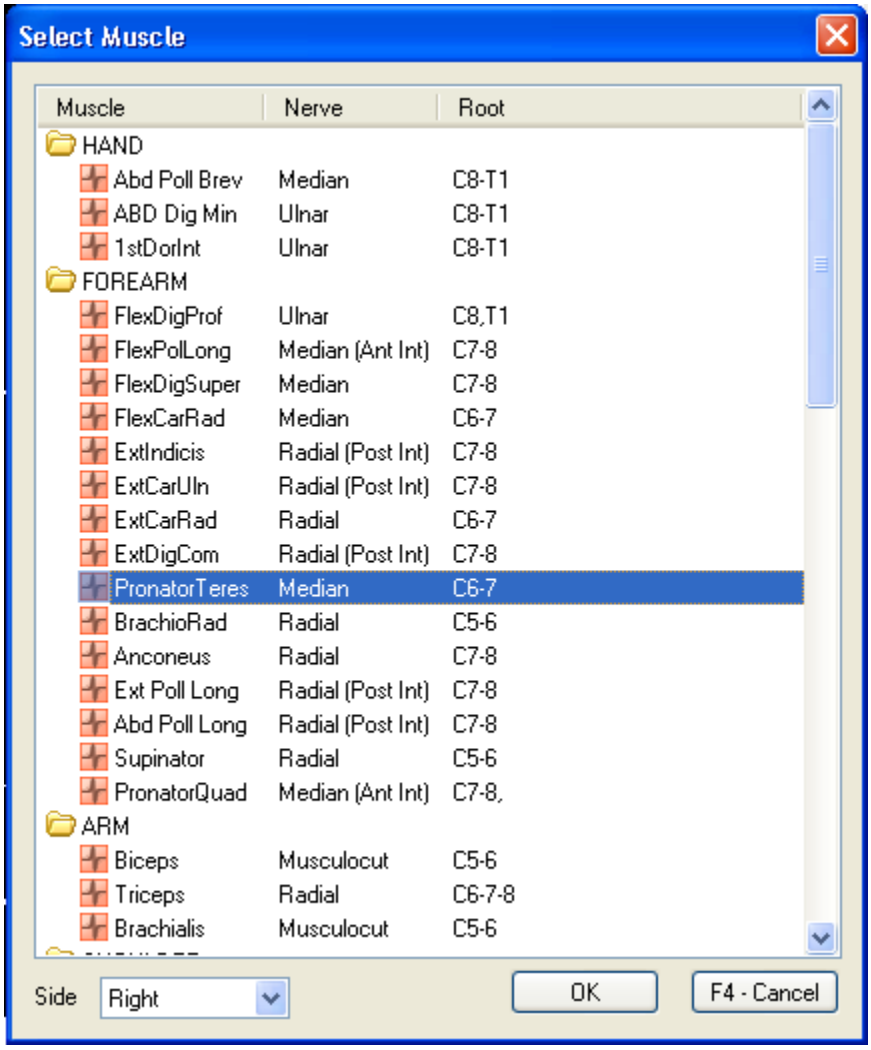
3. Click **OK**.

Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the EMG Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the EMG Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

   - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

   - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

- **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.
- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

 Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

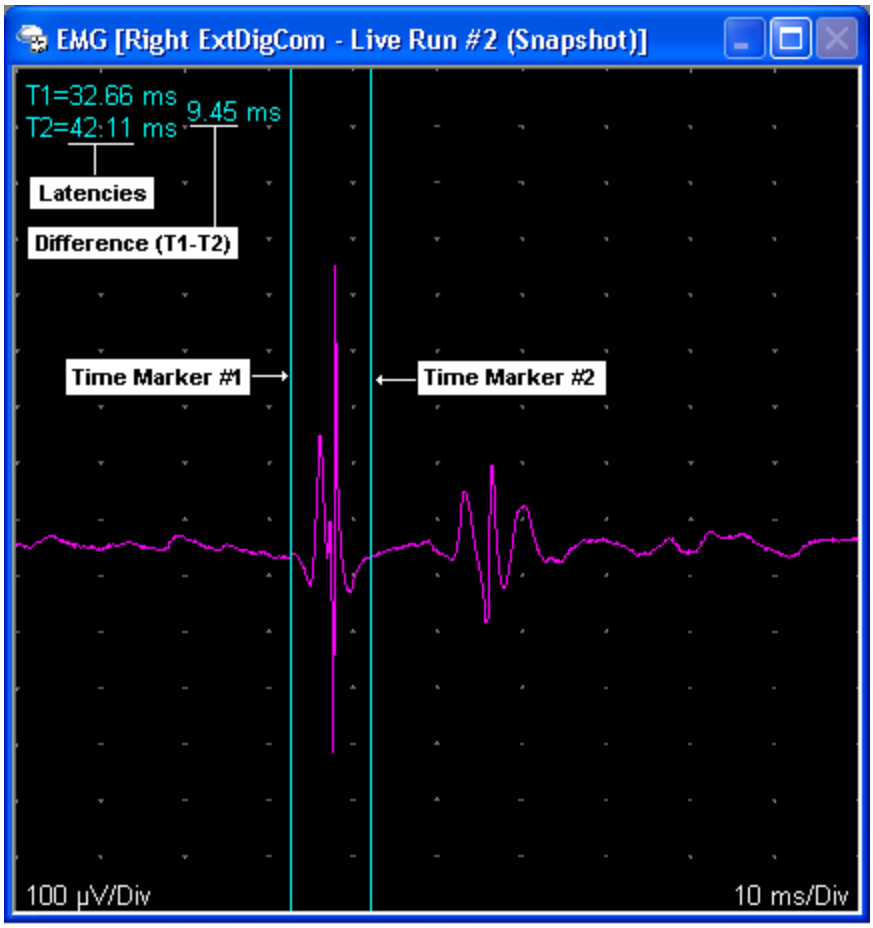
 Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

Time & Amplitude Markers

To quickly measure the duration or amplitude of a motor unit potential use the Time & Amplitude Markers.

Using the Time Markers

- **Right click** over the **EMG Trace window** and **select Time Markers** from the pop-up menu. Two vertical time markers will be displayed.
- **Move** the markers **by clicking** on them with the mouse **and dragging** them across the window.
- The **latency**, in milliseconds (from the left edge of the Trace window), is displayed for each Time Marker in the **upper left hand** corner of the Trace window. The **difference** between the two time markers is also indicated.
- To **remove** the Time Markers from the window, **right click** over the **EMG Trace window** and **de-select Time Markers** from the pop-up menu.



EMG Trace window with Time Markers.

Using the Amplitude Markers

- **Right click** over the **EMG Trace window** and **select Amplitude Markers** from the pop-up menu. Two horizontal amplitude markers will be displayed.
- **Move** the markers **by clicking** on them with the mouse **and dragging** them up or down in the window.
- The **amplitude**, in microvolts, between the two amplitude markers is shown in the **upper left hand** corner.
- To **remove** the Amplitude Markers from the window, **right click** over the **EMG Trace window** and **de-select Amplitude Markers** from the pop-up menu.

EMG Trace window with Amplitude Markers.

Using Cursor mode to manipulate the Time & Amplitude Markers

If you prefer using the Sierra Wave base unit's dedicated knob and function keys when working with the Time & Amplitude markers simply press the **F5 function key** on the PC's keyboard to enter **Cursor mode**. The functions of the base unit's knobs and function keys will change to those illustrated below. When your finished using Cursor mode, press the F5 function key a second time, or the OK key to exit from Cursor mode.

Cursor mode (F5)

(Knobs)

Lat 1 / Lat 2 - turn this knob to move latency marker number one. Press this knob, then turn to move latency marker number two. The latency values are displayed at the top left of the Trace window.

Amp 1 / Amp 2 - turn this knob to move amplitude marker number one. Press this knob, then turn to move amplitude marker number two. The amplitude value is displayed at the top left of the Trace window.

Sel. Trial - turn this knob to select a stored snapshot trace. When selected, the trace will be displayed in yellow color.

Gain - turn this knob to change the gain of the selected snapshot trace.

(F Keys)

Raster / Overlay - press this function key to toggle between displaying stored snapshot traces in raster or overlay (i.e., superimposed) modes.

AmpMrk On / Off - press this function key to toggle the amplitude markers On or Off within the Trace window.

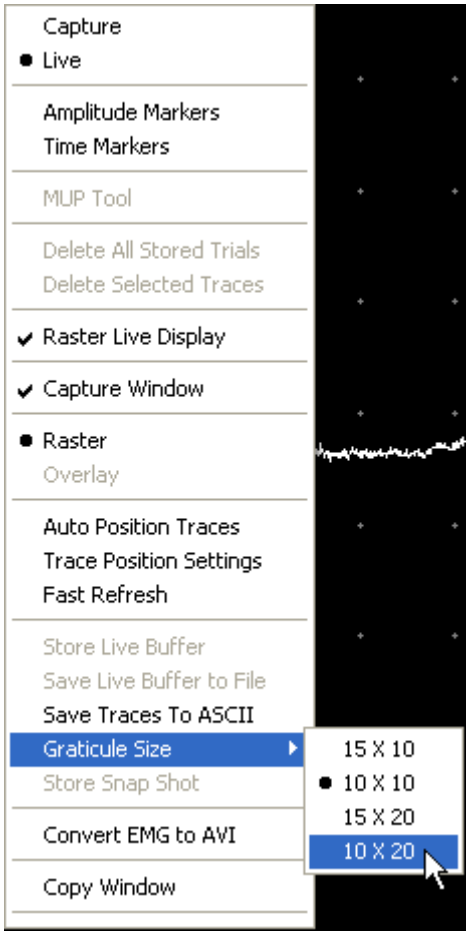
LatMrk On / Off - press this function key to toggle the latency markers On or Off within the Trace window.

Graticule Size

The EMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions.

To Change the EMG Trace window Graticule Size during an exam:

- **Right click** on the **EMG Trace** window.
- From the pop-up menu, highlight **Graticule Size**, a second level pop-up menu will be displayed.
- **Choose one** of the listed selections. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.



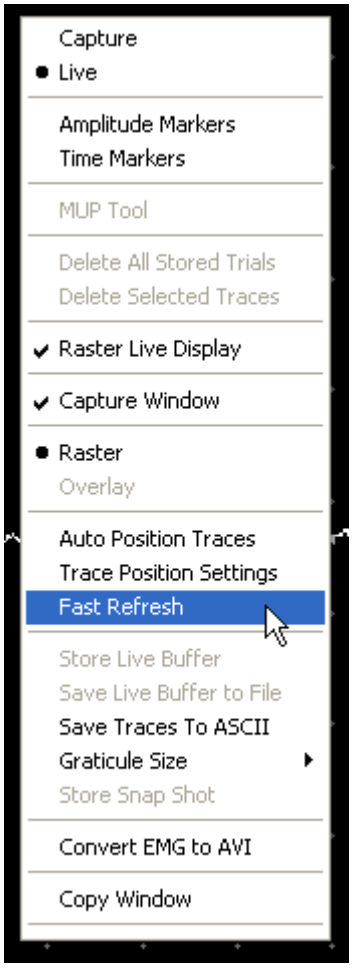
Graticule size selections for EMG Trace window.

Live and **Capture EMG** modes can have different graticule sizes. Factory default Graticule size for Live EMG mode is **10 x 10**. For Capture EMG mode it is **10 x 10**.

For information on changing the default Graticule size, see the topic "EMG Setup".

Fast Refresh Rate

This feature changes the drawing of the EMG trace so that it appears more like an oscilloscope display. Simply right-click over the EMG Trace window and select **Fast Refresh** from the pop-up menu. This setting adds a 2 division 'gap' and updates the trace at 60 Hz. When this setting is disabled the trace is drawn with no gap and refreshes at 15 Hz.



Enable Fast Refresh Rate for EMG trace.

Saving Changes to EMG Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the EMG Test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

EMG Interference Pattern Analysis (IP)

Performing IP Analysis

The electromyographic (EMG) interference pattern (IP) recorded by an intramuscular needle electrode contains the motor unit action potentials (MUAPs) of all active motor units that are within the recording area of the electrode. The IP is typically assessed by its appearance on the EMG machine's display and its sound on a loudspeaker. Several methods have been developed to quantify the IP, the "cloud plot" technique has gained popularity in recent years.

Follow these steps for performing IP Analysis:

1. **Select the EMG Test:**

   - **If a Study has already been selected**, simply click on an EMG muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
   - **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient.

2. **Activate IP Analysis mode.**

   Enable IP Analysis by performing one of the following.

   - Press the **F7** function key on the PC's keyboard.
   - Click on the **IPA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
   - Select **Interference Pattern Analysis** from the **Analysis** menu.

   The display will change to show the IP Analysis window in the location normally occupied by the Muscle Score Table window. The IP Analysis window contains three plots, **Amplitude vs. Turns/sec**, **Envelope vs. Activity**, and **NSS vs. Activity**. For more information on these plots, go to the Cloud Plot Descriptions topic.

   If you were in Capture mode the program will automatically switch to Live mode when IP Analysis is selected.

3. **Position the needle electrode within the muscle.**

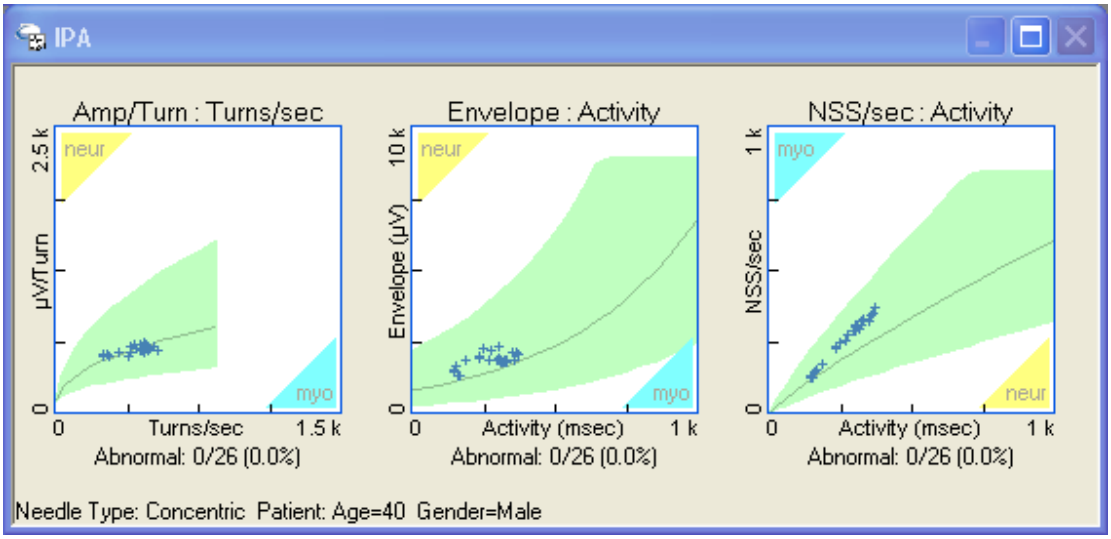
   Adjust the Gain setting so that motor unit potentials do not clip at moderate and full effort. The Sweep Speed setting is typically 10-20 ms/Div.

4. **Begin Analysis.**

Press the **F1 (Pause / Analyze)** function key to activate the **Analyze** mode. Record EMG activity during moderate to full effort. As the EMG data is analyzed data points will begin to be placed on the cloud plots, each data point represents a 500 millisecond epoch of EMG activity. Typically 20-30 data points should be collected for the muscle being examined (20 data points = 10 seconds), and these should be acquired from 6-10 different sites within the muscle.

The **Clear** key on the Sierra Wave base unit can be used to reset (i.e., clear) the cloud plots at any time.

Blue data points lie within the defined normal (light green) area and **red data points** lie outside the normal area. The total number of data points plotted on the cloud is shown below each plot as well as the number and percentage of abnormal data points.



IP Analysis window.

Press the **F1 (Pause / Analyze)** function key to activate the **Pause** mode while the needle is being repositioned within the muscle. Once the needle has been positioned, return to the **Analyze** mode.

5. **Stop Analysis.**

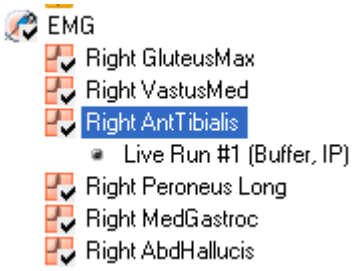
After the appropriate number of data points has been collected, press the **Run/Stop** key on the Sierra Wave base unit to stop the EMG acquisition (this also places IP Analysis in Pause mode).

6. **Store the IP Analysis**

To store the IP Analysis Cloud plots, press the **Store** key on the Sierra Wave base unit.

Once the IP Analysis Cloud plots have been stored an IP node will be displayed in the Study window for the muscle being examined.

The Live EMG Buffer can also be stored along with the IP Analysis plots by optionally pressing the **F2 (Store Live Buffer)** function key.



Study window with stored IP Analysis and Live Buffer for Right Ant Tibialis muscle.

7. **To record another IP Analysis run.**

   Press the **Run/Stop** key on the Sierra Wave base unit to start EMG acquisition and automatically clear the IP plots. Repeat steps 3 - 6.

8. **To Exit from IP Analysis mode.**

   To return to basic EMG, perform one of the following.

   - Press the **F7** function key on the PC's keyboard.
   - Click on the **IPA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
   - Select **Analysis Off** from the **Analysis** menu.

Knob & Fkey Controls (IP Analysis)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether EMG data acquisition is **running or stopped**.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Data Acquisition mode:

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Muscle Sel - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window.

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the Trace window. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the Trace window.

The Gain and Sweep will automatically reset to default values when a new muscle is selected in the Study window.

F Keys

Pause / Analyze - defaults to the **Pause** mode, in this mode Live EMG is displayed but no IP Analysis occurs. Press the key to activate **Analyze** mode, in this mode every 500 msec of EMG data is analyzed and plotted on the cloud plots.

Fibs / Recrt - press this function key to switch back and forth between **Fibs** and **Recrt** parameter settings. You can program different Gain and Sweep Speed parameters for these two modes and use this function key to easily toggle between the two.

This function key will automatically reset to the Fibs mode when a new muscle is selected in the Study window.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Data Acquisiton Stopped:

Knobs

Review / Play-Stop - turn this knob to move backward and forward within the EMG buffer. Press the knob to start & stop playback of the EMG buffer.

Muscle Sel - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window.

Gain / Sweep - turn the knob to change the gain of the EMG trace. Press the knob, then turn to change the sweep speed of the EMG trace.

F Keys

Store Snap Shot - press this function key to store the currently displayed EMG trace.

Store Live Buffer - press this function key to store the entire EMG buffer.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

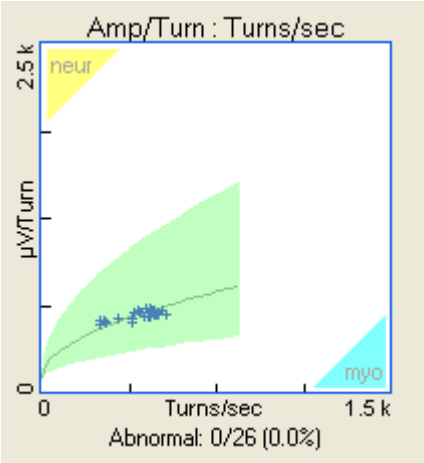
Cloud Plot Descriptions

IP Analysis uses three distinct plots, they are; **Amplitude vs. Turns/sec**, **Envelope vs. Activity**, and **NSS vs. Activity**.

Blue data points lie within the defined **normal (light green) area** and **red data points** lie outside the normal area. The total number of data points plotted on the cloud is shown below each plot as well as the number and percentage of abnormal data points.

All normative data is taken from the published literature. If a plot does not have normative data for a muscle then no normal (light green) area is shown on that plot.

Plot #1: Mean Amp/Turn vs. Turns/sec.



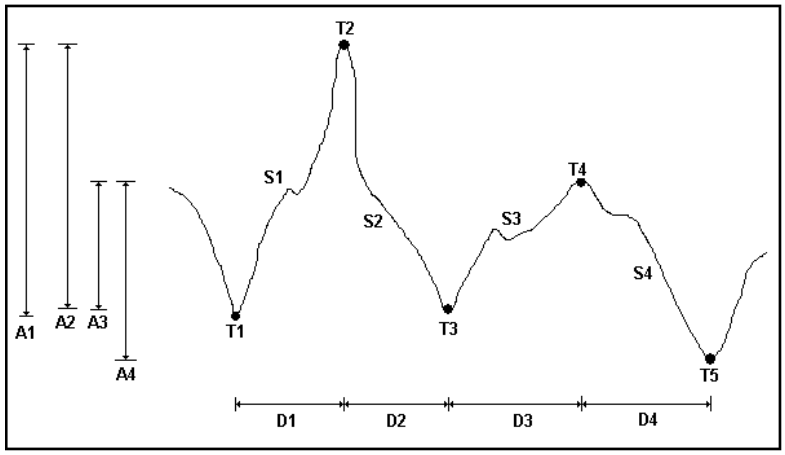
The mean amplitude per turn is plotted on the Y-axis, the number of Turns per second is plotted on the X-axis.

Definitions:

Turn - a turn ocurs at a local minimum or maximum of the EMG signal (i.e., peak or trough), where the signal changes its direction and the signal amplitude changes by at least 100 microvolts (uV) compared to the preceding and subsequent turns.

Segment - portion of the EMG signal between two consecutive turns.

Mean Amplitude per Turn - the mean amplitude of all the segments in the analyzed epoch.



Example EMG signal with five turns (T1-T5) defining four segments (S1-S4). The amplitudes (A1-A4) and durations (D1-D4) are shown.

Normative Data:

Normative data for the Amp vs. Turns plot are based on **Needle type** (concentric only), **Age** (less than 60 or greater than 60), **Muscle**, and **Gender**.

The Sierra Wave comes with **Concentric needle** normative data for the following muscles.

- Biceps Brachii
- Extensor Digitorum Communis
- Vastus Medialis (Quadriceps)
- Anterior Tibialis
- 1st Dorsal Interosseous (not age dependent)

 There is no normative data included for the **Monopolar needle** type.

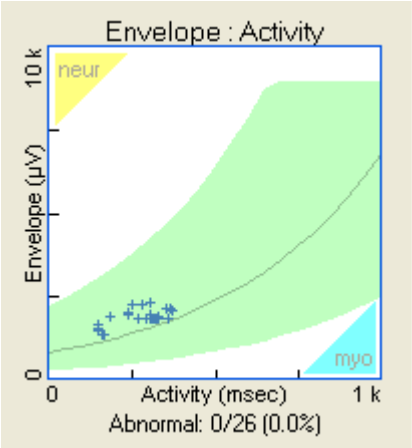
Interpretation:

Neuropathy - Mean Amplitude is increased, Turns/sec is normal or decreased.

Myopathy - Mean Amplitude is decreased, Turns/sec increased.

Generally, less than 10% of all data points should lie outside the normal boundaries (i.e., 2 out of 20 points). Points that cluster above the normal space are suggestive of a neuropathic process while points that cluster below the normal space are suggestive of a myopathic process. Sometimes the data points will all lie within the normal space but will tend to cluster either above or below the mean line, this can also be indicative of a disease process.

Plot #2: Envelope vs. Activity



Envelope is plotted on the Y-axis, the Activity is plotted on the X-axis.

Definitions:

Activity - as the force of muscle contraction increases, the IP becomes increasing "full", i.e., it contains more and more MUAP activity with less time between individual MUAPs. The activity parameter quantifies the "fullness" of the IP. Activity is calculated by summating the durations of all the segments within the 500 msec epoch that lie below the duration and amplitude limits. This sum is multiplied by 2 to give a value that corresponds to a 1-second epoch. Therefore, activity represents the time (in milliseconds) within a 1-second period during which MUAPs are present in the signal.

In order for a segment to be included in the activity measurement it must meet the following criteria:

- Amplitude between 2-10 mV and duration less than 5 msec.
- Amplitude between 0.5-2 mV and duration less than 3 msec.
- Amplitude less than 0.5 mV and duration less than 1.5 msec.

Envelope - quantifies the largest spikes of the IP. The envelope is defined as the amplitude that is exceeded by only 1% of the segments within the epoch.

Normative Data:

Normative data for the Envelope vs. Activity plot are based on **Needle type** (concentric only) and **Gender**. As such, all muscles are shown with the same normal space and change only with respect to the patient's gender. There is no normative data for the monopolar needle type.

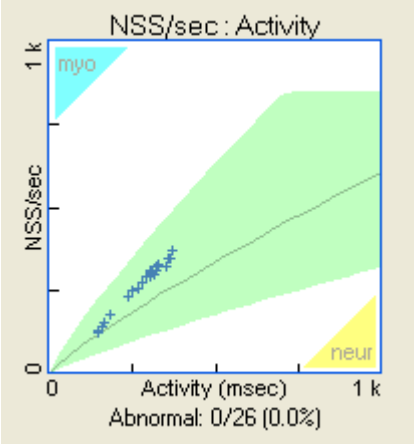
Interpretation:

Neuropathy - Activity is normal or reduced, Envelope is increased.

Myopathy - Activity is decreased, Envelope is decreased.

Generally, less than 10% of all data points should lie outside the normal boundaries (i.e., 2 out of 20 points). Points that cluster above the normal space are suggestive of a neuropathic process while points that cluster below the normal space are suggestive of a myopathic process. Sometimes the data points will all lie within the normal space but will tend to cluster either above or below the mean line, this can also be indicative of a disease process.

Plot #3: Number of Short Segments (NSS) vs. Activity:



The number of short segments (NSS) is plotted on the Y-axis, the Activity is plotted on the X-axis.

Definitions:

Activity - same as above for the Envelope vs. Activity plot.

Number of Short Segments (NSS) - this parameter assess the "complexity" of the IP by measuring the low-amplitude, short duration, high-frequency components of the IP.

In order for a segment to be included in the NSS measurement it must meet the following criteria:

- Amplitude between 0.5-2 mV and duration less than 3 msec.
- Amplitude less than 0.5 mV and duration less than 1.5 msec.

Normative Data:

Normative data for the NSS vs. Activity plot are based on **Needle type** (concentric only) and **Gender**. As such, all muscles are shown with the same normal space and change only with respect to the patient's gender. There is no normative data for the monopolar needle type.

Interpretation:

Neuropathy - Activity is normal or reduced, NSS is reduced.

Myopathy - Activity is decreased, NSS is increased.

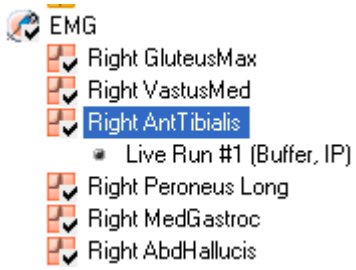
Generally, less than 10% of all data points should lie outside the normal boundaries (i.e., 2 out of 20 points). Points that cluster above the normal space are suggestive of a myopathic process while points that cluster below the normal space are suggestive of a neuropathic process (this is the reverse of the Envelope vs. Activity plot). Sometimes the data points will all lie within the normal space but will tend to cluster either above or below the mean line, this can also be indicative of a disease process.

Storing IP Analysis Results

To store the IP Analysis Cloud plots, press the **Store** key on the Sierra Wave base unit.

Once the IP Analysis Cloud plots have been stored an IP node will be displayed in the Study window for the muscle being examined.

The Live EMG Buffer can also be stored along with the IP Analysis plots by pressing the **F2 (Store Live Buffer)** function key.



Study window with stored IP Analysis and Live Buffer for Right Ant Tibialis muscle.

Deleting an IP Analysis Run

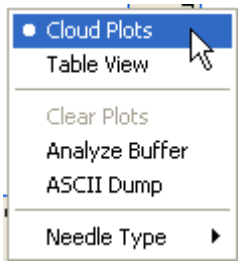
To **Delete** a stored IP Analysis run, follow these steps.

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted.

Analyzing a stored EMG Buffer

To Analyze a stored EMG Buffer:

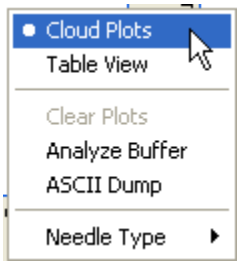
- Select the EMG Buffer by clicking on it in the Study window.
- Enable Interference Pattern Analysis.
  - Press the **F7** function key on the PC's keyboard.
  - Click on the **IPA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
  - Select **Interference Pattern Analysis** from the **Analysis** menu.
- Right click over the IPA cloud plots, from the pop-up menu select **Analyze Buffer**.



- The EMG data in the buffer will be analyzed and the cloud plots will be updated.
- Press the **Store** key to save the analysis results.

IP Analysis Options

Right-clicking the mouse over the IP Analysis window will display a pop-up menu with several options.



Cloud Plots - when selected this option will display the graphical cloud plots within the window. This is the default.

Table View - when selected this option will display a table showing the values associated with each data point that has been collected. The values listed are Turns/Sec, Amp/Turn, NSS, Envelope, and Activity.

Clear Plots - during data acquisition this option will reset and clear all data points from all the cloud plots. The Clear key on the Sierra Wave base unit also performs this function.

Analyze Buffer - selecting this option will analyze the currently selected stored EMG buffer in the Study window and update the cloud plots accordingly.

ASCII Dump - selecting this option will output the Table of data point values to a text file.

Needle Type - allows selection of either Concentric or Monopolar needle types. Normal data is provided only for the Concentric needle type.

IP Analysis Normative Data

The Sierra Wave's IP Analysis normative data has been taken directly from the published literature.

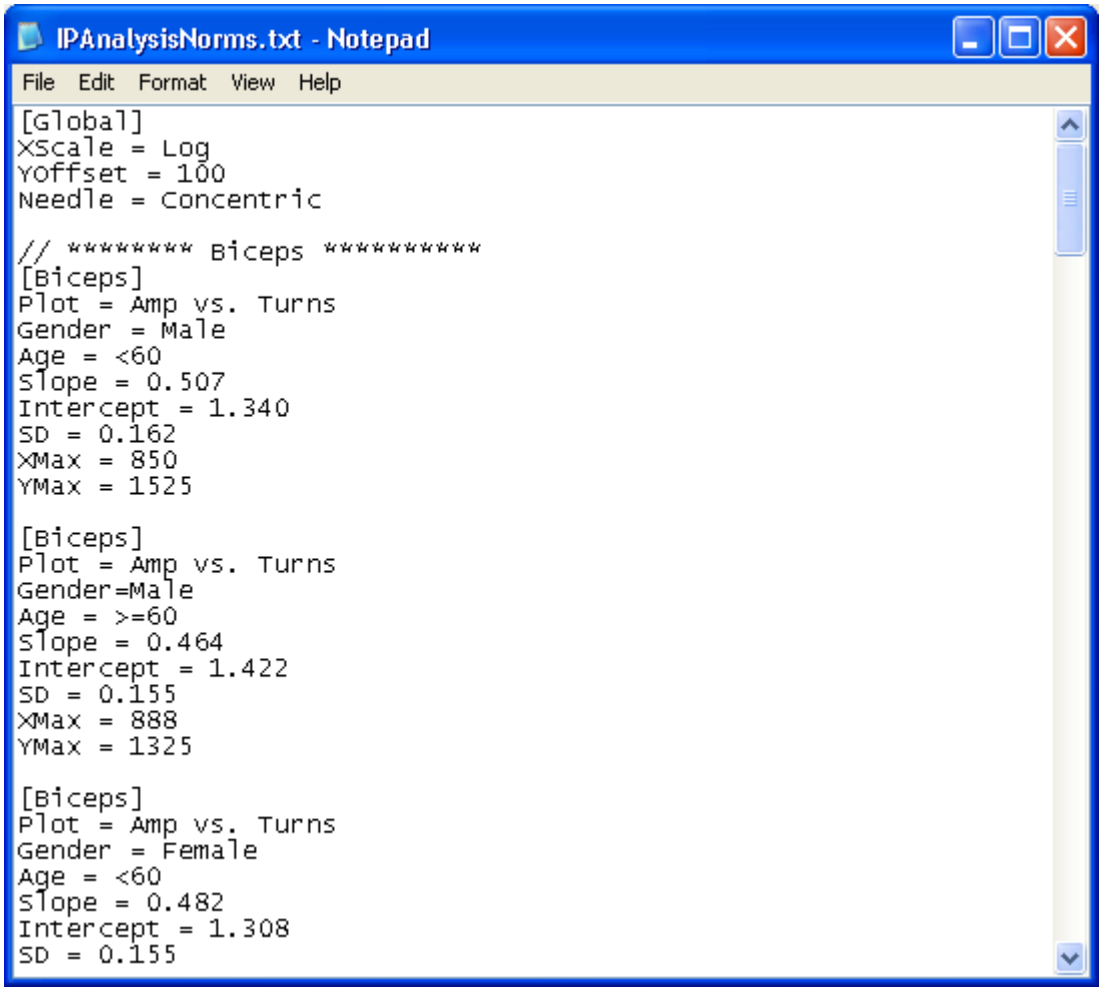
The normal cloud can be drawn using two methods. **Method #1** uses a regression curve and standard deviation. **Method #2** uses pre-defined points to outline the normal polygon.

All of the default normal clouds on the Sierra Wave use Method #1, as described in the literature.

An editable text file called "IPAnalysisNorms.txt" contains the parameters used to draw the normal clouds. By editing this file the user can modify the existing normative data or even add additional normative data for new muscles.

The **IPAnalysisNorms.txt** file is located in the C:\Cadwell\Sierra Wave folder.

When opened, the file looks like the following.



[Global]

The first part of the file defines some global attributes which are applied to each cloud. These attributes are ignored if the same attribute is specified for an individual cloud. There can be multiple global sections.

XScale=log (can be log or linear, if log, then x values of the regression curve are transformed from logarythmic to linear scale. If linear, no transform is done)

YOffset=100 (this value is added to the y values AFTER they have been transformed to linear scale)

Needle = Concentric (can be either Concentric or Monopolar)

[Default]

If there is not a cloud specified for a muscle then use this header to define a default for a particular plot type. This is used for the Envelope vs. Activity and NSS vs. Activity plots.

//****************Biceps**********************

This is a comment line. It begins with a double forward slash. It is not used by the program.

[Biceps]

Defines the muscle name.

Plot = Amp vs. Turns

Specifies the plot the cloud is for. Should contain the words Amp, Turns, Envelope, NSS, or Activity.

Gender = Male

Specifies if the plot is for Male or Female.

Age = <60

Specifies an age range. Format is comparison operator followed by an age value. Separate multiple age ranges by ';' or ','.

Examples:

Age = <60

Age = >15, <60

Slope = 0.507

Clouds are defined by Slope, YIntercept, and Standard. Deviation. This attribute defines the Slope of the regression curve.

Intercept = 1.340

Defines the Y-Intercept of the regression curve.

SD = 0.162

Defines the Standard Deviation that is added/subtracted from the regression curve to specify the top/bottom curves of the cloud.

XMax = 850

Defines an upper limit to x values of the cloud AFTER they have been transformed to linear scale. Default is full scale of the plot.

YMax = 1525

Defines an upper limit to y values of the cloud AFTER they have been transformed to linear scale. Default is zero.

StdDevCount = 3

Specifies how many Standard Deviations (SD) to add and subtract from the regression curve to form the upper and lower curves of the cloud. Default is 2.

Method #2 - Defined Points of the Polygon

If Method #2 is used to draw the normal cloud the following syntax would be used in place of using Slope, Intercept, SD, XMax, YMax, StdDevCount as described above.

Pt(0,200)

Specifies a single point in the polygon that defines the cloud. Syntax is: Pt(<x>, <y>). The following defines a cloud.

pt(0,200)

pt(125,250)

pt(625,375)

pt(832.5,375)

pt(832.5,1500)

pt(625,1375)

pt(375,1082)

pt(187.5,750)

pt(82.5,583)

IP Analysis References

1. On the Shape of the Normal Turns – Amplitude Cloud

Sanjeev D. Nandedkar, PhD, Donald B. Sanders, MD, and Erik V. Stalberg, MD

Muscle & Nerve, 14:8-13, January 1991

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Donald B. Sanders, Erik V. Stalberg, and Sanjeev D. Nandedkar

Journal of Clinical Neurophysiology, 13(5):385-400, 1996.

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E. Stalberg, J. Chu, V. Bril, S. Nandedkar, S. Stahlberg, and M. Ericsson

Technical Section – Electroencephalography and Clinical Neurophysiology

56: 672-681, 1983.

4. Automatic Analysis of the Electromyographic Interference Pattern. Part 1: Development of Quantitative Features.

Sanjeev D. Nandedkar, PhD, Donald B. Sanders, MD, and Erik V. Stalberg, MD.

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Sanjeev D. Nandedkar, PhD, Donald B. Sanders, MD, and Erik V. Stalberg, MD.

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6. A New Approach to Quantitative Electromyography

Nandedkar, S.D.: Wells, E.O.; Robertson, C.D.

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Teca Corporation, March 1994

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8. Sensitivity and Specificity of Needle Electromyography: A prospective study comparing automated interference pattern analysis with single motor unit analysis.

Arto C. Nirkko, Kai M. Rosler, Christian W. Hess

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9. Methods in Clinical Neurophysiology: Turns – Amplitude Analysis of the EMG Interference Pattern

Anders Fuglsang-Frederiksen

Dantec Corporation, December 1993

10. Quantitative EMG in Inflammatory Myopathy

Paul E. Barkhaus, MD, Sanjeev D. Nandedkar, PhD., and Donald B. Sanders, MD.

Muscle & Nerve 13:247-253, March 1990

11. Quantitative Analysis: Objective and Interactive Assessment in Electromyography.

Sanjeev D. Nandedkar and Paul E. Barkhaus

Clinical Evaluation and Diagnostic Tests for Neuromuscular Disorders, Chapter 12

Edited by Tulio E. Bertorini

Butterworth Heinemann Publisher, 2002

EMG Multi-Motor Unit Analysis

Performing Multi-Motor Unit Analysis

Multi-Motor Unit Analysis (MMUA) is an optional Quantitative EMG program that uses signal decomposition and template matching to extract, identify, and sort motor unit action potentials (MUAPs) from an epoch of EMG. The main goal of MMUA is to quantify MUP parameters, not do complete signal decomposition and detect every occurrence of a given MUP in the firing pattern. The method is called Multi-Motor Unit Analysis because many different MUPs usually can be obtained from each recording site.

The Sierra Wave's MMUA program can be used in two ways. It can be setup to immediately analyze a buffer of EMG activity as soon as it is acquired, or it can be used to analyze stored EMG buffers after the patient has left the office.

Follow these steps for performing Multi-Motor Unit Analysis:

1. **Select the EMG Test:**

   - **If a Study has already been selected**, simply click on an EMG muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
   - **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient.

2. **Activate the MMUA program.**

   Enable MMUA by performing one of the following.

   - Press the **F9** function key on the PC's keyboard.
   - Click on the **MMUA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
   - Select **Multi-Motor Unit Analysis** from the **Analysis** menu.

3. **Position the needle electrode within the muscle.**

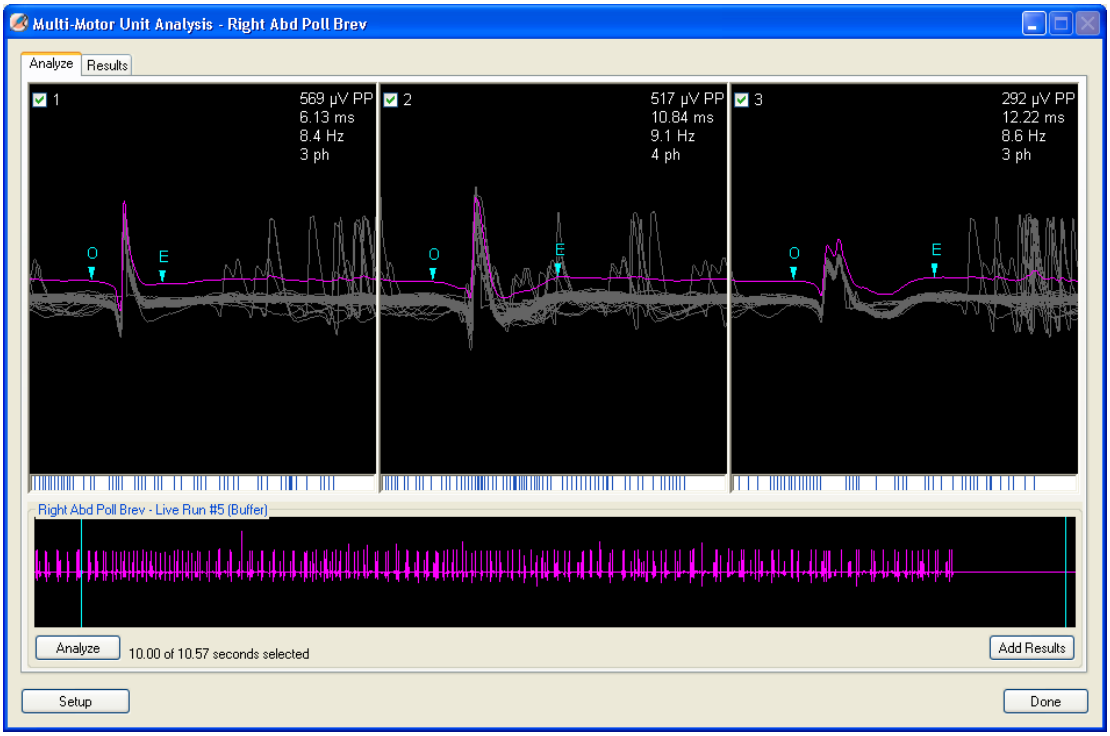
   The needle electrode (typically concentric) is inserted randomly in the muscle but positioned at a site where the EMG signal is crisp. No further adjustment of the electrode position is done. A slight to moderate contraction (5-30% of maximum force) is used. At this level of contraction the EMG signal may contain discharges of one to four different motor unit action potentials (MUAPs). Adjust the Gain setting so that motor unit potentials do not clip at

moderate effort. The Sweep Speed setting is typically 10-20 ms/Div. Up to 30 seconds of EMG can be analyzed but 5 to 10 second epochs are suggested.

4. **Acquire 10-30 seconds of EMG** activity and then press the **Run/Stop** key.

   The MMUA window will be displayed. The EMG Buffer has been analyzed and the results are shown on the Analyze tab.

   To analyze a previously acquired and stored EMG Buffer, simply click on the buffer you wish to analyze in the Study window.



MMUA Analyze view. 3 MUPs have been identified in this EMG buffer.

Analysis Overview:

The computer begins by identifying the spikes within the EMG signal. The first spike becomes a template against which all the other spikes are compared. So, if the next spike in the signal is considered the same as the template spike (based on template matching algorithms) it is sorted into that template's bin. If the spike does not match the template spike, it becomes the template for a second bin. This is repeated until all the spikes in the epoch are evaluated and sorted into bins.

When a bin contains several matches (>10), it is considered to represent discharges from a single MUAP. The spikes in the bin are averaged and the resulting averaged trace is displayed. Measurements are made on the averaged trace and allow the MUPs properties to be quantified. Typical

measurements include; Amplitude, Duration, #Phases (<= 4 is normal), Turns, Firing Frequency, and Thickness.

This process is repeated until 20-30 different MUPs have been acquired for the muscle under investigation. The mean and standard deviation is computed for all the MUPs and for just the Non-Polyphasic MUPs (i.e., the Simple MUPs). The total percentage of polyphasic MUPs found within the muscle is indicated as well.

5. The Analyze Tab

The EMG Buffer is shown across the bottom of the window. By default the program automatically analyzes the last 10 seconds of the buffer. You can move the start & end analysis markers (shown in blue) and analyze other portions of the buffer by clicking on the Analyze button. Up to 30 seconds can be analyzed at one time.

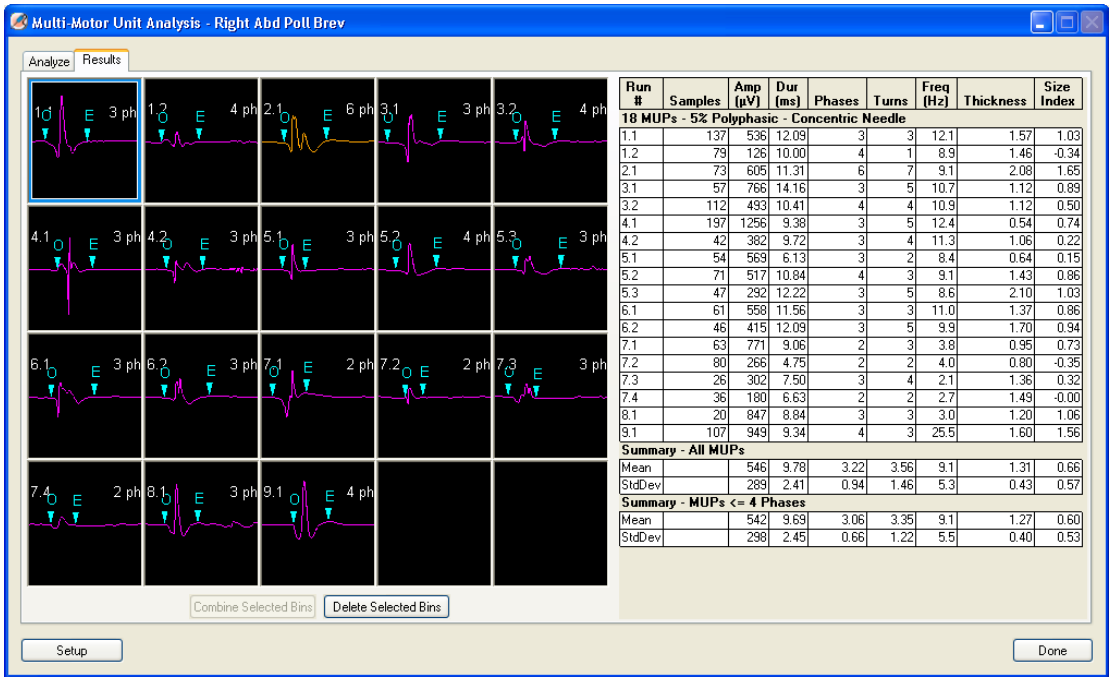
- Results are displayed in bins. All the individual MUAP traces are shown in light grey, the resulting averaged trace is shown in purple (non-polyphasic) or orange (polyphasic).
- The amplitude (peak to peak), duration (ms), firing rate (Hz), and number of phases (ph) are summarized in the top right of each bin.
- The firing pattern of the MUP is indicated by ‘tick marks’ below the bin. The marks indicate where the MUP was found within the epoch of EMG. Firing rate accuracy is better with increasing number of detections.
- You can overlay or raster the individual traces in a bin by using the right-click menu. The default is overlay.
- Bins with more than 10 traces are automatically selected (shown by check mark in upper left of bin)
- Bins with less than 10 traces are shown as "insufficient" and are not selected.
- MUPs with 5 or more phases are considered “Polyphasic” and the averaged trace is displayed in orange.
- Gaps in the firing pattern indicate portions of the signal where the MUAP discharge could not be extracted or resolved due to superimposition with other discharging MUAPs. Gaps may also occur if the MUAP stops firing.
- Sometimes the same MUAP may be sorted into multiple bins. This typically occurs when the MUAP waveform changes during the recording (e.g., electrode movement, MUAP instability) or when the MUAP is complex. The user can manually combine the bins in this situation.

To Combine Bins:

1. Hold down the **Control key** and single **left click** the mouse on the bins to be combined. Selected bins will have a blue box drawn around them.
2. **Right click** over any one of the selected bins and choose **Combine Bins** from the pop-up menu.

- Duration can be edited by moving the Onset and End cursors on the averaged trace.

6. Click the **Add Results button** to add the selected MUPs to the Results Table; the **Results Table** is then displayed automatically.



Run #	Samples	Amp (µV)	Dur (ms)	Phases	Turns	Freq (Hz)	Thickness	Size Index
18 MUPs - 5% Polyphasic - Concentric Needle								
1.1	137	536	12.09	3	3	12.1	1.57	1.03
1.2	79	126	10.00	4	1	8.9	1.46	-0.34
2.1	73	605	11.31	6	7	9.1	2.08	1.65
3.1	57	766	14.16	3	5	10.7	1.12	0.89
3.2	112	493	10.41	4	4	10.9	1.12	0.50
4.1	197	1256	9.38	3	5	12.4	0.54	0.74
4.2	42	382	9.72	3	4	11.3	1.06	0.22
5.1	54	569	6.13	3	2	8.4	0.64	0.15
5.2	71	517	10.84	4	3	9.1	1.43	0.86
5.3	47	292	12.22	3	5	8.6	2.10	1.03
6.1	61	558	11.56	3	3	11.0	1.37	0.86
6.2	46	415	12.09	3	5	9.9	1.70	0.94
7.1	63	771	9.06	2	3	3.8	0.95	0.73
7.2	80	266	4.75	2	2	4.0	0.80	-0.35
7.3	26	302	7.50	3	4	2.1	1.36	0.32
7.4	36	180	6.63	2	2	2.7	1.49	-0.00
8.1	20	847	8.84	3	3	3.0	1.20	1.06
9.1	107	949	9.34	4	3	25.5	1.60	1.56
Summary - All MUPs								
Mean		546	9.78	3.22	3.56	9.1	1.31	0.66
StdDev		289	2.41	0.94	1.46	5.3	0.43	0.57
Summary - MUPs <= 4 Phases								
Mean		542	9.69	3.06	3.35	9.1	1.27	0.60
StdDev		298	2.45	0.66	1.22	5.5	0.40	0.53

MMUA Results view. 18 MUPs have been acquired for this muscle.

7. The Results Tab

The Results Tab shows the averaged trace for each MUP and a cumulative table of MUP measurements. Purple traces indicate non-polyphasic MUPs, orange traces indicate polyphasic MUPs (>4 phases). The total number of MUPS and the percentage of polyphasic MUPs for the muscle are shown at top of the table. The bottom rows of the table show the mean & standard deviation calculations for All MUPs and for MUPs with only four or less phases.

- **Description of Table Entries**

  Run # - the first number designates the EMG Buffer that was analyzed, the second number specifies the MUP bin number.

 # Samples - the number of individual motor unit potentials that were sorted into this bin and contributed to the averaged trace.

Amplitude (peak to peak, uV) - the amplitude of the MUP trace, measured in microvolts.

Duration (ms) - the duration of the MUP trace, measured in milliseconds between the onset and end cursors.

Phases - the number of baseline crossings plus one, between the onset and end cursors.

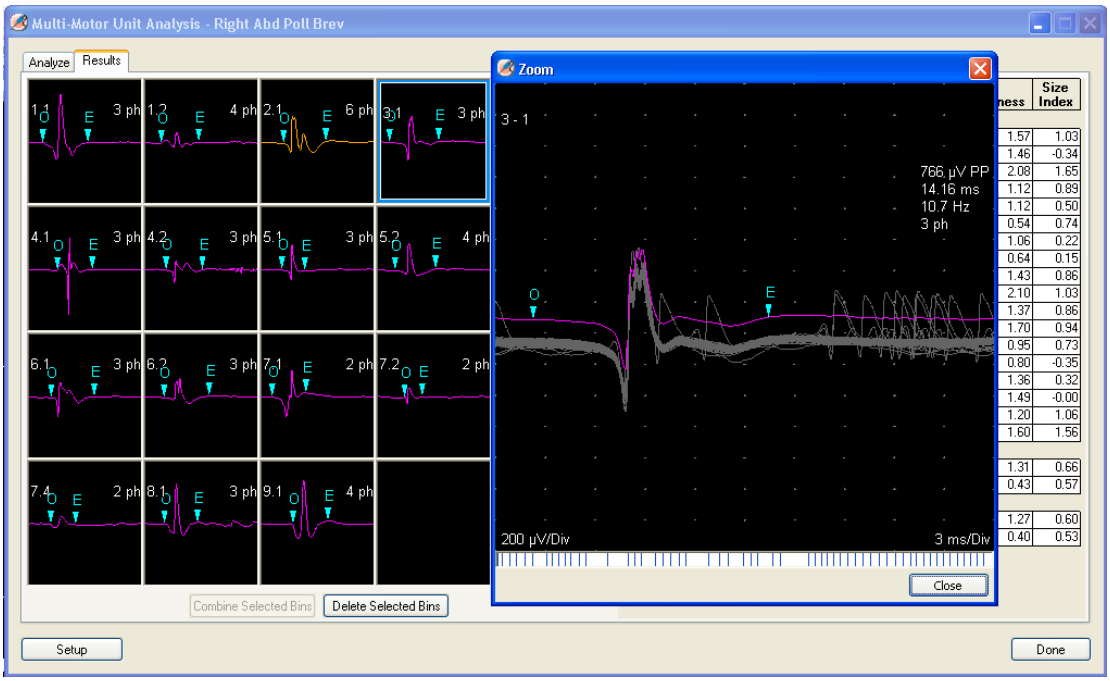
Turns - the number of times the potential changed direction, by at least 50 uV, measured between the onset and end cursors.

Frequency (Hz) - the firing rate of the motor unit potential, measured in cycles per second, or hertz. Firing rate accuracy is better with increasing number of samples.

Thickness - the Area / Amplitude ratio, typically decreased in myopathy.

Size Index - calculated as 2 x Log_{10} (Thickness).

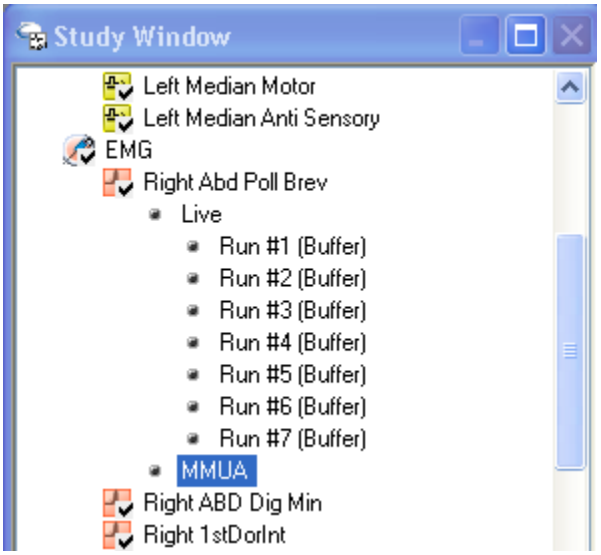
- Bins can be combined using the same method that is described above for the Analyze tab.
- Bins can be deleted by selecting the bin and then clicking the **Delete Selected Bins** button. A selected bin has a blue box drawn around it.
- Double clicking on a bin will open that bin in a larger window, called the **Zoom window**. The Zoom window allows for easier viewing or adjustment of cursors. You can right-click on the zoom window and choose to overlay or raster the individual traces within that bin.



MMUA Results Tab and Zoom Window for bin 3-1.

8. **Click the Done button.** The MMUA window is minimized.

An MMUA node is now shown in the Study window for the tested muscle. Clicking on this node will re-display the Results Table.



Study window showing MMUA node for the Right Abd Poll Brev muscle.

MMUA is still enabled. If you record new EMG the analysis will automatically pop-up when the EMG is stopped. Analysis will also automatically occur if you click on a different stored buffer in the Study window.

9. **Record additional EMG or select another stored EMG Buffer from the Study window.** Repeat until 20-30 MUPs are obtained for the muscle under investigation.

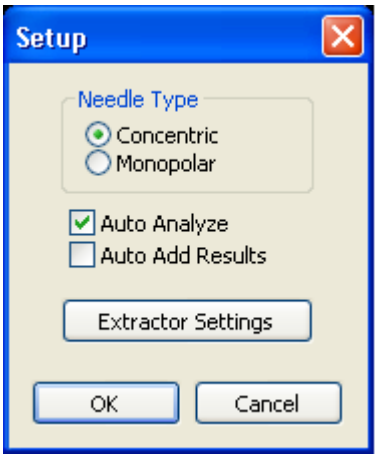
10. **Turn Off Multi-Motor Unit Analysis.**

    To turn MMUA off, perform one of the following.

    - Press the **F9** function key on the PC's keyboard.
    - Click on the **MMUA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
    - De-select **Multi-Motor Unit Analysis** in the **Analysis** menu.

MMUA Setup Options

To access the MMUA Setup options, click the **Setup button** while viewing the **Analyze Tab**.



MMUA Setup

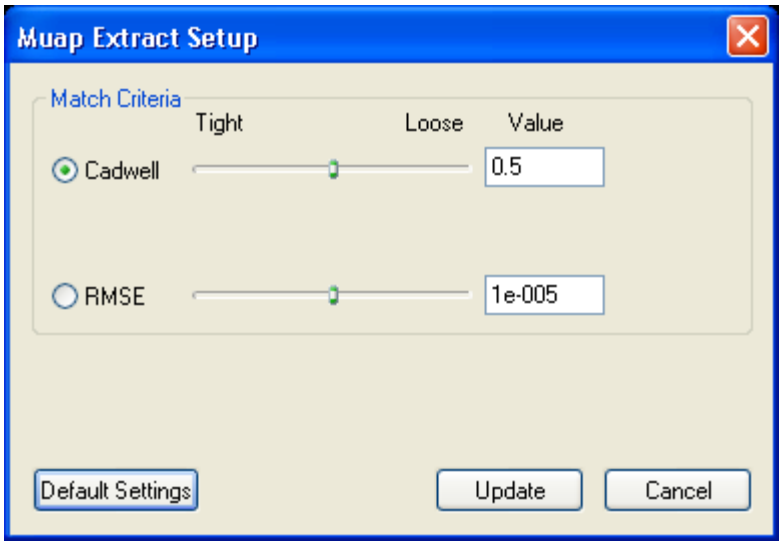
Needle Type – documents the needle type in the results table.

Auto Analyze – when checked, the program automatically analyzes the last 10 seconds of the EMG buffer.

Auto Add Results – when checked, the program will automatically add all sufficient MUPs to the results table.

Extractor Settings button:

Clicking the Extractor Settings button opens the **MUAP Extract Setup** window.



MMUA Extraction Settings

Match Criteria:

The **Cadwell** and **RMSE** (Root Mean Square Error) extractor routines are part of the template matching algorithm used to calculate how closely a candidate MUAP compares to and matches a template MUAP. The smaller the error between the candidate and the template, the closer the match.

The **Cadwell** method compares the candidate and template by computing a sum of differences, point by point, between the two and then divides this sum by the integrated area under the template MUAP. This method takes into account the individual point differences and the overall size and shape of the MUAPs. This is the factory default setting.

The **RMSE** method calculates how much the candidate deviates from the template by computing the sum of the squared differences, point by point, between the two and then taking the square root of the sum. This is closely related to statistical standard deviation.

The slider bars can be used to increase (tighten) or decrease (loosen) the amount of acceptable error between the template and the candidate.

Printing MMUA Results

MMUA results can be included in reports by either of the methods described below.

Method #1: Automatic using a designated QuickReport template.

Launch QuickReport and select a template that contains the report items needed in order to include the MMUA results. The factory default template "MMUA Report" is one example.

 The two report items needed in the template are the Sierra item "MMUA Tables" and the Sierra item "MMUA Waves".

Method #2: Manual copy & paste into a report.

To Copy & Paste the trace bins:

From the MMUA Results Tab

- Right click over any one of the MUP traces.
- From the pop-up menu, select **Copy All Bins**.
- Start QuickReport or Word.
- Right click within the report document and select **Paste**.

To Copy & Paste the results table:

From the MMUA Results Tab

- Right click over any row in the Results Table.
- From the pop-up menu, select **Copy**.
- Start QuickReport, Word, or Excel.
- Right click and select **Paste**.

Deleting MMUA Results

To delete the MMUA results for a muscle:

- **Right click over the MMUA node** in the Study window.
- From the pop-up menu, select **Delete**.
- Click **OK** to the warning message that is displayed.

MMUA References

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Sanjeev D. Nandedkar and Paul E. Barkhaus

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Edited by Tulio E. Bertorini

Butterworth Heinemann Publisher, 2002

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Erik Stalberg, Sanjeev Nandedkar, Donald B. Sanders, Bjorn Falck

Journal of Clinical Neurophysiology

13(5): 401-422 Lippincott Raven Publishers, Philadelphia, 1996

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Christian Bischoff, MD, Erik Stalberg, MD, Bjorn Falck, MD, and Karin Edebol EEG-Olofsson.

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August 1994

Multi-MUP EMG Analysis in Clinical Routine

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Sanjeev D. Nandedkar, PhD, Paul E. Barkhaus, MD, and Alison Charles, BA

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Erik Stalberg, Steen Andreassen, Bjorn Falck, Heikki Lang, Annelise Rosenfalck, and Werner Trojaborg

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3(4):313-348, Raven Press, New York, 1986

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Kevin C. McGill and Leslie J. Dorfman

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EMG Single Motor Unit Analysis (SMUA)

Performing Single Motor Unit Analysis

Single Motor Unit Analysis (SMUA) is an extension of the EMG Capture mode and allows captured motor units to be averaged and quantified. The program automatically places cursors on the averaged motor unit response and calculates the following measurments; **Rise Time**, **Amplitude**, **Duration**, **Area**, **Phases**, and **Turns**. Multiple runs can be performed on a muscle with the mean and standard deviation automatically computed for all the measurements.

Follow these steps for performing SMUA Analysis:

1. **Select the EMG Test:**

   - **If a Study has already been selected**, simply click on an EMG muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
   - **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient.

2. **Activate SMUA Analysis mode.**

   Enable SMUA Analysis by performing one of the following.

   - Press the **F8** function key on the PC's keyboard.
   - Click on the **SMUA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
   - Select **Single Motor Unit Analysis** from the **EMG Analysis** menu.

   The display will change to show the SMUA Table window in the location normally occupied by the Muscle Score Table window.

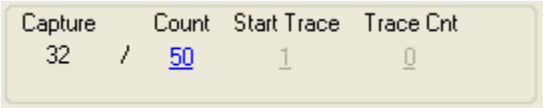
   If you were in Live EMG mode the program will automatically switch to Capture mode when SMUA Analysis is selected.

3. **Position the needle electrode within the muscle.**

4. **Set the capture buffer Count value.**

   The Count value is the total number of traces that can be collected in the SMUA trace buffer. When a motor unit potential crosses the Trigger Line the

trace is added to the trace buffer and the Capture number is incremented by one. The Count can be set to 10, 20, 30, or 50. This setting is located in the EMG Controls window and can be easily changed using the mouse.



5. Adjust the Gain and Sweep Speed.

Adjust the Gain setting so that motor unit potentials do not clip at the top or bottom. Adjust the Sweep Speed setting so that an individual motor unit potential can be displayed, typically 2 - 5 ms/Div.

During EMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

You can also use the mouse to change these settings in the **EMG Controls** window or **Controls Toolbar**.

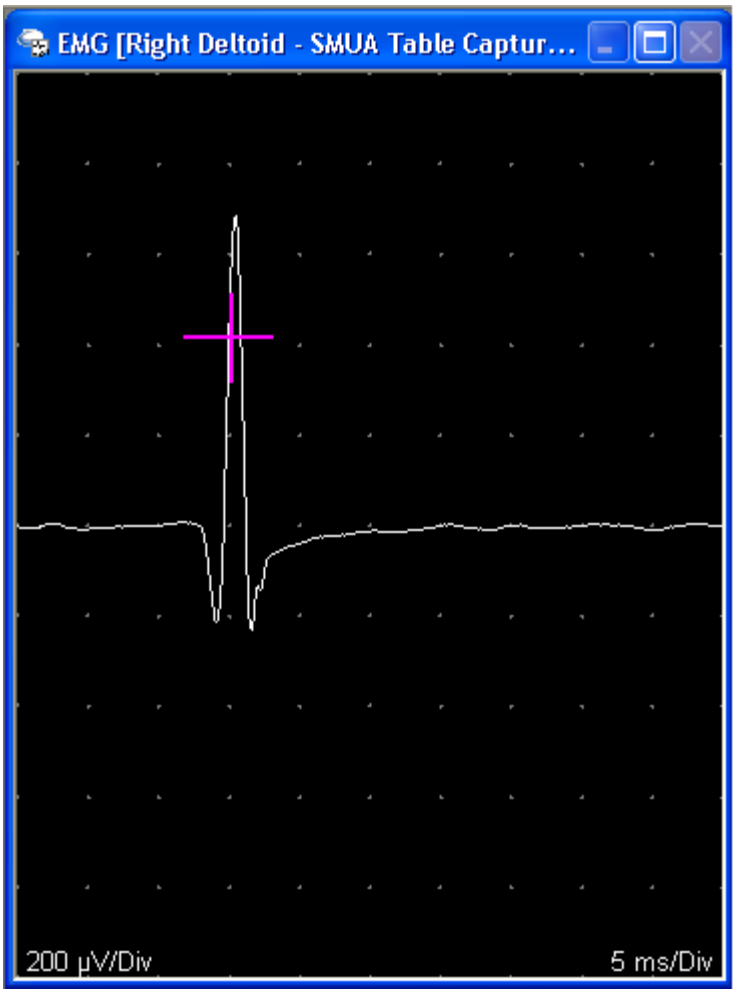
6. Adjust the Trigger Level

In SMUA mode a voltage level trigger and delay marker are displayed within the Trace window. The level of the voltage trigger can be adjusted using **Knob #3 (Trigger Lvl)**. When EMG activity exceeds the trigger level (in either the negative or positive direction) the capture count is incremented and the sweep is captured momentarily and is repositioned with the crossing point at the delay marker. This allows for easier visualization of motor unit potentials.

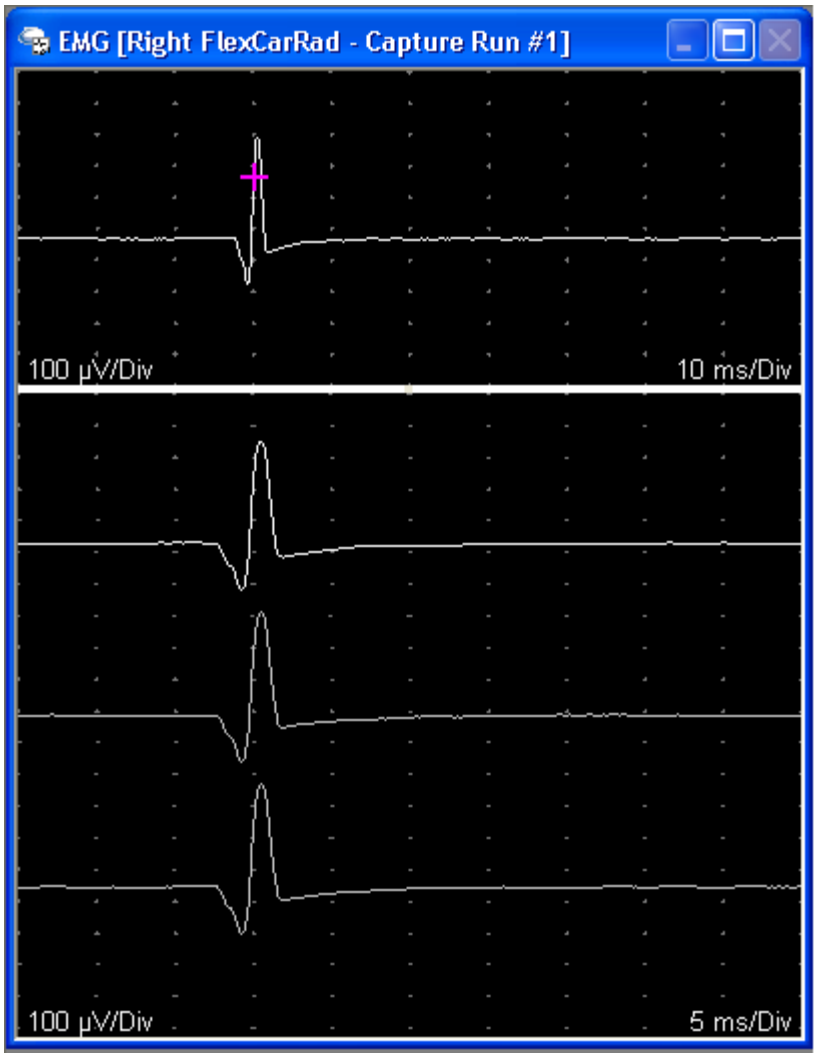
Pressing Knob #3 will activate the **Dual Trigger** feature. In this mode there will be two trigger level markers displayed within the trace window. Only motor unit potentials that exceed the lower trigger level but do not exceed the top trigger level will be captured. This allows small amplitude motor units to be captured in the presence of larger amplitude motor units.

7. Capture Motor Unit Potentials

Acquire motor unit potentials until the buffer Count is reached. The **Clear** key can be used to reset the buffer count to zero at any time.



SMUA Capture mode with Trigger Level marker and Delay at third division.

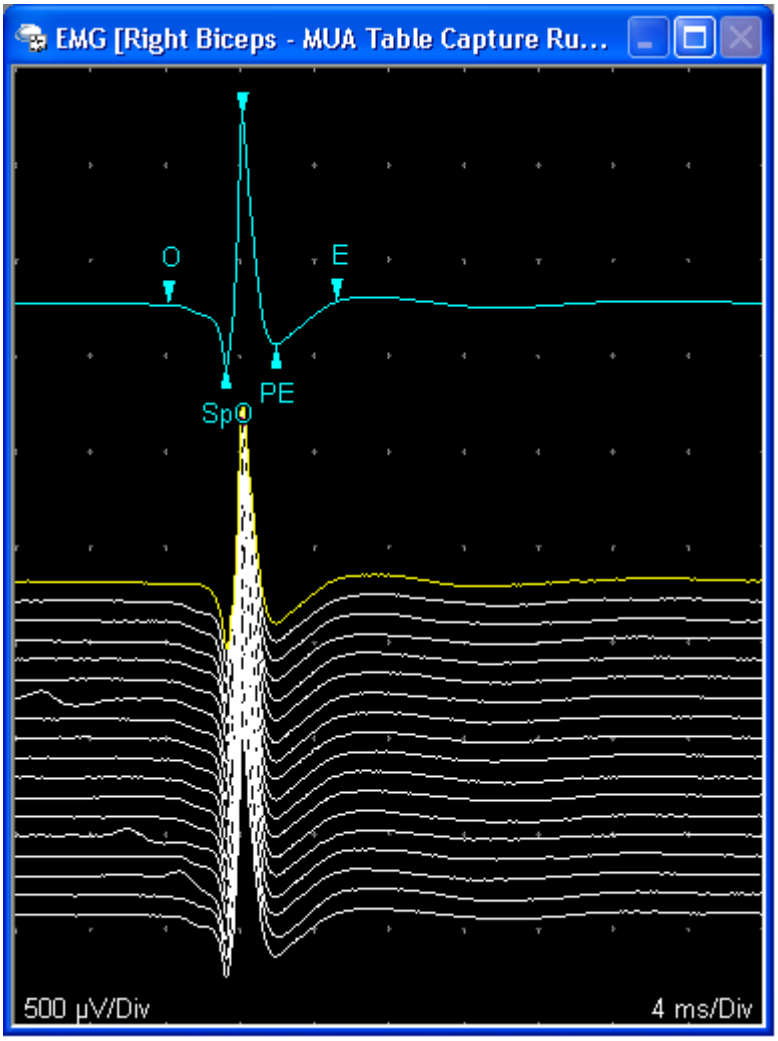


SMUA Capture mode with Capture Window enabled. For more information on the Capture Window, click here.

8. Stop Data Acquisition

Press the **Run/Stop** key on the Sierra Wave base unit to stop data acquisition. This will change the display to the **Data Analysis mode**. The captured traces will be displayed in a rastered format with the resulting average trace displayed at the top in blue color. Cursors are automatically placed on the averaged trace.

The cursors are **Onset (O)**, **Spike Onset (SpO)**, **Peak (P)**, **Peak End (PE)**, and **End (E)**.



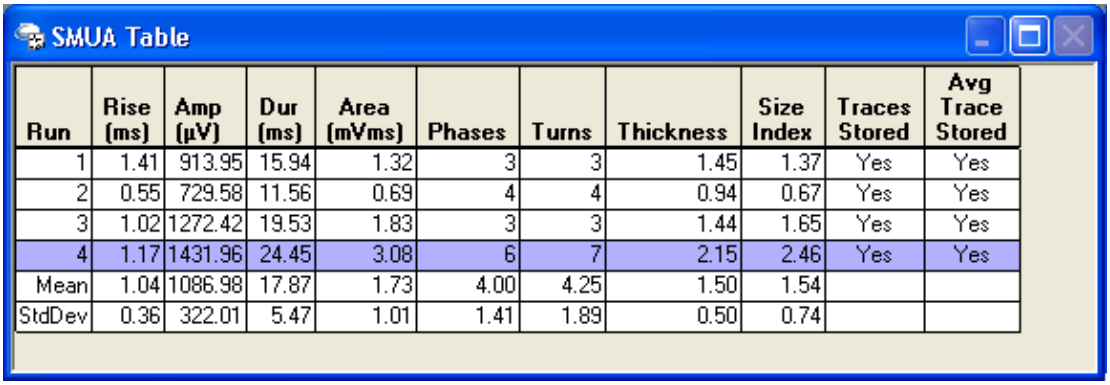
SMUA, data acquisition stopped, average of rastered traces shown at top.

9. Review the Captured Traces and Adjust Cursors.

Knob #4 (Trace Sel /Delete) can be used to delete artifacts from the capture buffer. Simply turn the knob to select the trace, when selected the trace will be displayed in yellow color, press the knob to delete the selected trace. The averaged trace is automatically updated as soon as any captured trace is deleted.

If necessary, use the mouse to adjust the SMUA cursor positions. Simply click on a cursor and drag it along the averaged trace to a new position.

The SMUA Table will display the measurements for the averaged motor unit.



SMUA Table

Run	Rise (ms)	Amp (µV)	Dur (ms)	Area (mVms)	Phases	Turns	Thickness	Size Index	Traces Stored	Avg Trace Stored
1	1.41	913.95	15.94	1.32	3	3	1.45	1.37	Yes	Yes
2	0.55	729.58	11.56	0.69	4	4	0.94	0.67	Yes	Yes
3	1.02	1272.42	19.53	1.83	3	3	1.44	1.65	Yes	Yes
4	1.17	1431.96	24.45	3.08	6	7	2.15	2.46	Yes	Yes
Mean	1.04	1086.98	17.87	1.73	4.00	4.25	1.50	1.54		
StdDev	0.36	322.01	5.47	1.01	1.41	1.89	0.50	0.74		

SMUA Table window.

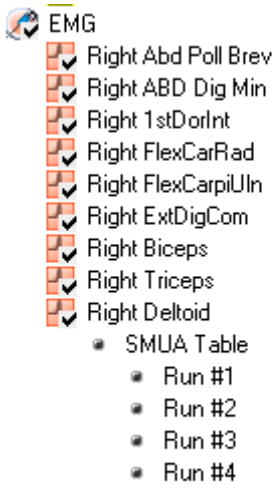
- **Run** - displays the run number.
- **Rise (ms)** - displays the rise time of the motor unit potential, this is the time (in milliseconds) between the spike onset (SpO) and the peak (P) cursors.
- **Amp (uV)** - displays the amplitude of the motor unit potential (in microvolts), this can be measured from the spike onset (SpO) to the peak (P) or from the peak (P) to the peak end (PE) whichever is larger.
- **Dur (ms)** - displays the duration of the motor unit potential, this is the time (in milliseconds) between the onset (O) and the end (E) cursors.
- **Area (mVms)** - displays the full rectified area of the motor unit potential (in millivolt milliseconds) betwen the onset (O) and end (E) cursors.
- **Phases** - displays the number of phases in the motor unit potential. This is calculated as the number of baseline crossings plus one.
- **Turns** - displays the number of turns in the motor unit potential. A turn is any change in direction of the signal that exceeds 50 uV between the onset (O) and end (E) cursors.
- **Thickness** - the Area / Amplitude ratio, typically decreased in myopathy.
- **Size Index** - calculated as 2 x Log_{10} (Thickness).
- **Traces Stored** - a "Yes" indicates that the captured traces for the run have been stored.
- **Avg. Trace Stored** - a "Yes" indicates that the averaged motor unit trace and the measurements associated with it have been stored.

The **Mean** and **Standard Deviation** values are automatically calculated and updated as new runs are added to the SMUA Table.

10. Store the SMUA results.

Press the **Store key** on the Sierra Wave base unit to **keep the run** (i.e., keep the averaged trace and measurements), by default all the captured traces for the run are stored as well. In the **SMUA Table** the "Traces Stored" and "Avg. Trace Stored" fields for the current run will change from No to Yes.

As each SMUA run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows four runs stored for the Right Deltoid muscle.



If you decide not to keep the run, do not press the Store key, simply return to the Acquisition mode by pressing the Run/Stop key and the run will be discarded.

11. Return to Data Acquisition mode and acquire additional motor unit potentials.

Press the **Run/Stop** key to return to **Acquistion mode** and repeat **steps 6 - 10** to acquire additional SMUA runs for the muscle. Up to 20 runs can be acquired per muscle.

12. To Exit from SMUA mode.

To return to Live EMG, perform one of the following.

- Press the **F8** function key on the PC's keyboard.

- Click on the **SMUA** button on the Wave's PC Function Key menu. To enable the function key menu click on the View menu, then select PC Function Menu.
- Select **Analysis Off** from the **EMG Analysis** menu.

Knob & Fkey Controls (SMUA)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether SMUA data acquisition is **running or stopped.** The functions also change when **Cursor mode** is enabled.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Data Acquisition mode:

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Muscle Sel - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window.

Trigger Lvl / Dual Trig - defaults in **Trigger Lvl** mode, turn this knob to move the trigger level indicator up or down within the Trace window. Press this knob to activate the **Dual Trigger** mode. In Dual Trigger mode the trace will be captured if it falls between the two trigger level indicators (useful for capturing small amplitude motor units in the presence of large amplitude motor units)

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the Trace window. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the Trace window.

The Gain and Sweep will automatically reset to default values when a new muscle is selected in the Study window.

F Keys

Live / Capture - press this function key to switch back and forth between **Live** or **Capture** acquisition modes. For SMUA, capture mode should be selected.

Fibs / Recrt - press this function key to switch back and forth between **Fibs** and **Recrt** parameter settings. You can program different Gain and Sweep Speed parameters for these two modes and use this function key to easily toggle between the two.

This function key will automatically reset to the Fibs mode when a new muscle is selected in the Study window.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Data Acquisition Stopped:

Knobs

Run Select - turn this knob to highlight and review stored runs in the MUA Table. When the run is highlighted the traces for that run will be displayed in the trace window.

Muscle Sel - turn this knob to highlight a different muscle name within the EMG test protocol in the Study window.

Start Trace / Trace Cnt - this knob effects how the traces in the SMUA capture buffer are displayed. Turn the knob to change the starting display trace number. Press the knob, then turn to change the trace count number.

Here's an example of how to use the **Trace Cnt** and **Start Trace** settings to view subsets of the capture buffer:

Assume there are 50 total traces in the capture buffer. The Trace Cnt will default to 50 and the Start Trace number will default to 1.

Therefore all 50 traces (1 to 50) are displayed in the Trace window. Now, change the Trace Cnt to 20 and leave the Start Trace number at 1. You will see traces 1-20 displayed in the Trace window. You can now change the Start Trace number to 21, now you can view traces 21-40. Change the Start Trace number again and it goes to 41, now you can view traces 41-50.

Trace Sel / Delete - defaults to the **Trace Sel** mode, turn this knob to select a captured trace. When selected, the trace will be displayed in yellow. Press the knob to **Delete** the selected trace from the capture buffer.

F Keys

Raster / Overlay - press this function key to toggle between displaying captured EMG traces in raster or overlay (i.e., superimposed) modes.

Muscle List - opens the EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Cursor Mode: (data acquisition stopped)

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the averaged SMUA trace. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

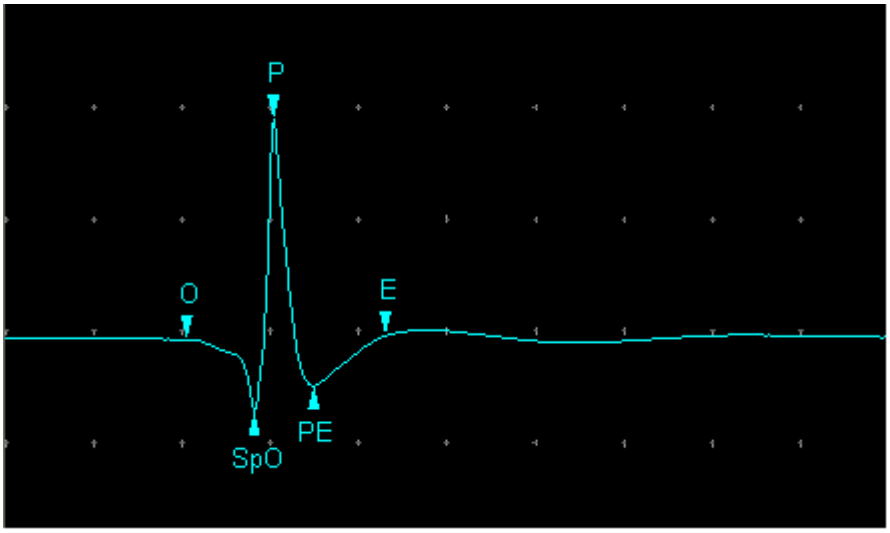
Gain - turn this knob to change the gain of all the traces in the trace window. The current gain setting for the window is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the averaged SMUA trace.

SMUA Cursors

Cursors are automatically placed on the averaged SMUA trace. The cursors are Onset (**O**), Spike Onset (**SpO**), Peak (**P**), Peak End (**PE**), and End (**E**).



SMUA averaged trace.

To adjust the positions of the Cursors, follow one of these procedures.

- **Using the Knobs** - press the **F5 (Cursor) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

  After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

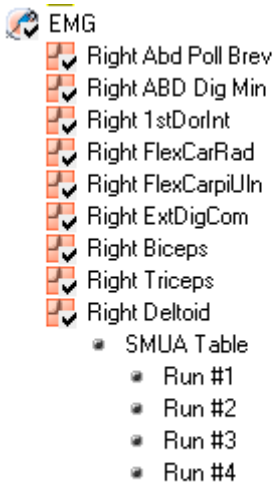
- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.

Measurements in the MUA Table are updated automatically when the cursor positions are changed.

Storing SMUA Results

Press the **Store key** on the Sierra Wave base unit to **keep the SMUA run** (i.e., keep the averaged trace and measurements), by default all the captured traces for the run are stored as well. In the **SMUA Table** the "Traces Stored" and "Avg. Trace Stored" fields for the current run will change from No to Yes.

As each SMUA run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows four runs stored for the Right Deltoid muscle.



Deleting a Run

To **Delete** a stored SMUA run, follow these steps.

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted and the mean and standard deviation values in the MUA Table are automatically re-calculated.

EMG Guidance

EMG Guidance Basics

Select the EMG Guidance Test:

- **If a Study has already been selected**, simply click on an EMG Guidance muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name. Notice that as soon as any muscle is selected within the EMG Guidance test protocol, all the muscles are automatically added to the muscle injection table.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual EMG Guidance test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that as soon as any muscle is selected, it is displayed within the Study window and is automatically added to the muscle injection table.

The **Automatic Log Muscle** feature can be disabled in the **EMG Guidance Test Setup** window. When this feature is disabled the muscles in the Study window are not automatically added to the muscle injection table. You will need to use the **F2 (Muscle Sel/Add to Log)** knob or the **Left mouse button** to manually add the appropriate muscles to the injection table.

Once the muscle has been selected. Follow these steps for performing routine EMG Guidance data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate.

   Typical Settings for EMG Guidance

   Gain = 100 or 200 uV/Div

   Hicut = 10k Hz

   Locut = 10 - 30 Hz

   Sweep Speed = 10 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

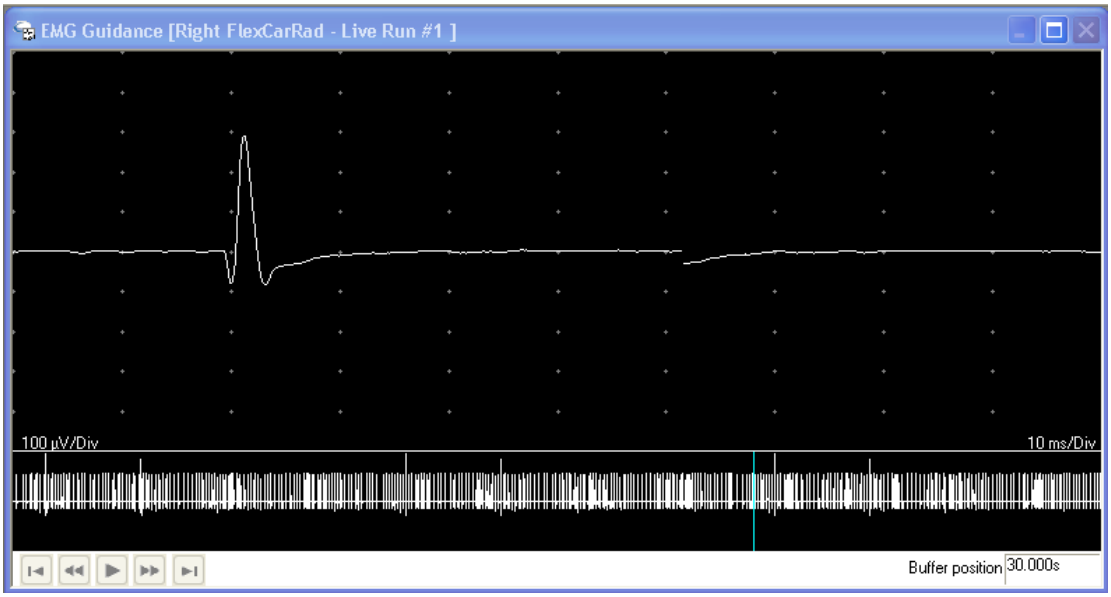
3. **Insert the Needle Electrode**

4. **Adjust Volume**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume Knob** on the left hand side of the base unit.

5. **View Live EMG**

   Free-running EMG is displayed in the Trace window and a compressed view of the EMG Live Buffer is displayed below this. A moving blue marker shows the current position within the buffer. At any time data acquisition can be stopped and the data in the Live Buffer can be reviewed or played back (see step #7 below).



EMG - Live mode

6. **Adjust Gain & Sweep**

   During EMG Guidance data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

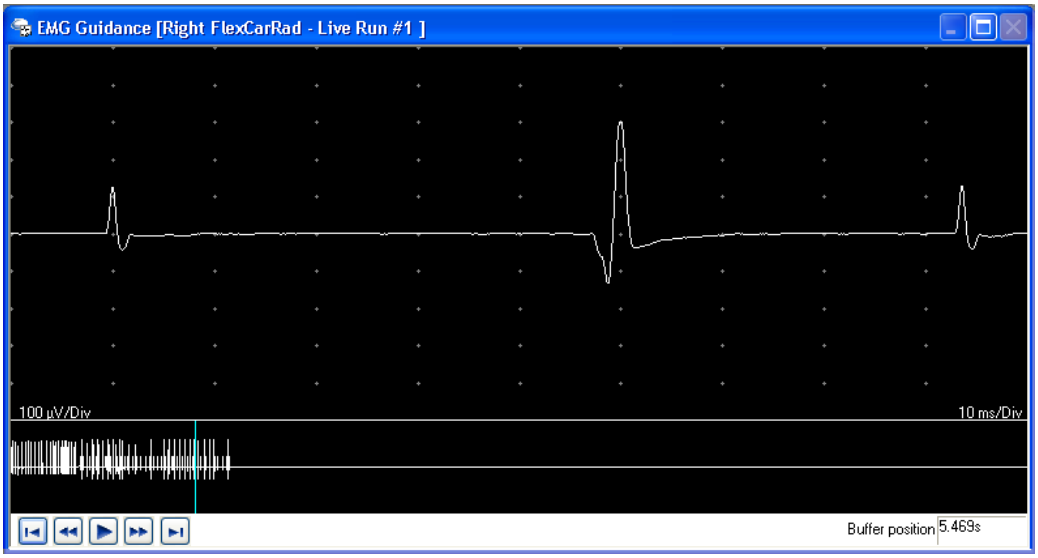
   You can also use the mouse to change these settings in the **Controls Toolbar**.

7. **Stop Data Acquisition and Review (optional)**

   To stop data acquisition press the **Run/Stop key** on the **Sierra Wave base unit.**

Stopped Live EMG:

Review the Live Buffer - move backwards and forwards in the Live EMG buffer by turning **Knob #1 (Review / Play-Stop)**, press the knob to replay the buffer. You can also review by dragging the blue marker back and forth within the compressed buffer area using the mouse.



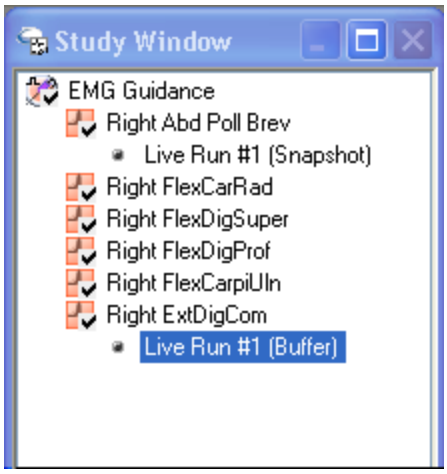
EMG - Stopped Live mode

Store a Snapshot - press the **F1 (Store Snap Shot)** function key or the **Store key** on the Sierra Wave base unit to store the currently displayed sweep. The stored sweep will be displayed in purple.

Store the entire Live Buffer - press the **F2 (Store Live Buffer)** function key. The trace will be displayed in blue indicating that the entire buffer has been stored.

Prior to storing any EMG traces, Use **Knob #2 (Muscle Sel)** to highlight the correct muscle name in the Study window. This will ensure that the EMG data will be stored with the correct muscle name.

As EMG is stored, you will see a new **node** appear in the Study window below the muscle name. This indicates what has been stored for this muscle. The example below shows a Snapshot stored for the Right Abd Poll Brev muscle, and a Live Buffer stored for the Right ExtDigCom muscle.



Example of stored EMG Guidance nodes in the Study window.

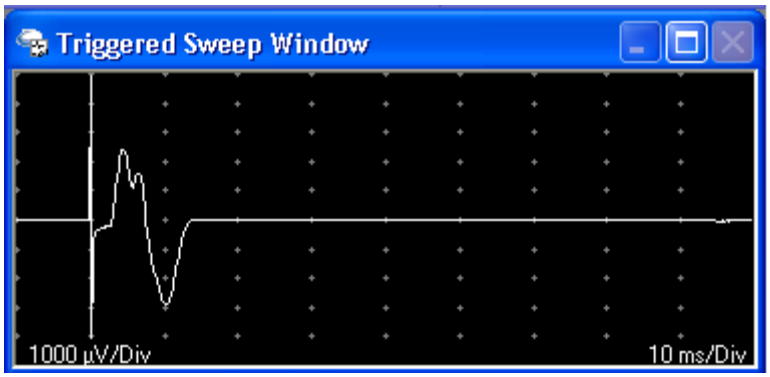
8. Return to Data Acquisition Mode

If you stopped data acquisition, press the **Run/Stop key** on the **Sierra Wave base unit** to resume data acquisition.

9. Stimulate through the Needle Electrode (optional)

In some cases the muscle can be better localized by stimulating through the injectable needle while simultaneously recording surface EMG over the intended muscle.

- Connect the **injectable needle** electrode to the **cathode (-)** of the electrical stimulator.
- Connect a **surface electrode** to the **anode (+)** of the electrical stimulator.
- Place **surface electrodes over the intended muscle** and connect to **Act 1** and **Ref 1** on the amplifier.
- Press the **Stim button** on the electrical stimulator to deliver a single stimulus, or press the **F1 (Stim OFF / Stim ON)** function key to initiate repetitive stimulation, through the injectable needle.
- Adjust the stimulus intensity using the wheel on the electrical stimulator or **Knob #3 (Intensity / Pulse Width)**.
- The surface recorded EMG will be displayed in both the **Live EMG window** and the **Triggered EMG window**. The Triggered EMG window is only activated when the electrical stimulation is enabled.



Triggered EMG window.

The Triggered EMG window has a 1 division sweep delay.

10. Inject the Muscle.

Please refer to the appropriate guide for the amount of Botox or Myobloc to inject.

11. Modify Muscle Injection Table

With the **Automatic Log Muscle** feature enabled, as soon as a muscle is selected in the Study window, or added to the Study window using the **F3 (Muscle List)** function key, it is automatically added to the **Muscle Injection Table**.

To change the muscle injection data for a muscle:

- Turn **Knob #3 (Score Table / Modify)** until the highlight is over the field that you want to change, press the knob to pop up a list of choices, turn the knob to highlight one of the choices and press again to select it.
- Using the **left mouse button**, click on the field that you want to change. From the pop up list of choices click again to make a selection.

Muscle Injection Table

Side	Muscle	Nerve	Root	BTX-Type	Lot #	# Sites Injected	Location	# Units/Site	Comments
Right	Abd Poll Brev	Median	C8-T1	BTX-A (Botox)	1234	2	Prox+Mid	50/75	
Right	FlexCarRad	Median	C6-7	BTX-A (Botox)	1234	1	Proximal	75	
Right	FlexDigSuper	Median	C7-8	BTX-A (Botox)	2345	2	Prox+Dist	25/25	
Right	FlexCarpiUln	Ulnar	C8,T1	BTX-A (Botox)	2345	2	Mid+Dist	25/50	
Right	ExtDigCom	Radial (Post Int)	C7-8	BTX-A (Botox)	3456	1	Middle	50	
Right	FlexDigProf	Ulnar	C8,T1	BTX-A (Botox)	3456	1	Distal	50	

12. Select Next Muscle

Turn **Knob #2 (Muscle Sel / Del from Log)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the muscle from the list.

Move the Needle Electrode to the new muscle and repeat the above steps as necessary.

 It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

13. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Injection table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected tests traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

14. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the Sierra Wave base unit and select a Test Protocol from the **Study/Test** menu.

EMG Guidance Test Setup

EMG Guidance test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here to go to this topic.

Amplifier / Stimulator Switch Box

EMG guidance can be utilized to help the clinician accurately localize the muscle or nerve injection site and to monitor activity after the delivery of the medicinal product. Guidance can be in the form of live EMG activity & audio from the injection needle or by electrical stimulation through the injection needle.

For live EMG guidance the hypodermic needle is connected to the EMG amplifier's (-) input with a reference electrode placed on the surface and connected to the amplifier's (+) input.

For Electrical Stimulation guidance the hypodermic needle is connected to the cathode (-) of the electrical stimulator with the reference electrode connected to the anode (+).

The Cadwell Amp/Stim Switch Box eliminates the need to manually move the injection needle and reference electrode from the amplifier to the electrical stimulator. A 2-position switch allows the injection needle & reference electrode to be routed to either the amplifier or stimulator inputs.

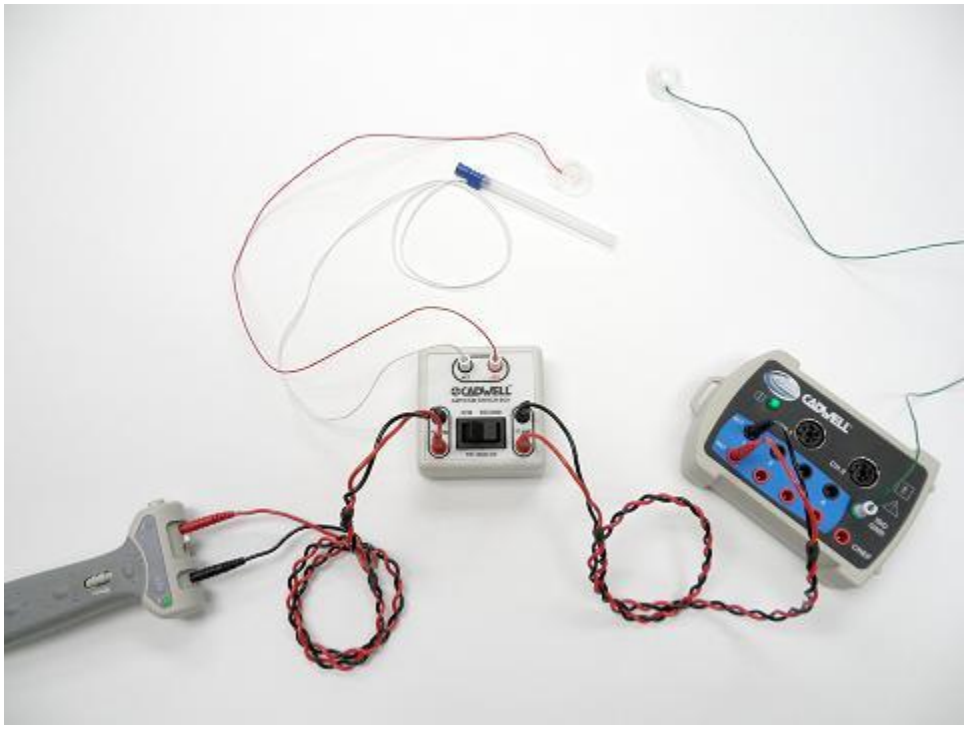
Top view of Amp/Stim Switch Box, switch in the Record position.

Ordering Information:

The Amp/Stim Switch Box Kit (Part number 9732022) contains the following items:

QTY	DESCRIPTION	PART NUMBER
1	Amp/Stim Switch Box	190266-200
2	Interconnect Cable, 24 inch, Red & Black Twisted, 1.5 mm safety DIN each end.	302785-000
1	Amp/Stim Switch Box Instructions	190266-620

Diagram of Connections:



Connect the injection needle to the ACT (black) input on the switch box. Connect the recording reference electrode to the REF (red) input on the switch box. Connect the patient ground electrode to the amplifier's ground input.

Remove the probes from the end of the stimulator; this is done by pulling them straight out. Connect the first interconnect cable from the black and red STIM inputs on the switch box to the cathode (-) and anode (+) of the electrical stimulator respectively. The Cathode is indicated by the green LED.

Connect the second interconnect cable from the black and red TO AMP inputs on the switch box to the amplifier's channel 1 Active and Reference inputs respectively.

Position the Amp/Stim Switch Box, Electrical Stimulator, and Amplifier in a convenient location.

Start with the Switch Box in the RECORD position.

Operation of the Amp/Stim Switch Box:

For live EMG – set the switch to the **RECORD** position.

For electrical stimulation – set the switch to the **STIM** position, and then enable electrical stimulation and adjust the stimulation current. Note: In the Stim position the recording inputs are shorted.

 This device does not provide patient isolation.

 This device is not intended for patient contact.

Storing a Live Snapshot

1. Stop EMG Guidance data acquisition by pressing the **Run/Stop key** on the **Sierra Wave base unit**.

   Data acquisition will be stopped and the last complete sweep of EMG Guidance data will be displayed.

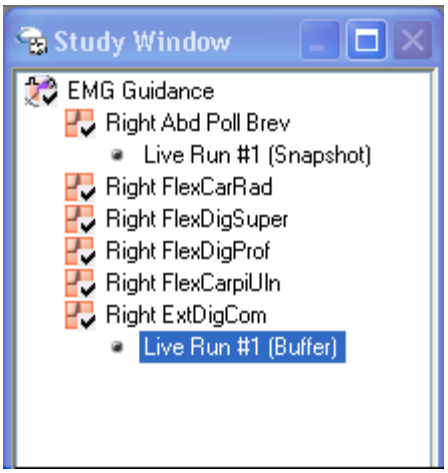
2. Move backward or forward within the EMG Guidance buffer until the trace that you want to store is displayed.

3. Verify that the correct muscle name is highlighted in the Study window. If necessary, use **Knob #2 (Muscle Sel / Del from Log)** to highlight a different muscle name.

4. Store the snapshot by performing one of the following actions,

   - Press the **F1 (Store Snap Shot)** function key on the **Sierra Wave base unit**.
   - Press the **Store key** on the **Sierra Wave base unit**.
   - Press the **Store button** on the **Electrical Stimulator handle.**

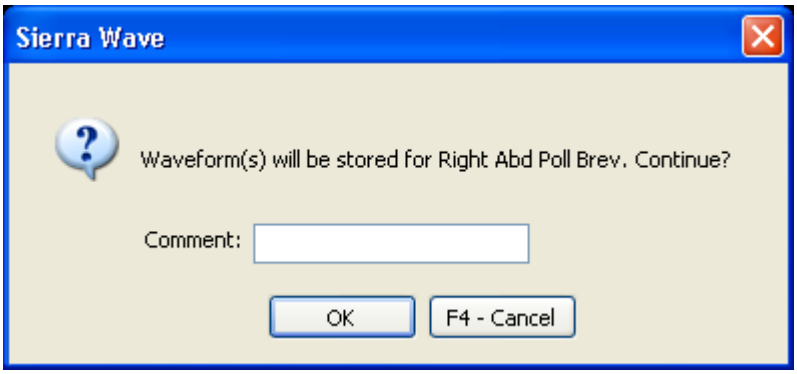
5. The stored EMG Guidance snapshot will be displayed in purple color and an entry will appear underneath the currently selected muscle name in the Study window.



Study window showing stored EMG snapshot for the Right Abd Poll Brev muscle.

6. Return to EMG Guidance data acquisition mode by pressing the **Run/Stop key** on the **Sierra Wave base unit**.

If the **Confirm Store Commands** option is enabled for the EMG Guidance test protocol, the program will display a confirmation window whenever a Live Snapshot or Live Buffer are stored. This ensures that the data is stored with the correct muscle name and side and provides a place for a comment to be entered as well.



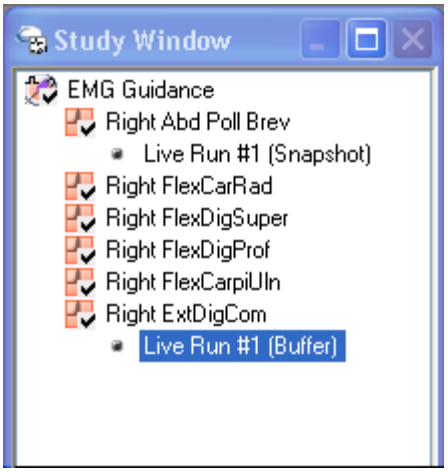
Storing a Live Buffer

1. Stop EMG Guidance data acquisition by pressing the **Run/Stop key** on the **Sierra Wave base unit**.

   Data acquisition will be stopped and the last complete sweep of EMG Guidance data will be displayed.

2. Verify that the correct muscle name is highlighted in the Study window. If necessary, use **Knob #2 (Muscle Sel / Del from Log)** to highlight a different muscle name.

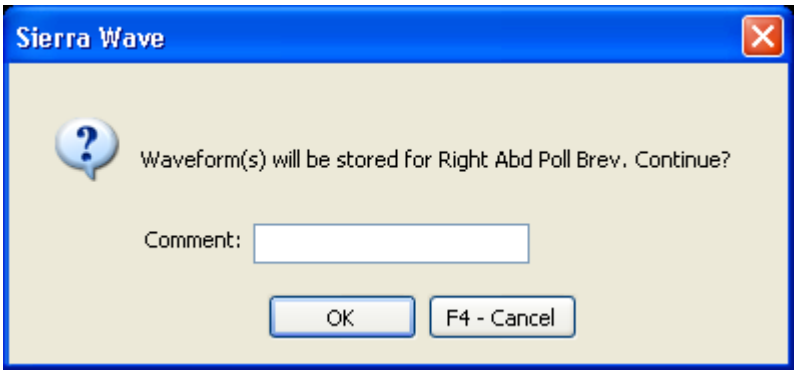
3. Store the EMG Guidance Buffer by pressing the **F2 (Store Live Buffer)** function key on the **Sierra Wave base unit**.
4. The EMG Guidance trace color will change from white to light blue to indicate that the buffer has been stored and an entry will appear underneath the currently selected muscle name in the Study window.



Study window showing stored buffer for Right ExtDigCom muscle.

5. Return to EMG Guidance data acquisition mode by pressing the **Run/Stop key** on the **Sierra Wave base unit**.

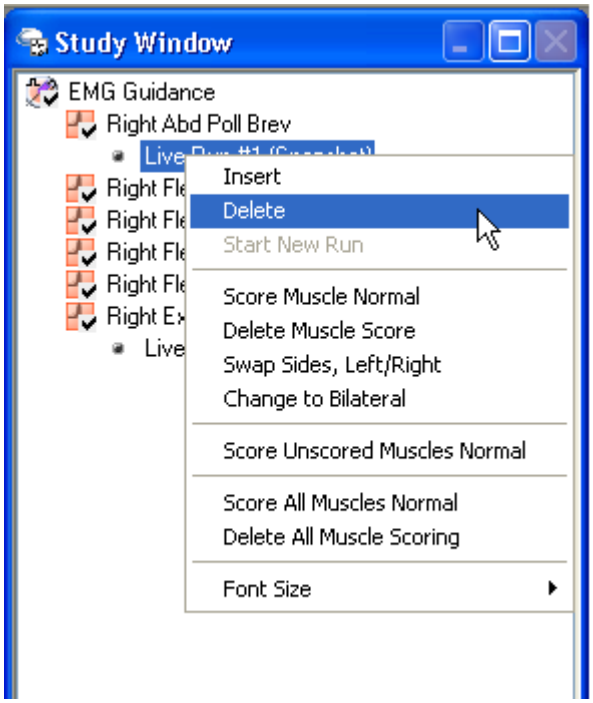
If the **Confirm Store Commands** option is enabled for the EMG Guidance test protocol, the program will display a confirmation window whenever a Live Snapshot or Live Buffer are stored. This ensures that the data is stored with the correct muscle name and side and provides a place for a comment to be entered as well.



Deleting a Snapshot or Buffer

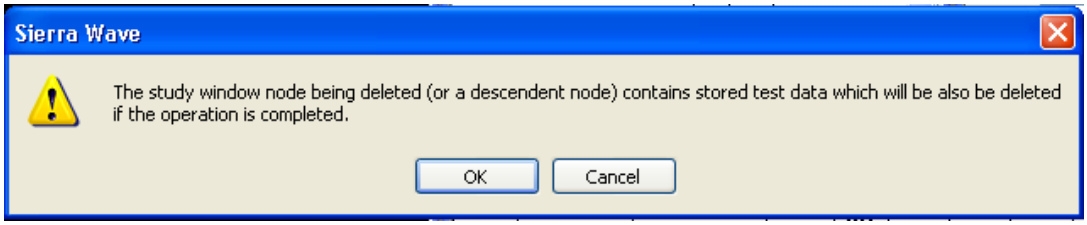
1. **Right click** the mouse over the stored **Snapshot**, **Live Buffer**, or **Capture run** in the Study window.

2. From the pop-up menu select **Delete**.



Right click and select Delete.

3. A confirmation message will be displayed, select **OK**.



Muscle Injection Table

EMG Guidance Muscle Injection Table

With the **Automatic Log Muscle** feature enabled, as soon as **any EMG Guidance muscle** is selected within the Study window, or is added to the Study window using the **F3 (Muscle List)** function key, it is automatically added to the **Muscle Injection Table**.

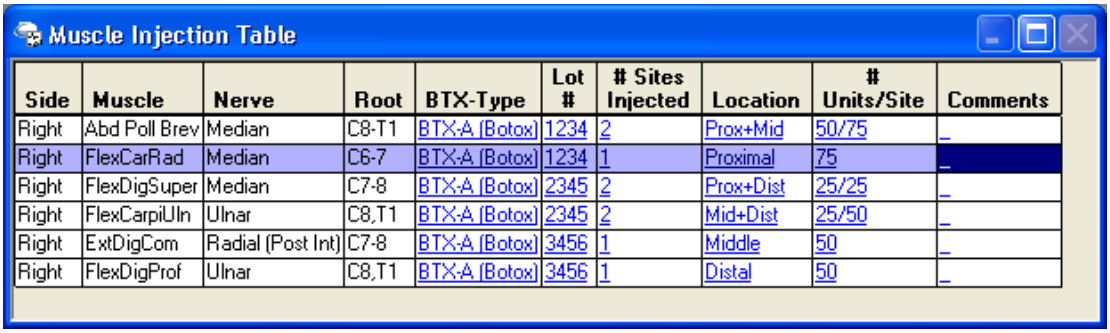
The **Automatic Log Muscle** feature can be disabled in the **EMG Guidance Test Setup** window. When this feature is disabled the muscles in

the Study window are not automatically added to the muscle injection table. You will need to use the **F2 (Muscle Sel/Add to Log)** knob to manually add the appropriate muscles to the injection table.

Modifying Injection Data

To change the Injection Data for a muscle,

- Turn **Knob #3 (Score Table / Modify)** until the highlight is over the scoring field that you want to change, **press the knob** to pop up a list of choices, **turn the knob** to highlight one of the choices and press again to select it.
- Using the **left mouse button**, click on the scoring field that you want to change. From the pop up list of choices click again to make a selection.



Side	Muscle	Nerve	Root	BTX-Type	Lot #	# Sites Injected	Location	# Units/Site	Comments
Right	Abd Poll Brev	Median	C8-T1	BTX-A [Botox]	1234	2	Prox+Mid	50/75	
Right	FlexCarRad	Median	C6-7	BTX-A [Botox]	1234	1	Proximal	75	
Right	FlexDigSuper	Median	C7-8	BTX-A [Botox]	2345	2	Prox+Dist	25/25	
Right	FlexCarpiUln	Ulnar	C8,T1	BTX-A [Botox]	2345	2	Mid+Dist	25/50	
Right	ExtDigCom	Radial (Post Int)	C7-8	BTX-A [Botox]	3456	1	Middle	50	
Right	FlexDigProf	Ulnar	C8,T1	BTX-A [Botox]	3456	1	Distal	50	

Muscle Injection Table

Deleting a Row from the Muscle Injection Table

To delete a row from the Muscle Injection Table, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Del from Log)** until the muscle you want to remove from the Muscle Injection Table is **highlighted** in the Study window, then **press the knob** and the corresponding row in the table will be deleted.
- **Right click** the mouse over **the row** you want to delete, then select **Delete Row** from the pop-up menu.

When a muscle is deleted from the Muscle Injection Table the checkmark next to the muscle name in the Study window is also removed.

Deleting all Rows from the Muscle Injection Table

To delete all rows from the Muscle Injection Table, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Delete from Log)** until the muscle name you want to remove from the Muscle Injection Table is **highlighted** in the Study window, then **press the knob** to delete the row. Repeat this process until all the rows are deleted.
- **Right click** the mouse over any row in the Muscle Injection Table, then select **Delete All Rows** from the pop-up menu. A confirmation message will be displayed, select **OK**.

 When a muscle is deleted from the Muscle Injection Table the checkmark next to the muscle name in the Study window is also removed.

Adding a Muscle that has been deleted from the Muscle Injection Table

To add one muscle, perform one of the following.

- **Turn Knob #2 (Muscle Sel / Add to Log)** to **highlight** the **muscle name** in the Study window. **Press the knob** to add the muscle to the injection table.
- **Right click** the mouse over the **muscle name** in the Study window. From the pop-up menu select **Score Muscle Normal**.

To re-add all muscles.

- **Right click** the mouse over any **muscle name** in the Study window. From the pop-up menu select **Score All Muscles Normal**.

Sorting the Muscle Injection Table

Initially, the muscles are added to the injection table in the same order that they are listed in the Study window.

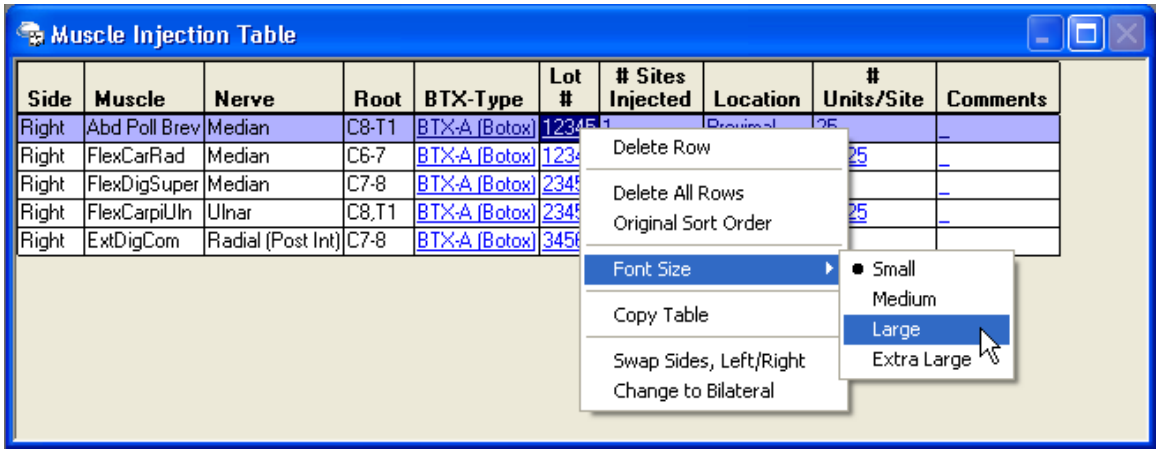
Single click on the **column heading** (e.g. # Sites Injected) to sort the table by the entries in that column. Sorting priority is first by number (0-9), then alphabetically (a-z).

Restoring Original Sort Order

Right click the mouse on any row in the Muscle Injection Table and select **Original Sort Order** from the pop-up menu.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply right click on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Injection Table.

Swap Sides

To swap the side parameter on a muscle, perform one of the following.

- **Right click** the mouse over the **muscle name** in the **Study window**. From the pop-up menu select **Swap Sides, Left/Right**.
- **Right click** the mouse over the corresponding **row in the Muscle Injection Table**. From the pop-up menu select **Swap Sides, Left /Right**.

If the muscle was listed only **once** in the Study window, then it will be swapped to the opposite side.

If the muscle was listed in the Study window **twice**, as a right sided muscle and as a left sided muscle, then both the entries will have their side parameter swapped. You can never have more than one Right or Left sided muscle in the Study window.

If the muscle being swapped contains stored data (i.e., a snapshot or buffer), the data is also moved to the opposite side.

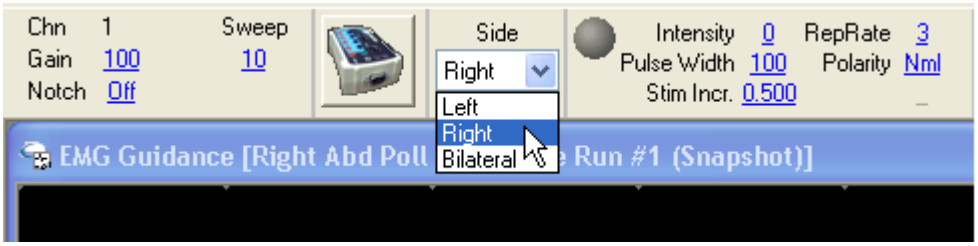
Change Sides

Changing the Side parameter for a muscle is different than Swapping Sides. When you change sides, the highlight moves from the currently selected muscle in the Study window (e.g. Right Abd Poll Brev) to the same muscle but with the opposite side (e.g., Left Abd Poll Brev).

If the muscle corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **EMG Guidance Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



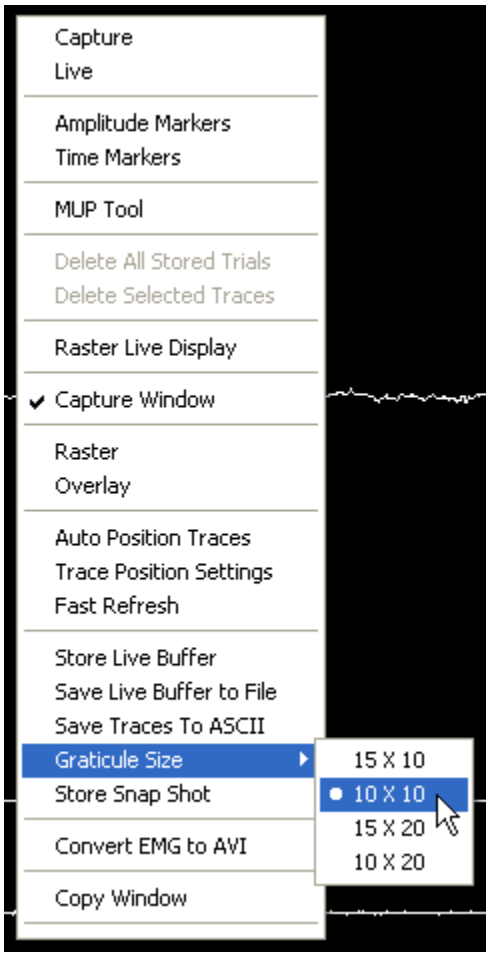
Graticule Size

The EMG Guidance Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions.

To Change the EMG Guidance Trace window Graticule Size during an exam:

- **Right click** on the **EMG Guidance Trace** window.
- From the pop-up menu, highlight **Graticule Size**, a second level pop-up menu will be displayed.

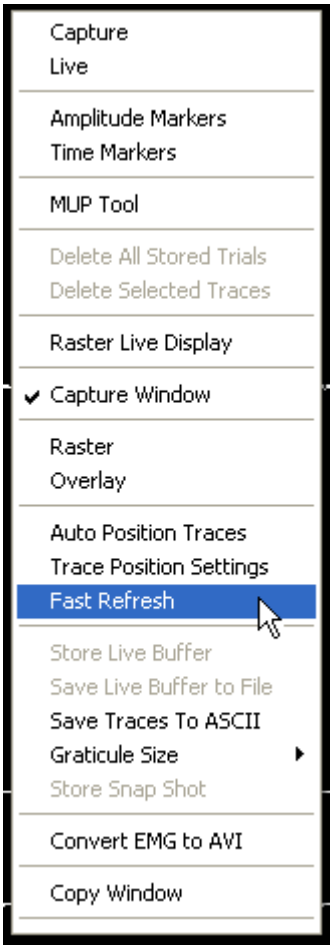
- **Choose one** of the listed selections. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.



Graticule size selections for EMG Guidance Trace window.

Fast Refresh Rate

This feature changes the drawing of the EMG Guidance trace so that it appears more like an oscilloscope display. Simply right-click over the EMG Guidance Trace window and select **Fast Refresh** from the pop-up menu. This setting adds a 2 division 'gap' and updates the trace at 60 Hz. When this setting is disabled the trace is drawn with no gap and refreshes at 15 Hz.



Enable Fast Refresh Rate for EMG Guidance trace.

Saving Changes to EMG Guidance Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the EMG Guidance Test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

NCV

NCV Basics

This topic is a repeat of the basic NCV steps found in the **Getting Started** chapter.

Select the NCV Test:

- **If a Study has already been selected**, simply click on a nerve name (i.e., Right Median Motor) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual NCV test protocol from the **Study/Test** menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing routine NCV data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the nerve being tested.

Typical Settings

	Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
Motor Nerves	2k to 5k	10k	10	5.0
Sensory Nerves	10 to 20	2k	10	2.0

2. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Verify Stimulation Sites and Segments**

   The selected nerve's recording site name, stimulation site names, and defined segments are shown within the **NCV Tables** window.

Nerve name and recording site name.

The **Site table** displays the stimulation site names, one per row. This table will display the onset or peak latency, amplitude measurements, duration and area measurements, and normal values. By default, the first stimulation site's row is highlighted as soon as the nerve is selected. The name of this site also appears on the active (white) trace's label.

Site	NR	Onset (ms)	Norm Onset (ms)	O-P* Amp (mV)	Norm O-P Amp
Wrist	_	3.9	<4.2	13.3	>5
Elbow	_	9.7	_	12.6	_
Axilla	_	11.6	_	12.1	_
Erbs	_		_		_
_	_		_		_

Site table with third stimulation site selected.

The **Segment table** displays the segments over which velocity calculations are to be made. Each row in this table represents one segment. This table has a column for entering distances and for displaying the calculated and normal velocity.

Site1	Site2	Delta-0 (ms)	Dist (cm)	Vel (m/s)	Norm Vel (m/s)
Elbow	Wrist	5.8	30.0	52	>50
Axilla	Elbow	1.9	12.0	63	_
Erbs	Axilla		0.0		_
_	_		0.0		_

Segment table.

4. Electrode Placement

Attach the electrodes to the patient.

5. Check Stimulator Polarity

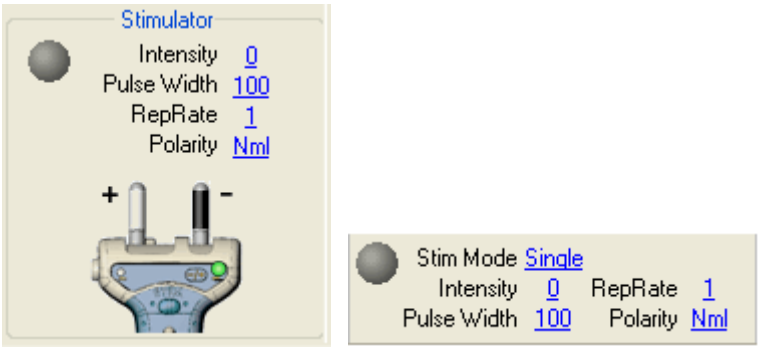
For Nerve Conductions Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **NCV Controls** window or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with

the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

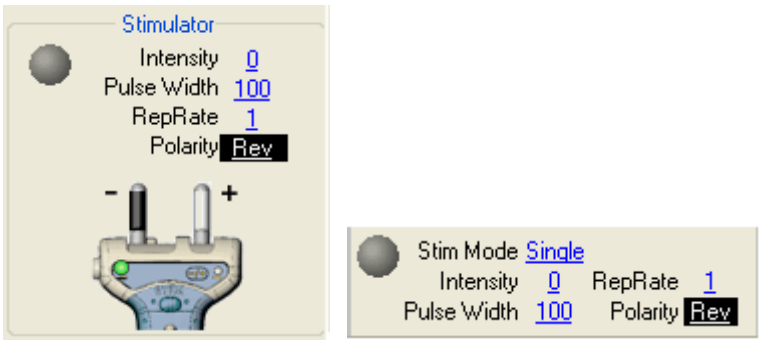
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

6. Stimulate the first Site

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

The **Single key** on the Sierra Wave base unit can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

Continue to increase the intensity level and stimulate until a supra-maximal response is acquired. If the response is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain /Sweep)** on the Sierra Wave base unit.

8. If necessary, Adjust Auto Cursors

Auto Cursors are placed on the response as soon as it is displayed. The cursors are **Onset (O)**, **Peak (P)**, **Trough (T)** and **Recovery (R)**. The configuration of the Site and Segment tables determines which of the four cursors are placed on the trace. The positions of these cursors can be adjusted by performing one of the following actions;

- By using **Knob #2 (Sel Cursor / Move Cursor)** on the Sierra Wave base unit.
- By clicking on them with the **left mouse button** and dragging them to their new position.

For the correct placement of the auto-cursors the response must meet or exceed certain amplitude and slope criteria. When these criteria are not met the cursors will be placed on the response in the following pattern.

Pattern of auto-cursor placement when amplitude criteria is not met.

The Peak (P) cursor will be positioned at the third division with the Onset (O) cursor placed one-quarter division in front and the Trough (T) and Recovery (R) cursors placed one-quarter and one-half division respectively following it. If you believe that there is a response present you can move the cursors to their appropriate positions, or if there really is no response present, you can mark the response as "NR" in the Site table.

9. Store the Response

To store the response and advance to the next stimulation site, perform one of the following actions;

- Press the **Store button** on the **Electrical Stimulator handle**.
- Press the **Store key** on the **Sierra Wave base unit**.
- Press the **Footswitch** pedal (assuming the pedal is programmed for the Store function).
- Click the **Store button** in the **NCV Controls** window.

When the response is stored the color of the trace changes from **white to purple** and the next row in the Site table is automatically highlighted.

If the nerve has only one stimulation site, it is not necessary to store the response. The Sierra Wave will automatically keep the trace when you change nerves or test protocols.

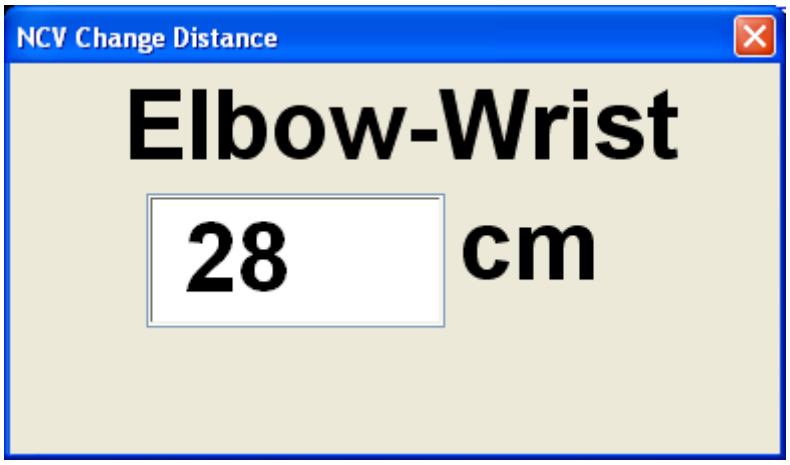
10. Stimulate and Store Additional Sites

Continue to stimulate and store additional sites on the nerve.

11. Enter Distance to calculate Velocity

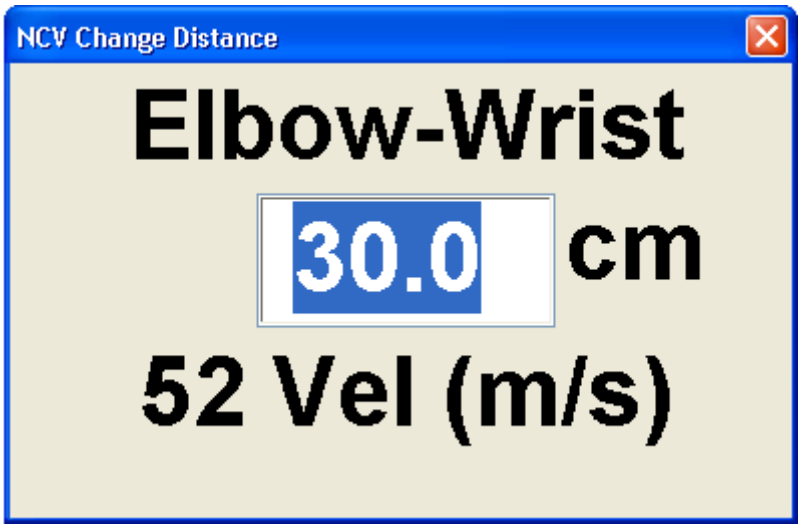
Measure the distances for each segment and enter the values (in centimeters) into the segment table. There are two ways to enter the distance.

- Press the **Distance key** on the **Sierra Wave base unit** or **click** on the appropriate distance field with the **mouse**. The first distance field will become activated and a small pop-up window is displayed showing the segment name and a place for the distance measurement, type the distance value and then press the **Enter key**. *You can also press the Distance key a second time instead of pressing the Enter key.*



Distance pop-up window.

- Press **Programmable button #1** on the **Electrical Stimulator handle**. A small pop-up window is displayed showing the segment name, distance value, and velocity. Now, **turn the wheel on the stimulator handle to increase or decrease the distance value in 0.5 cm increments**. When the correct distance value is reached, press **Programmable button #1** a second time or press the **Enter key**.



Distance pop-up window.

12. Compare Left vs. Right side Data & Traces (optional)

This feature allows for easy comparison of the latency, amplitude, and velocity differences between the left and right sides of a nerve. It also allows for a visual comparison of the traces obtained for each side.

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side and a table of difference values.

Normal values can be entered for the side-to-side difference measurements with abnormal values flagged by the program.

Press the **F10 - L/R Cmp** function key a second time to return to the standard NCV display.

13. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

14. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another NCV nerve in the **Study** window.
- **Click** on another NCV nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (NCV)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item / Site - in **Study Item** mode, turn this knob to highlight and load a different Test Protocol in the Study window. In **Site** mode, turn this knob to select a site (by highlighting a row) within the NCV Site table.

Sel Cursor / Move Cursor - this knob defaults to the **Move Cursor** mode and can be used to move either the Onset or Peak cursor on the active (white) trace. Press this knob to switch to **Sel Cursor** mode which will allow you to move the focus (yellow triangle) to any cursor on any trace within the Trace window.

Intensity / Pulse Width - this knob defaults to the **Pulse Width** mode and can be used to increase or decrease the electrical stimulus pulse width, the current value (in microseconds) is displayed on the knob icon. Press this knob to switch to the **Intensity** mode and turn to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon.

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the Trace window. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the Trace window.

F Keys

Distance - pressing this key will activate (highlight) the first distance cell in the NCV Segment Table. Repeated pressing will activate other distance cells in the table. Once a distance cell is activated you can type in the distance value for that segment.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Nerve List - opens the Nerve List window which allows you to select and add nerves to your Study window.

TabData - opens the TabData Summary window.

PC Function Keys (F5-F12)

F5-Cursor - enables Cursor mode (see below).

F6-Position - enables Position mode (see below).

F7-Swap Sides - press to swap the side parameter for the nerve.

F8-Sort Traces - press to sort the traces by increasing latency.

F9-Avg On - press to enable the signal averager.

F10-L/R Cmp - press to display the opposite side's traces and the Left vs. Right comparison tables for the nerve.

F11-Upd. Traces - press to update the Site table based on the current position of the traces.

F12-Clear All - press to delete all traces for the nerve.

Cursor mode (F5)

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trial - turn this knob to select an NCV trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected NCV trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trace.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trace.

All On / All Off - defaults to **All On** mode. Press to hide all cursors on all traces.

Position mode (F6)

Knobs

Sel. Trial / Move - defaults to **Select Trial** mode, turn this knob to select a stored NCV trace. When selected, the trace will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trace up or down within the Trace window.

Move Active - turn this knob to move the active (white colored) trace up or down within the Trace window.

Sel. Trial / Delete - turn this knob to select a stored NCV trace. When selected, the trace will be displayed in yellow color. Press the knob to permanently delete the selected trace.

Gain - turn this knob to change the Gain of the selected NCV trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Smooth All - each time this key is pressed the traces will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

NCV Test Setup

NCV test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here to go to this topic.

Normal Values (NCV)

From the **Edit menu** select **Test Menu**. When the Test Menu Setup window is displayed click on the **NCV** test protocol in the test list. The NCV test protocol settings will be displayed on the right hand side of the screen.

In the **Nerve List**, select the nerve you want to make changes to.

There are three methods for entering normal values; **Simple Value Limit, Simple Value Limit by Age Group,** or **Prediction Equation**.

Method #1 Simple Value Limit:

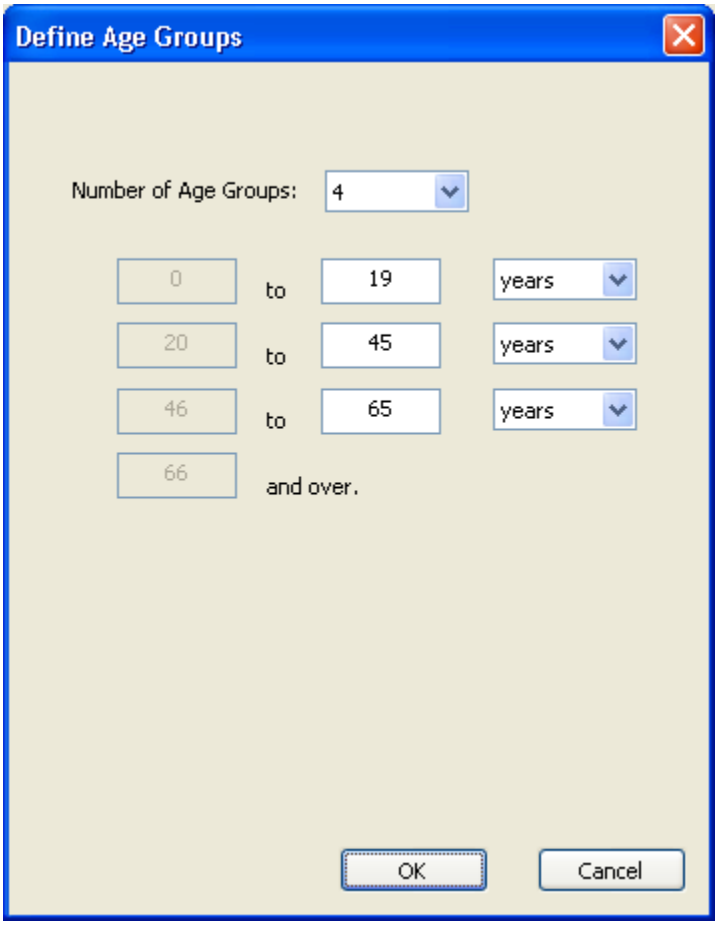
Click in the normal value field and type the desired value, then press Enter. You can use symbols such as > (greater than) or < (less than) if you like.

Method #2 Simple Value Limit by Age Group:

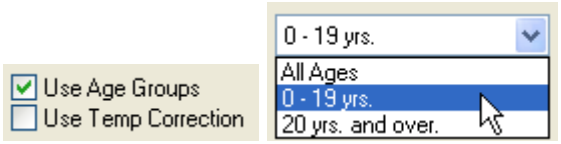
Up to 8 Age Groups can be defined and normal values can be entered for each group. The Sierra Wave program will compute the patient's age based on their date-of-birth and then use the appropriate age group norms.

To define the Age Groups:

1. Click on the **Define Age Groups** button.



2. Select the **number** of Age Groups, the maximum is 8.
3. Fill in the **upper age limit** for each group, select **years** or **months**, and click **OK**.
4. **Select a Nerve** from the nerve list.
5. Check the **Use Age Groups** box. This will enable the **age groups drop-down list**.

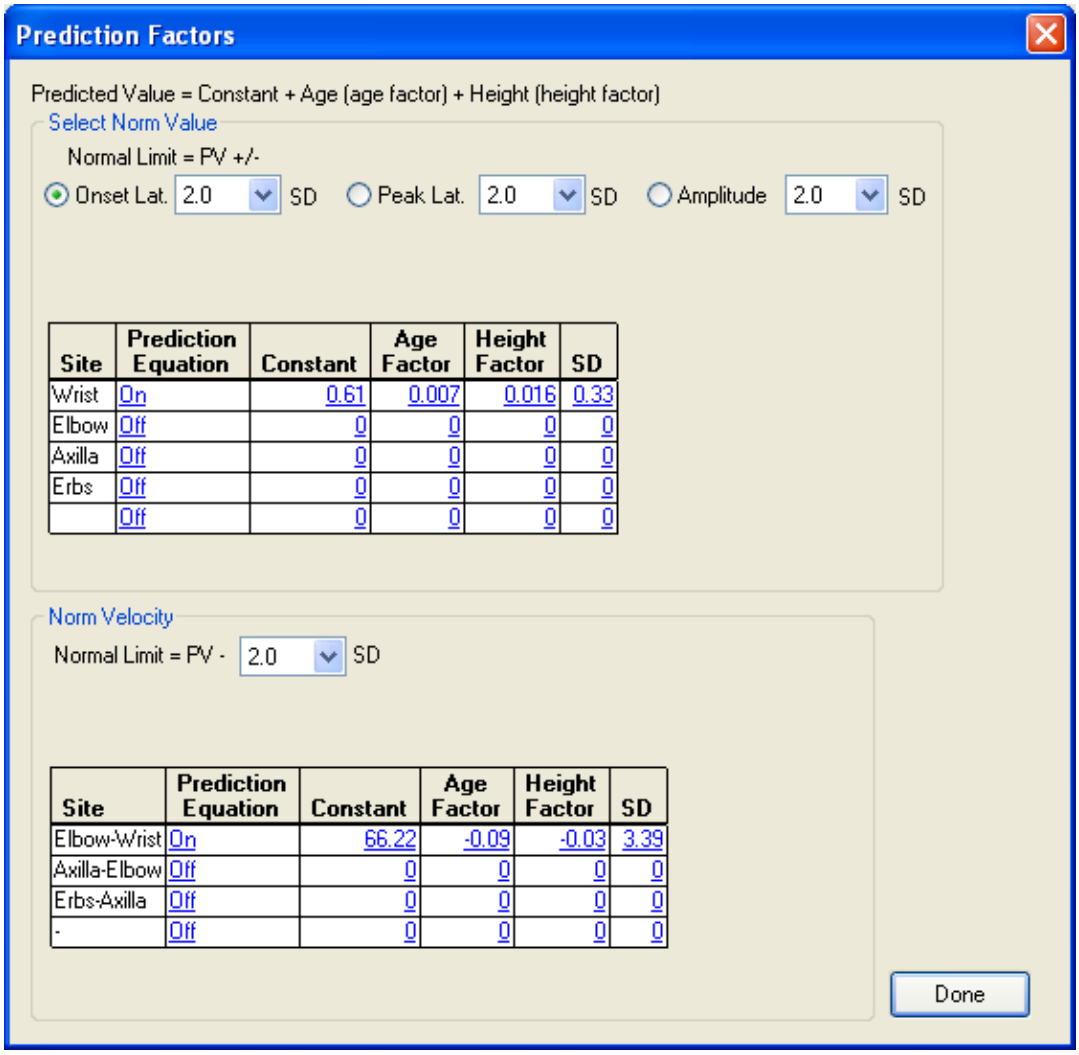


6. Enter the normal values for this age group into the **Site** and **Segment** tables. Repeat for each age group in the drop-down list.
7. Select another nerve in the nerve list, repeat steps 5 and 6.

If the patient's **date-of-birth is not entered** into the patient information window, the program will use the normal values entered for the **All Ages** group.

Method #3 Prediction Equation:

Normal values can be predicted using the patient's **Age** and **Height**. Click on the **Prediction Equation button**, a window will be displayed which allows you to input the factors for Age, Height, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. The equation can be used to predict Onset latency, Peak latency, Amplitude, and Velocity. If the equation is enabled, the normal value in the Site or Segment table is replaced with the letters "**PV**", for predicted value. This signifies that the normal value is not a simple value limit but will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height** have been input in the Patient Information window.



Prediction Equation setup window.

The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

If the standard deviation is known then:

Normal Value = Predicted Value +/- 'x' Standard Deviations

Typically:

Latency Norm = Predicted Value + 2 SD

Amplitude Norm = Predicted Value – 2 SD

Velocity Norm = Predicted Value – 2 SD

To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0** or **>0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal values will be displayed.

When the prediction equation is enabled you cannot input a simple value limit for the norm.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

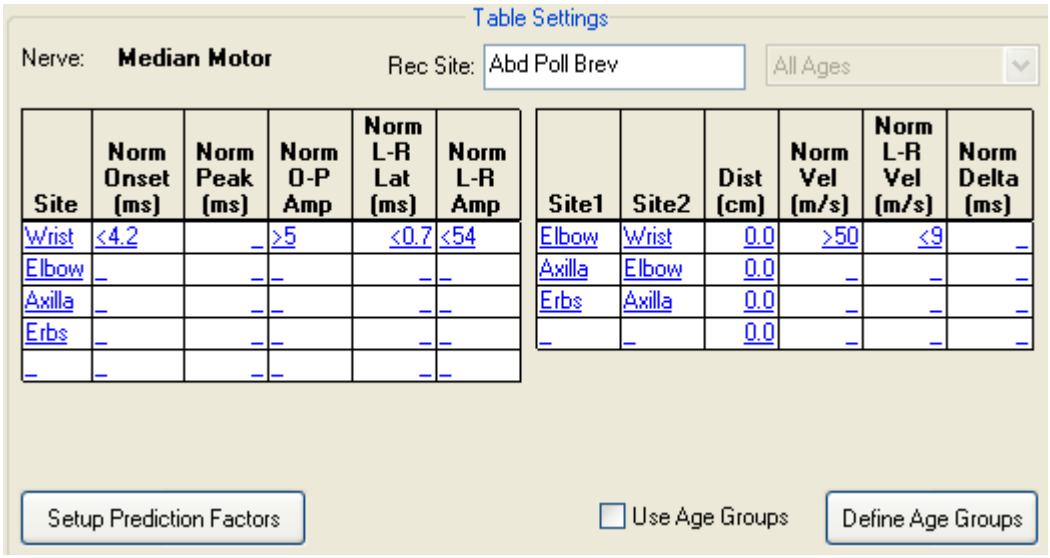
Using Prediction Equations (NCV)

Normal values can be predicted using the patient's **Age** and **Height**. This topic will outline the steps needed to enable prediction equations for the Median Motor Onset latency and Conduction Velocity across the Elbow-to-Wrist segment. Follow these same steps to program equations for other nerves in the nerve list.

Setup Steps:

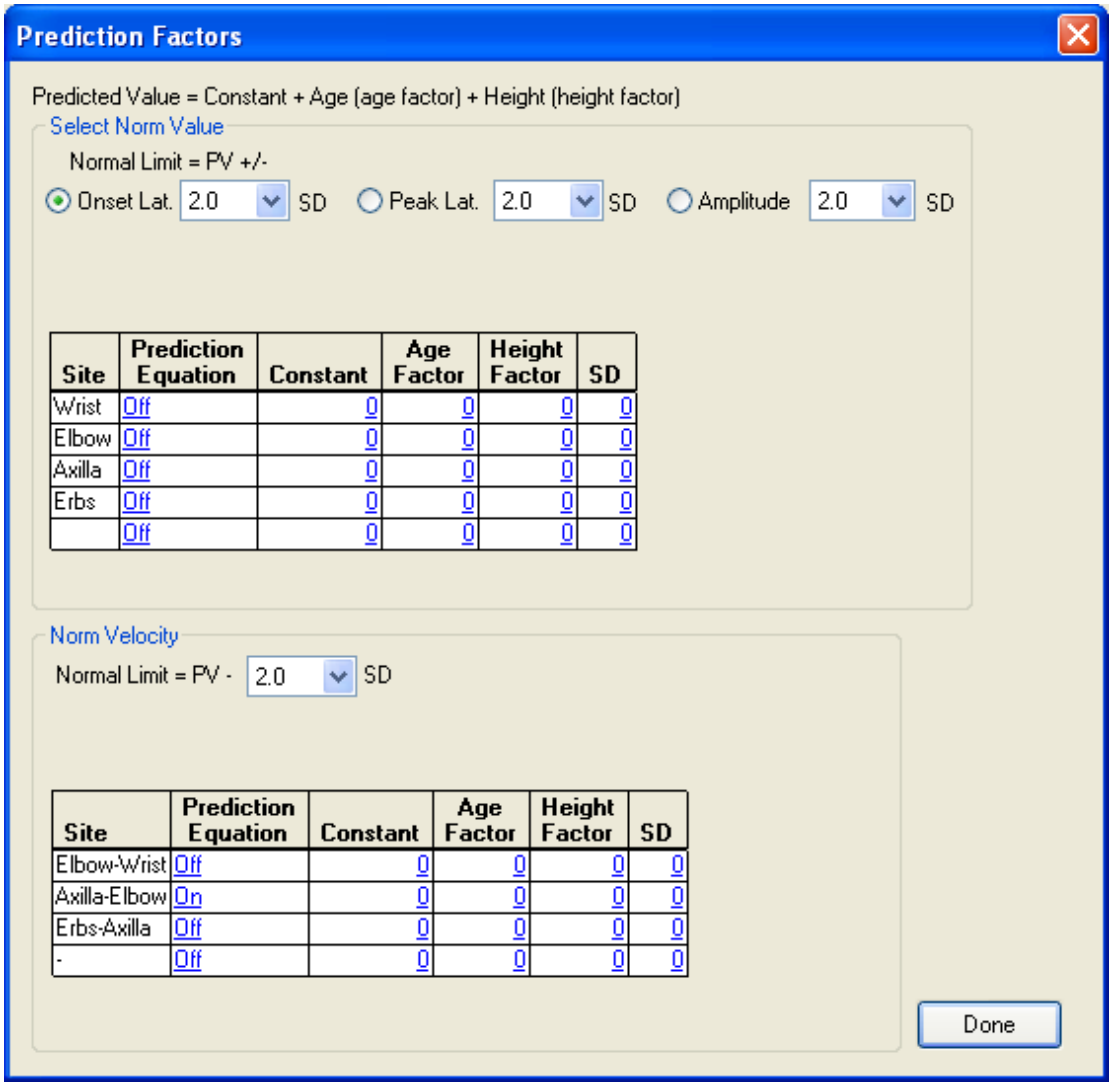
1. From the **Edit menu**, select **Test Setup**.
2. Select the **NCV** test.

3. Select a nerve in the **Nerve List** (i.e., Median Motor). You will see a button labeled **"Setup Prediction Factors"** below the Site Table.



Site & Segment Tables for Median Motor Nerve.

4. Click on the **Setup Prediction Factors button**. The window shown below will be displayed.



Prediction Setup window.

5. To setup the equation for **Onset Latency at the Wrist**.

a. Select **Onset Lat.** at the top of the window.

b. Enable the equation by changing the **Off** setting to **On** for the **Wrist** site.

c. Enter the appropriate values for Constant, Age Factor, Height Factor, and one Standard Deviation.

d. Set the upper limit of normal by selecting the number of standard deviations from the Onset Lat. drop-down list.

e. Repeat steps a. to d. to setup Peak Latency and/or Amplitude.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

6. To setup the equation for **Elbow-to-Wrist Velocity**.

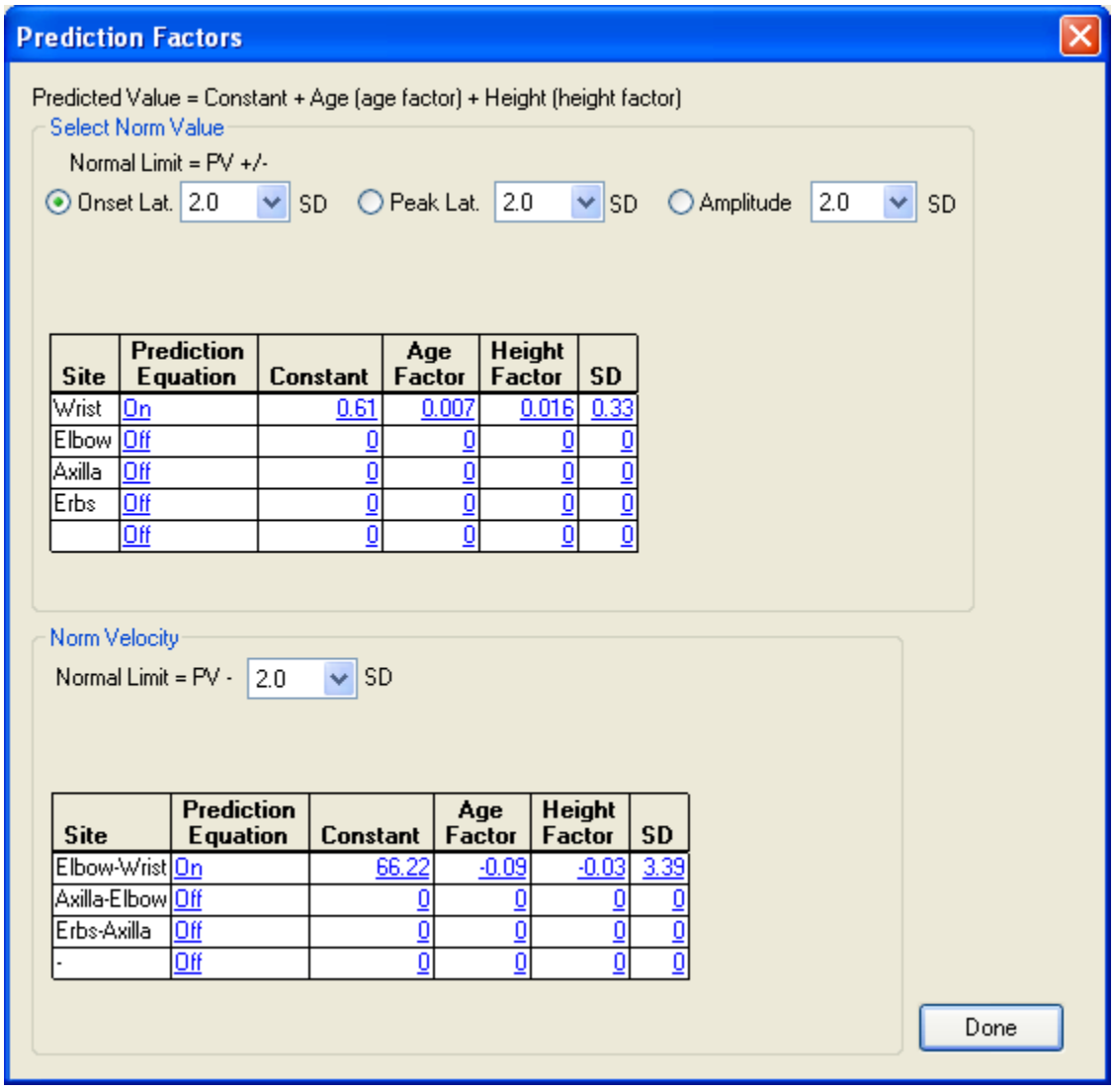
a. Enable the equation by changing the **Off** setting to **On** for the **Elbow-Wrist** segment.

b. Enter the appropriate values for Constant, Age Factor, Height Factor, and one Standard Deviation.

c. Set the lower limit of normal by selecting the number of standard deviations from the drop-down list.

d. Repeat steps a. to c. for other velocity segments.

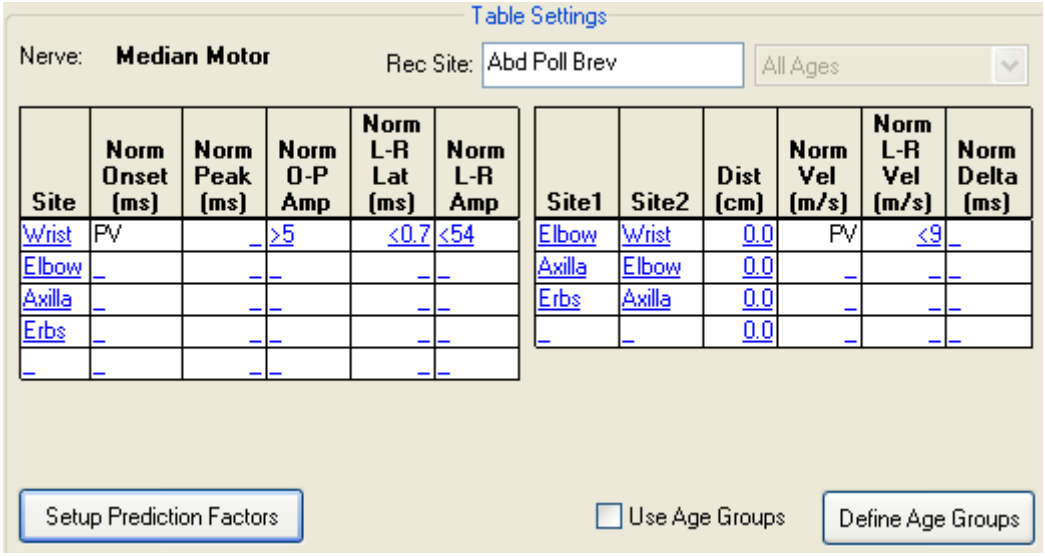
Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.



Completed setup for wrist latency and elbow-wrist velocity.

7. Click **Done**.

8. Note the text **"PV"** in the **Norm Onset** and **Norm Velocity** fields. This indicates that the predicted value equation has been enabled for these values and that the normal values for these measurements will be automatically calculated by the program once the data acquisition screen has been loaded and the patient's **Date Of Birth (i.e., Age)** and **Height** have been entered.



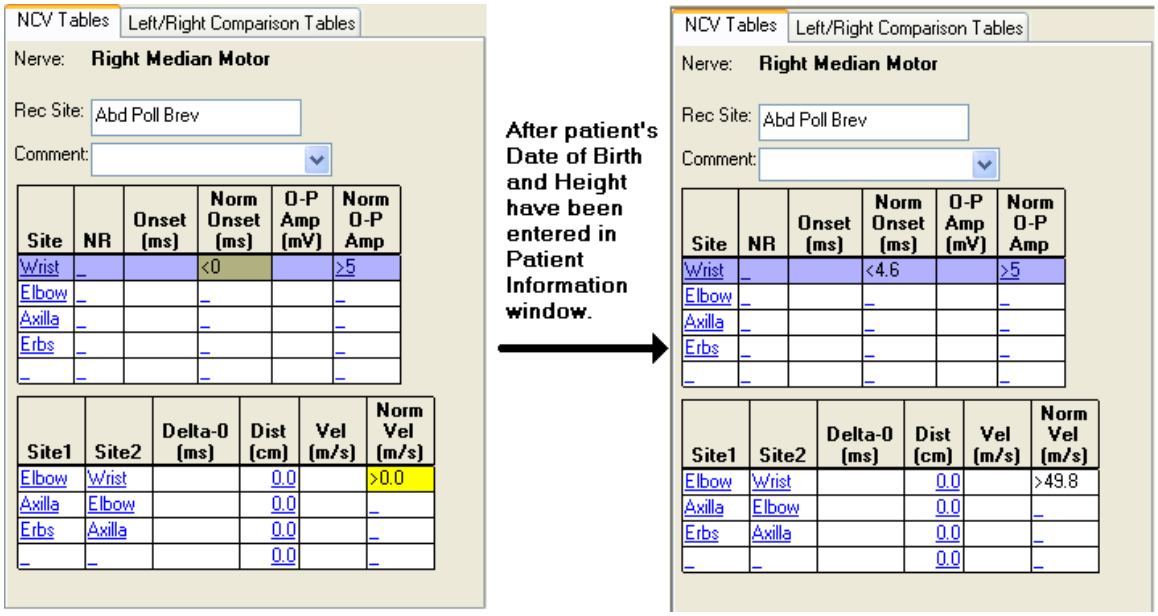
Site and Segment Table for Median Motor Nerve.

9. Program other nerves by repeating steps 1-8.

10. Click **OK** to close the Test Setup window and save your changes.

Data Acquisition Mode:

If the patient's Date Of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0** or **>0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal values will be displayed.

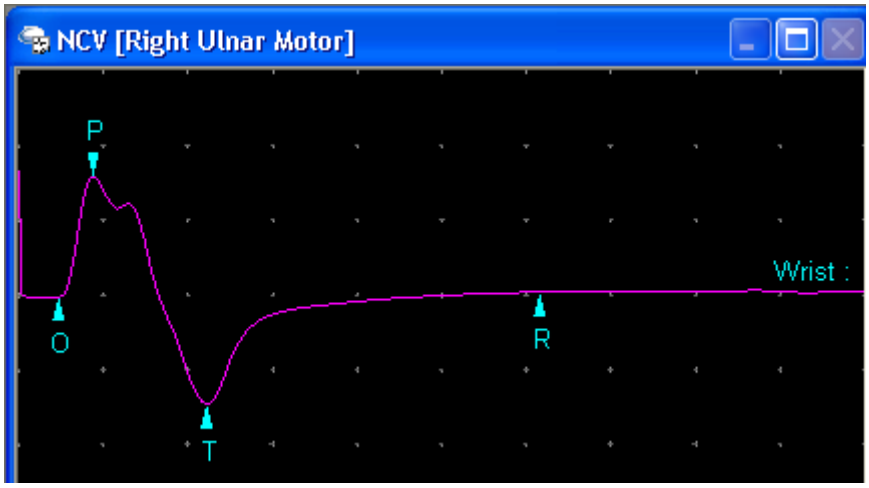


When the prediction equation is enabled you cannot edit the norm value field.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

NCV Cursors

In the NCV Test Protocol, if the response is of sufficient amplitude, cursors are automatically placed on the trace. Up to four cursors are placed on each trace, they are **Onset (O)**, **Peak (P)**, **Trough (T)**, and **Recovery (R)**. The configuration of the Site and Segment tables determines which of the four cursors will be needed on the trace.



NCV trace with cursors positioned.

If the amplitude criteria is not met the cursors will be placed on the response in the following pattern.

Pattern of auto-cursor placement when amplitude criteria is not met.

The Peak (P) cursor will be positioned at the third division with the Onset (O) cursor placed one-quarter division in front and the Trough (T) and Recovery (R) cursors placed one-quarter and one-half division respectively following it. If you believe that there is a response present you can move the cursors to their appropriate positions, or if there really is no response present, you can mark the response as "NR" in the Site table.

Adjusting Cursor Positions

The positions of the cursors on a trace can be easily adjusted by following one of the methods below.

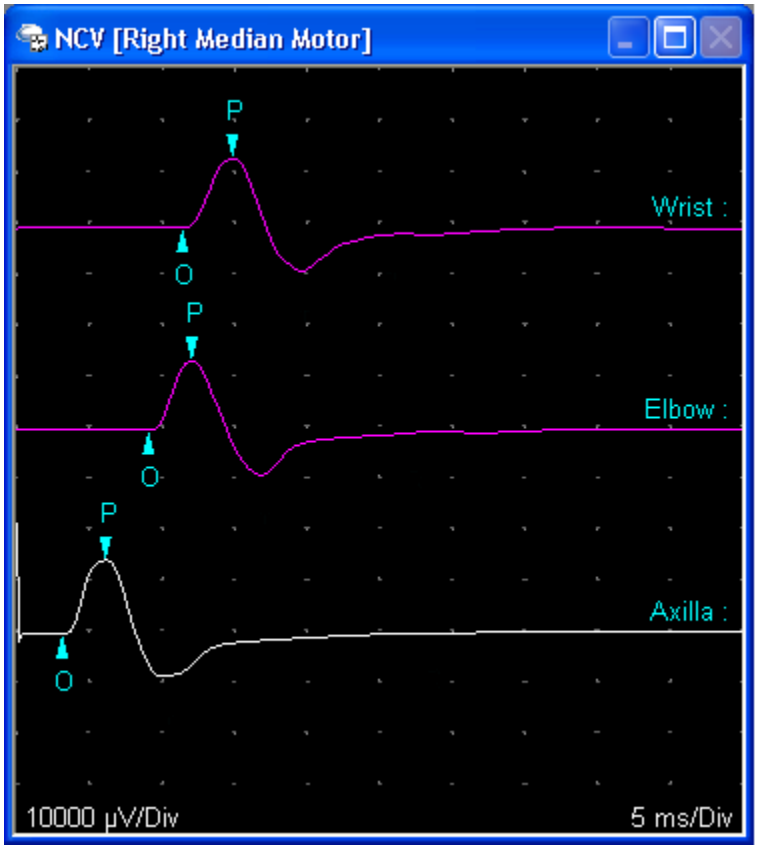
- **Using Knob #2 (Sel Cursor / Move Cursor)** - this knob defaults to the **Move Cursor** mode and can be used to move either the Onset or Peak cursor on the active (white) trace. Press this knob to switch to **Sel Cursor** mode which will allow you to move the focus (yellow triangle) to any cursor on any trace within the Trace window.
- **Using the F5-Cursor mode** - press the **F5** key on the PC's keyboard to change the base unit's knob and functions keys to cursor mode. See the Knob & Fkey Controls topic for further information.
- **Using the mouse** - simply left click on the appropriate cursors blue triangle and drag the cursor along the trace to its new location. While the cursor is being moved the blue triangle is replaced with a yellow triangle.

Sorting Traces

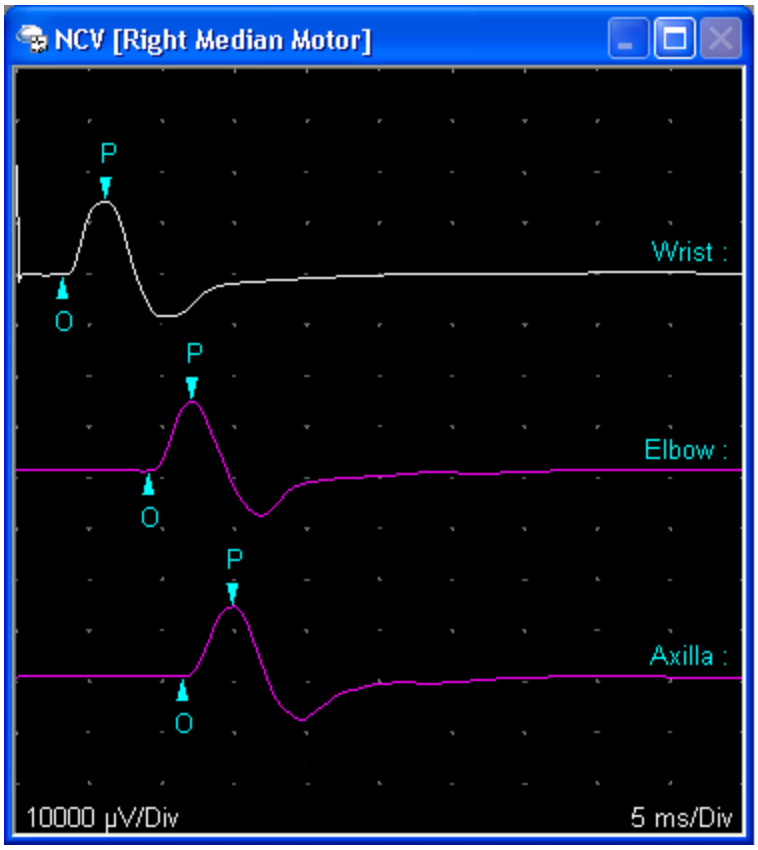
Typically the NCV Site Table lists the stimulation sites from distal to proximal and stimulation is performed in the same manner. However you can acquire traces in a different order than what is listed in the NCV Site Table and then sort the traces later by increasing latency. For motor nerves the onset latency is used, for sensory nerves either the onset or peak latency is used depending on how that nerve type is configured.

To Sort the NCV Traces perform one of the following.

- **Press the F8 function key** on the PC's keyboard. In the NCV test protocol the F8 key is always assigned the Sort Traces function.
- **Right click** the mouse over the **Trace window** and select **Sort Traces** from the pop-up menu.



Example of Median Motor performed out of order, from proximal to distal.



Example of the previous Median Motor after using the Sort Traces function. Traces now match the order of the site names listed in the NCV Site Table.

Swap Sides

To swap the side parameter on a nerve, perform one of the following.

- **Right click** the mouse over the **nerve name** in the **Study window**. From the pop-up menu select **Swap Sides**.
- Press the **F7 function key** on the PC's keyboard. In the NCV test protocol the F7 key is always assigned the Swap Sides function.

If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

If the side you are swapping to already has stored traces, then a second run will automatically be added to that existing nerve. If necessary, you can then swap the side on the first run.

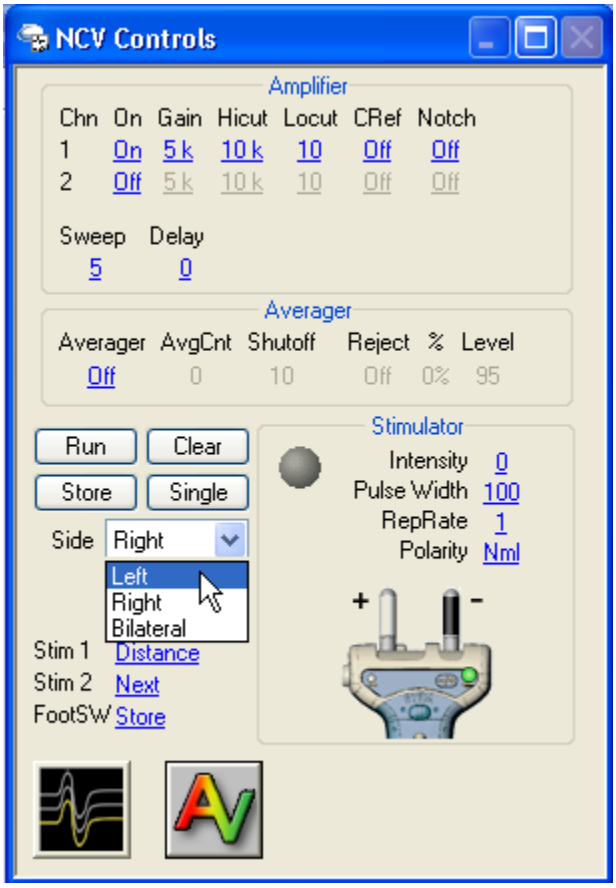
Change Sides

Changing the Side parameter for a nerve is different than Swapping Sides. When you change sides, the highlight in the Study window simply moves to that nerve in the Study window. No traces are transferred.

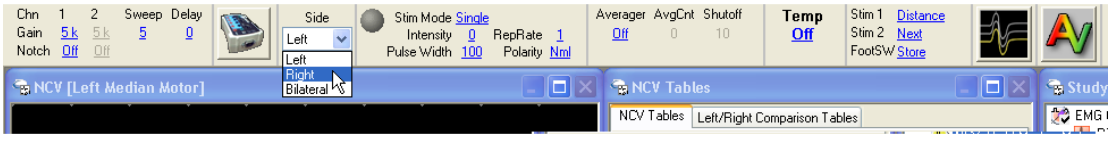
If the nerve corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **NCV Controls window**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



In the **Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.

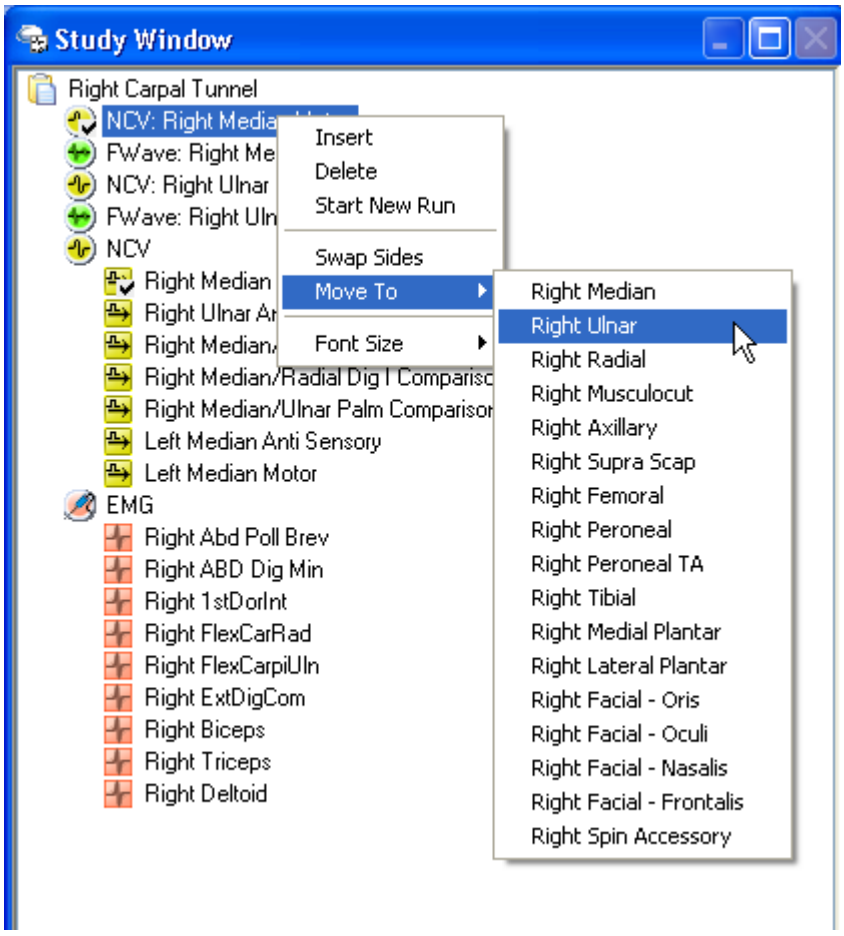


Move To

This feature allows the NCV traces to be moved to a different nerve of the same 'nerve type'. For example, motor nerve traces can be moved to any other motor nerve in your nerve list.

To Move the traces to another nerve:

- **Right click** the mouse over the nerve in the Study window.
- Select **Move To** from the pop-up menu.
- Select a nerve from the displayed list.



No Response

If no response can be obtained for a stimulation site you can indicate this using the **NR** column in the NCV Site Table.

Simply click within the **NR column** just to the right of the site's name. The text "NR" will be displayed for that site and any cursor values for the site will be cleared.

Site	NR	Onset (ms)	Norm Onset (ms)	O-P Amp (mV)	Norm Amp
Wrist	NR		<4.2		>5
Elbow	_		_		_
Axilla	_		_		_
Erbs	_		_		_
_	_		_		_

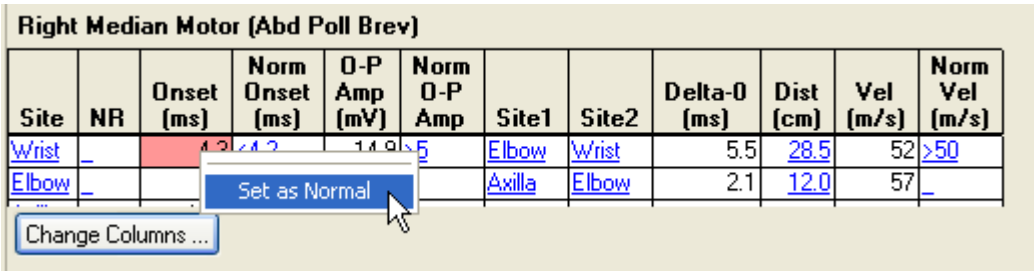
NCV Site Table with NR indicated for the Wrist site.

If you mistakenly click in the wrong NR box, click on the "NR" text and it will be removed and the cursor values will be restored.

Override an Abnormal Value

You can override the abnormal value flag when you believe that a value is actually within acceptable limits. This function can be performed from the main acquisition screen for the nerve, or from within the TabData window if the individual nerve's node is highlighted in the left hand column.

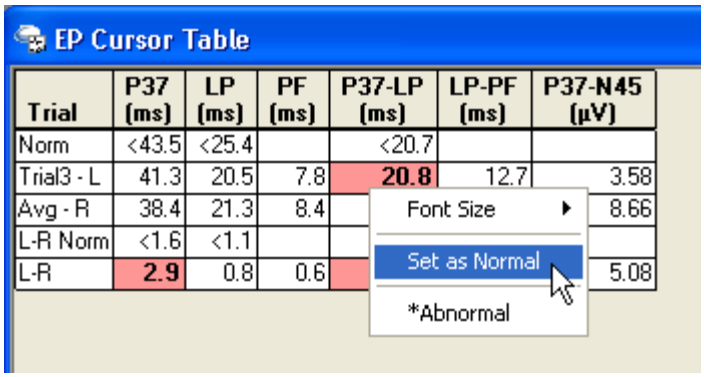
Simply **right-click** the mouse over the abnormal value, then select **Set as Normal** from the pop-up menu. The abnormal flag (red color or bold text) will be removed.



Median motor cursor table.

If you make a mistake, right click over the value again, and then remove the check mark next to Set as Normal. The abnormal flag will return.

This feature is also available in EP cursor tables.



Tibial SEP cursor table.

Using Abnormal Severity Meanings

This feature gives a user the ability to specify an abnormal value's degree of abnormality (e.g., mildly increased, moderately increased, or severely increased) for a latency value rather than simply having the findings sentence indicate that a latency is only 'increased'.

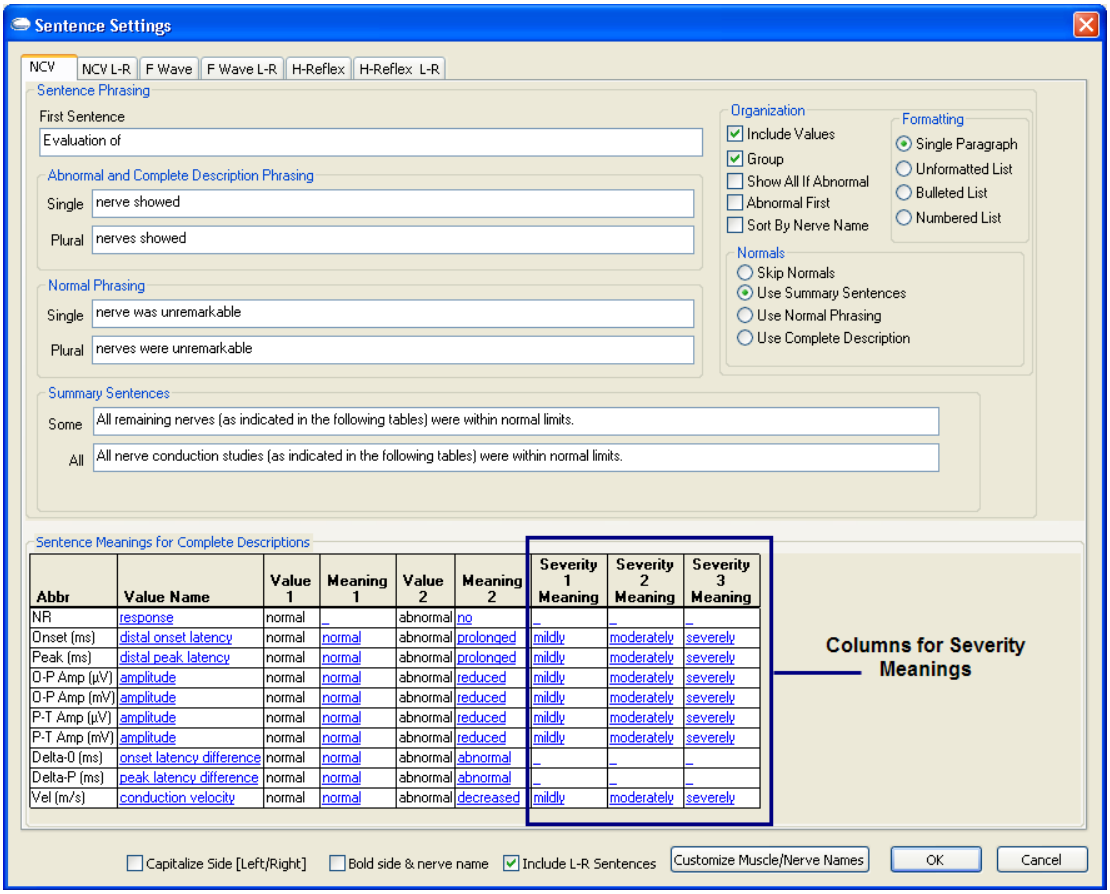
You can define the wording used for up to 3 severity ranges in the **NCV Sentence Setup** window and this feature can be automated by using a range of values for the normal value of a nerve.

Abnormal Severity Setup

In the **NCV Sentence Setup** window there are three columns for specifying the degree of abnormality. The columns are titled **Severity Meaning 1**, **Severity Meaning 2**, and **Severity Meaning 3**.

These columns allow you to specify the additional wording that can be used in the findings sentence when a value is found to be abnormal. You can fill-in some, all, or none of rows in these columns.

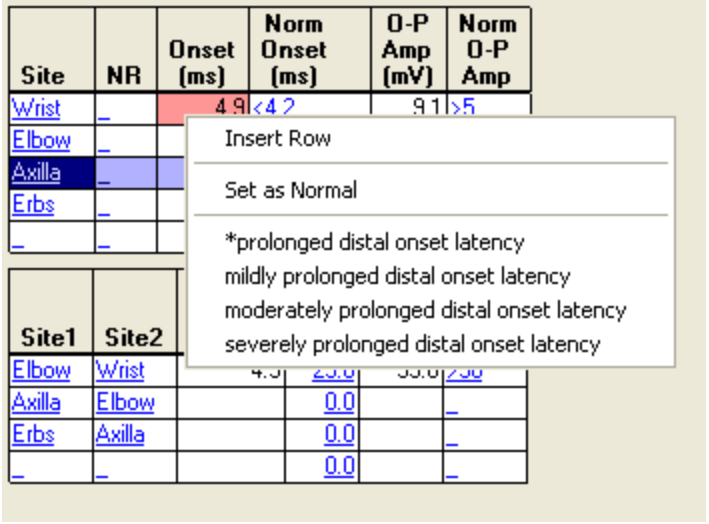
To open the NCV Sentence Setup window, go to the **TabData window** and select the top level **NCV node** in the left hand column. Click on the **Sentence Setup button** shown in the lower right hand corner.



NCV Sentence Setup window.

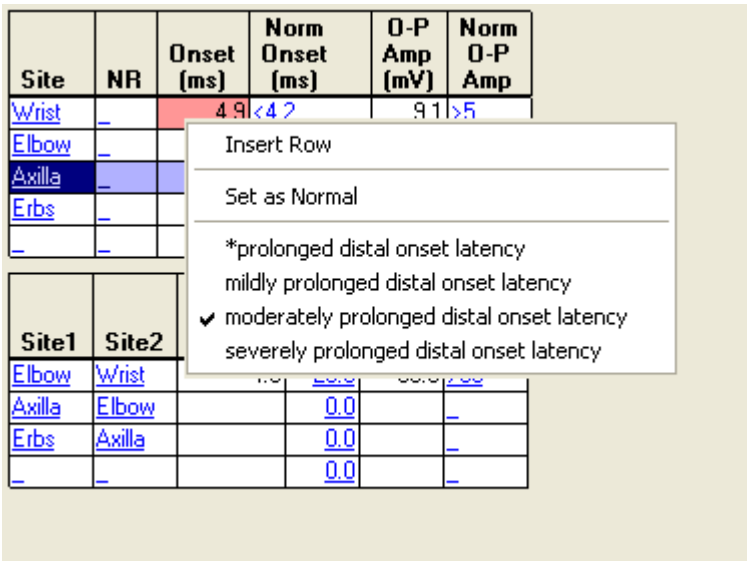
How to use the Abnormal Severity Meanings

In either the NCV Acquisition screen or from within the TabData window (if the individual nerve's node is highlighted in the left hand column) right click over the abnormal value to display a list of possible meanings. The following example shows the result of right clicking over an abnormal Onset Latency.



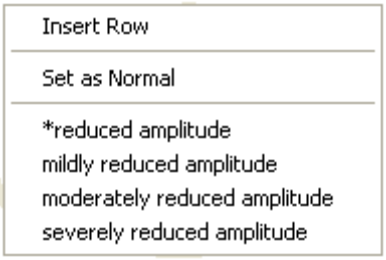
An asterisk (*) indicates the sentence generator's currently assigned default meaning. You can override the default meaning by selecting one of the additional abnormal meanings from the list. You can also override the program and set the meaning for the value to Normal.

When an abnormal meaning other than the default is selected, a check mark appears next to that meaning. To remove a selection, simply click on that meaning again and the check mark will be deleted.

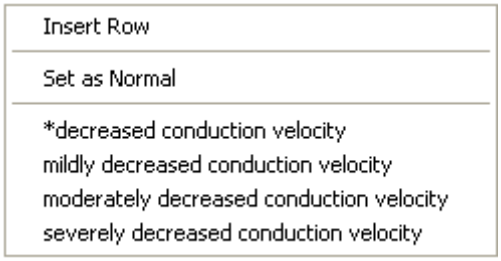


Meaning changed to "moderately".

Right clicking over an abnormal **Amplitude** or **Velocity** value will list appropriate selections for those values.

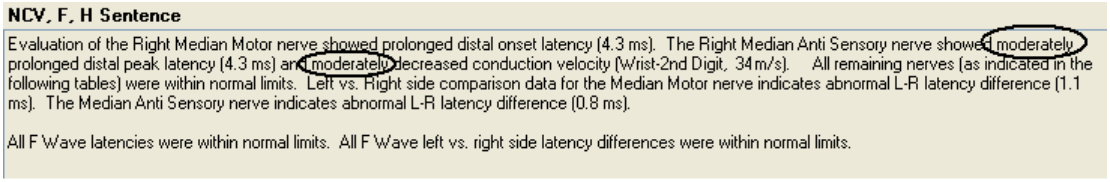


Right click over Amplitude value.



Right click over Velocity value.

In the following example, the default meaning for both the distal peak latency and conduction velocity of the Right Median Anti-Sensory nerve were changed to “moderately”.

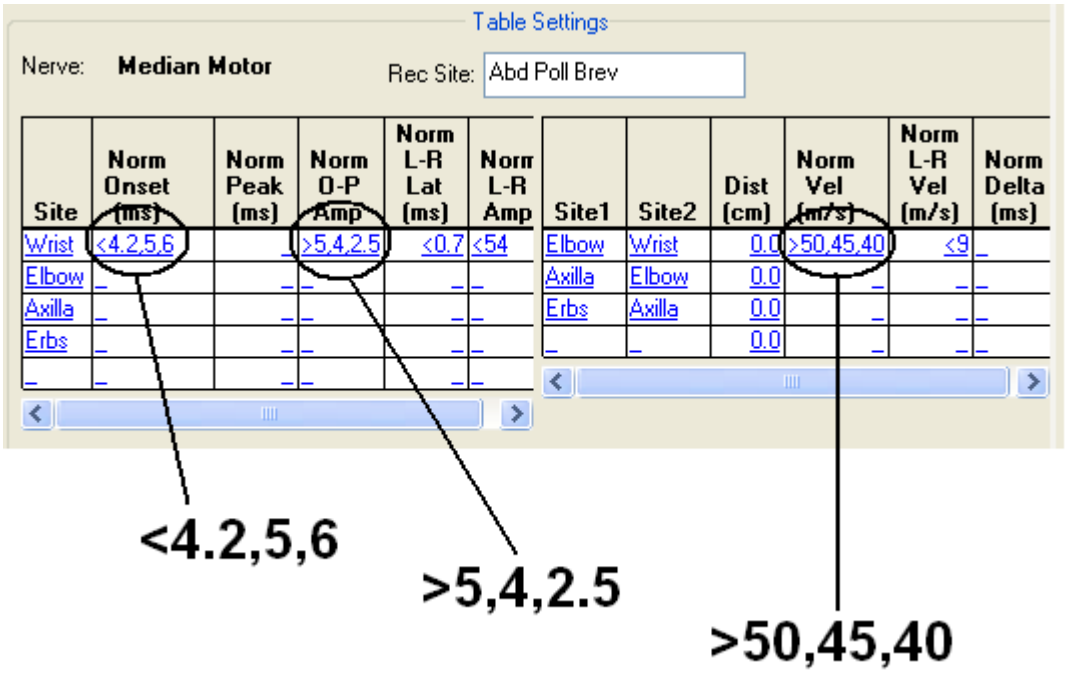


Automating this feature using Normal Value Ranges

The selection for the sentence’s abnormal meaning can be automated by specifying a range of values in the norm field of a nerve. Up to three ranges can be specified that correspond to Severity Meaning 1, Severity Meaning 2, and Severity Meaning 3.

After the initial normal value is specified (e.g. <4.2) **commas** can be used to setup the additional abnormal ranges for the sentence generator.

The following example shows how this can be done for the Onset, Amplitude, and Velocity measurements of the Median Motor nerve.



- **Using <4.2,5,6 for the Onset normal value sets up the following ranges.**

  <4.2 sets the normal limit. (Anything greater than this value is flagged as abnormal).

  4.3 – 5.0 represents the #1 severity range (i.e., mildly increased).

  5.1 – 6.0 represents the #2 severity range (i.e., moderately increased).

  6.1 and above represents the #3 severity range (i.e., severely increased).

  To determine what the three Latency ranges will be, use the following formula.

  Severity Range #1 = 1st value (**plus** 0.1) to 2nd value.

  Severity Range #2 = 2nd value (**plus** 0.1) to 3rd value.

  Severity Range #3 = 3rd value (**plus** 0.1) and above.

- **Using >5,4,2.5 for the distal Amplitude normal value sets up the following ranges.**

>5 sets the normal limit. (Anything less than this value is flagged as abnormal).

4.9 – 4.0 represents the #1 severity range (i.e., mildly decreased).

3.9 – 2.5 represents the #2 severity range (i.e., moderately decreased).

2.4 or less represents the #3 severity range (i.e., severely decreased).

 To determine what the three Amplitude ranges will be, use the following formula.

Severity Range #1 = 1st value (**minus** 0.1) to 2nd value.

Severity Range #2 = 2nd value (**minus** 0.1) to 3rd value.

Severity Range #3 = 3rd value (**minus** 0.1) or less.

- **Using >50,45,40 for the distal Velocity normal value sets up the following ranges.**

  >50 sets the normal limit. (Anything less than this value is flagged as abnormal.)

  49 – 45 represents the #1 severity range (i.e., mildly decreased).

  44 – 40 represents the #2 severity range (i.e., moderately decreased).

  39 or less represents the #3 severity range (i.e., severely decreased).

   To determine what the three Velocity ranges will be, use the following formula.

  Severity Range #1 = 1st value (**minus** 1) to 2nd value.

  Severity Range #2 = 2nd value (**minus** 1) to 3rd value.

  Severity Range #3 = 3rd value (**minus** 1) or less.

- **If only two values are used for a norm, such as <4.2,6.5 for latency.**

  <4.2 sets the normal limit.

  4.3 – 6.5 represents the #1 severity range (i.e., mildly prolonged).

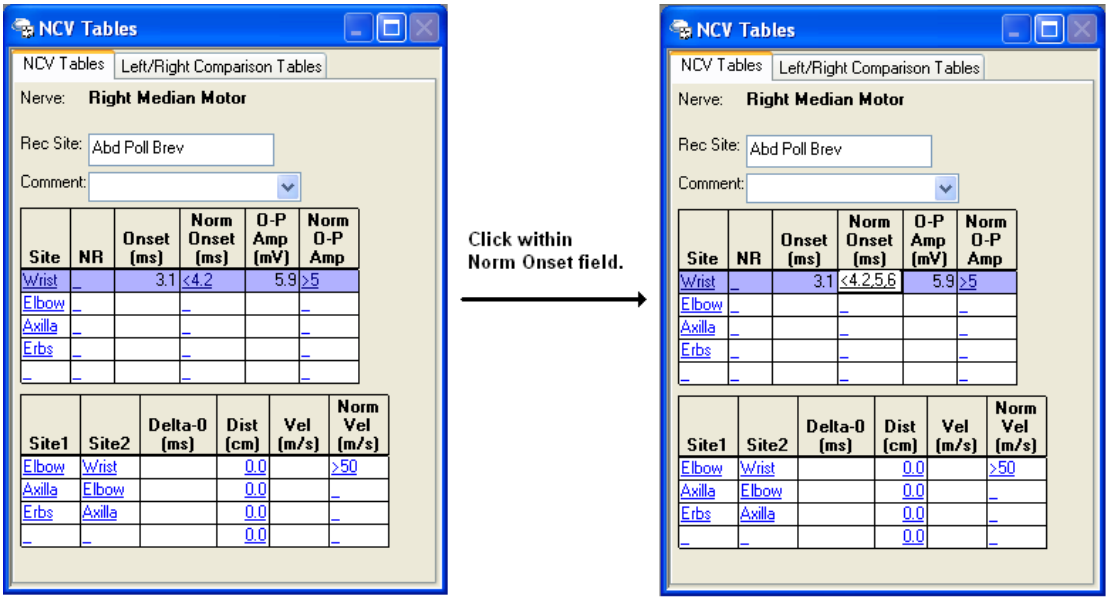
  6.6 and above represents the #2 severity range (i.e., moderately prolonged).

  Severity #3 is not used.

- **If only one value is used for a norm, such as <4.0 for latency.**

  For a latency value of 4.1 or higher the findings sentence will use the default meaning, “prolonged onset latency”.

Normal value ranges are hidden in the acquisition view unless the norm field is selected with the mouse for editing purposes. The ranges are also hidden in the TabData window and in final reports.



Typical Acquisition View. Only the first normal value in the range is displayed.

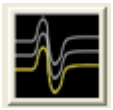
Norm Onset field has been selected, and now all values in the range are displayed.

Trace History

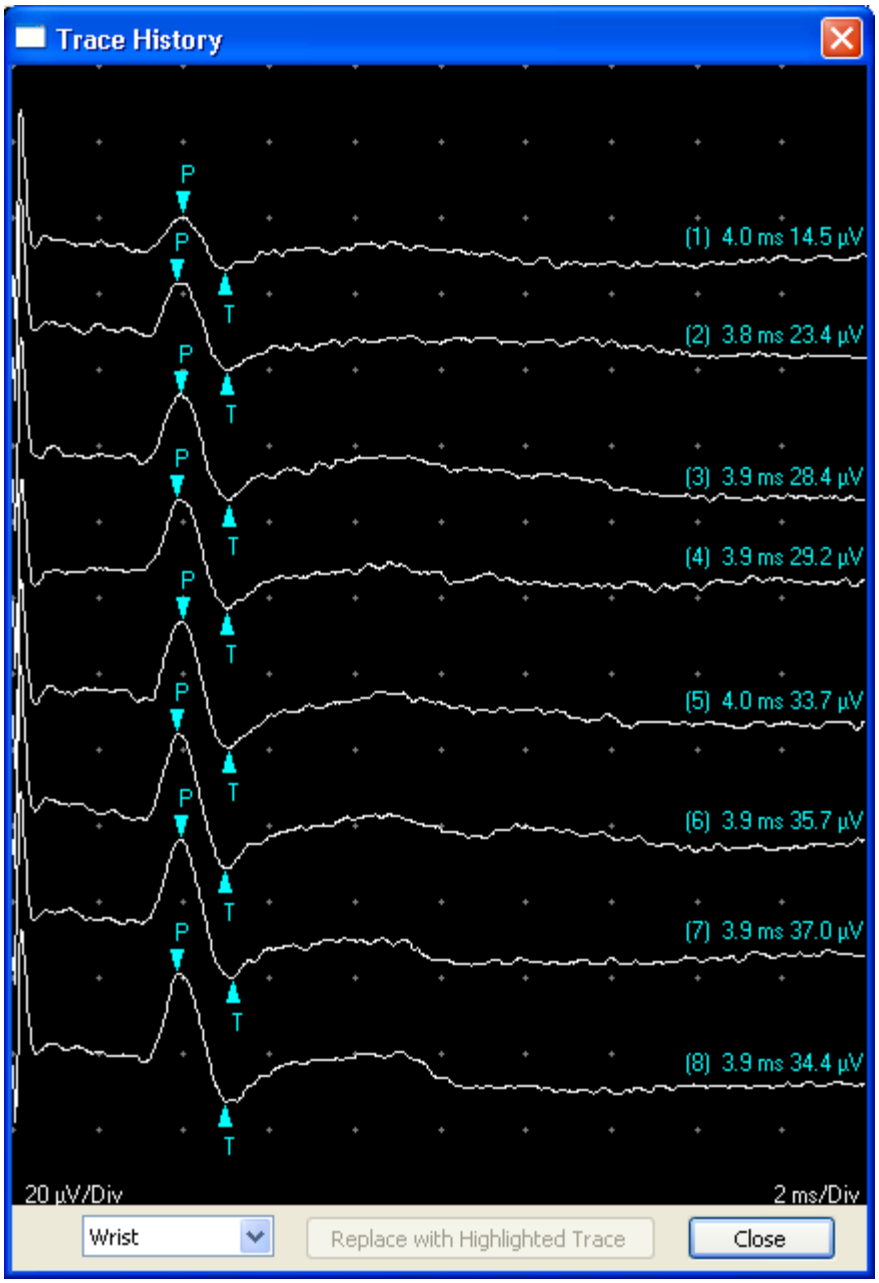
The Trace History feature stores up to 30 traces for each stimulation site that is tested on a nerve. This allows you to easily review previously acquired traces and replace your current trace with a better one from the history.

To access the Trace History window:

- Click on the Trace History icon in the toolbar.



- The Trace History window will be displayed.

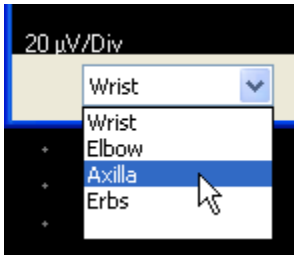


Trace History window showing all 8 stimulations that were performed at the Wrist for the Left Median anti-dromic sensory nerve. The latency and amplitude values are displayed in the trace label.

Prior to clicking on the Trace History icon you should store the trace for the current stimulation site.

To select a Site:

- The window defaults to the last stimulated site. Select a different site from the drop-down list at the bottom of the window.



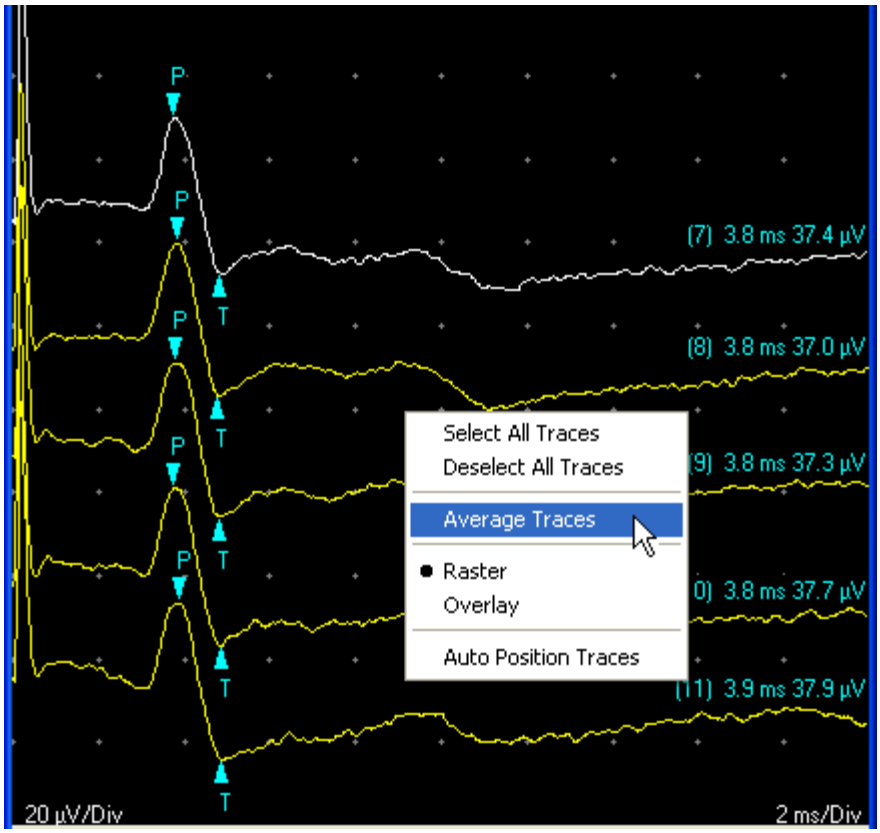
To replace the current trace:

You can replace the current trace for a site with any of the traces shown in the history.

- Left-click on a trace in the history to highlight it.
- Click on the **Replace with Highlighted Trace** button.
- The current trace is replaced with the selected trace and the Trace History window is automatically closed.

To average traces in the history:

- **To average all traces** - right-click within the window and click on **Select All Traces**. Then, right-click again and select **Average Traces**. The newly averaged trace is placed at the bottom of the trace stack.
- **To average only selected traces** - select the desired traces by left-clicking on each trace while holding down the Control key. Once you have selected all the traces to be averaged, right-click and select **Average Traces**. The newly averaged trace is placed at the bottom of the trace stack.



After selecting traces, right-click and select Average Traces.

- You can now replace the current trace for a site with the newly averaged trace. See steps above on replacing the current trace.

To re-stimulate a site:

The Trace History window replaces the old method of re-stimulating a site. Now, as soon as you re-stimulate a site, the trace history window will be displayed so you can see all previously collected traces for that site and any new stimulations that are performed.

- Click on **the row in the site table** corresponding to the site you want to re-stimulate.
- **Stimulate** the site.
- The **Trace History window will be automatically displayed**. It will show all previous traces that have been collected for this site and automatically adds new traces as the site is re-stimulated.
- Perform one of the following actions:
    - Press the **Store button** on the electrical stimulator or the **Store key** on the base unit. The most recent trace will replace the previously

stored trace for that site. Close the Trace History window by clicking on the **Close** button.

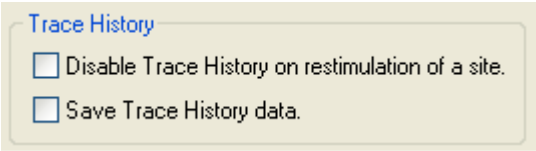
- **Select a trace in the history**, and then click on the **Replace with Highlighted Trace** button.
- **Keep the original trace** by clicking the **Close** button.

To position & size the Trace History window:

The program will automatically remember any changes that are made to the positioning and size of the trace history window.

Trace History Setup Options:

There are two configuration options for the Trace History window. These options are found on the General Settings tab of the NCV Test Menu editor.



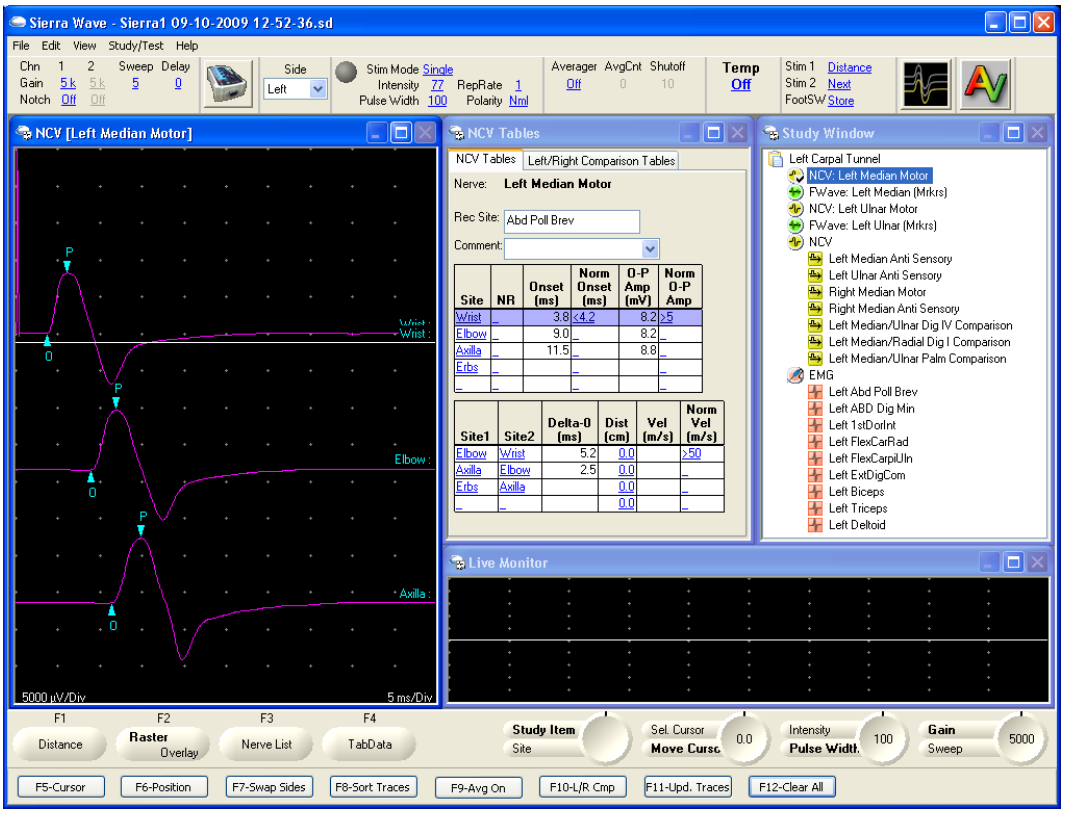
- **Disable Trace History on restimulation of a site** - when this box is checked the Trace History window will be suppressed (hidden) during re-stimulation of a site.
- **Save Trace History data** - when this box is checked the program will store all Trace History data in the patient's record. If this box is unchecked the trace histories will be cleared when the patient's exam is closed (File - Close Exam).

Re-Stimulate a Site

The Sierra Wave provides an easy way to re-stimulate a site and compare the new traces to the previously stored trace. You have the choice of keeping the original trace or you can replace it with any trace from the Trace History window.

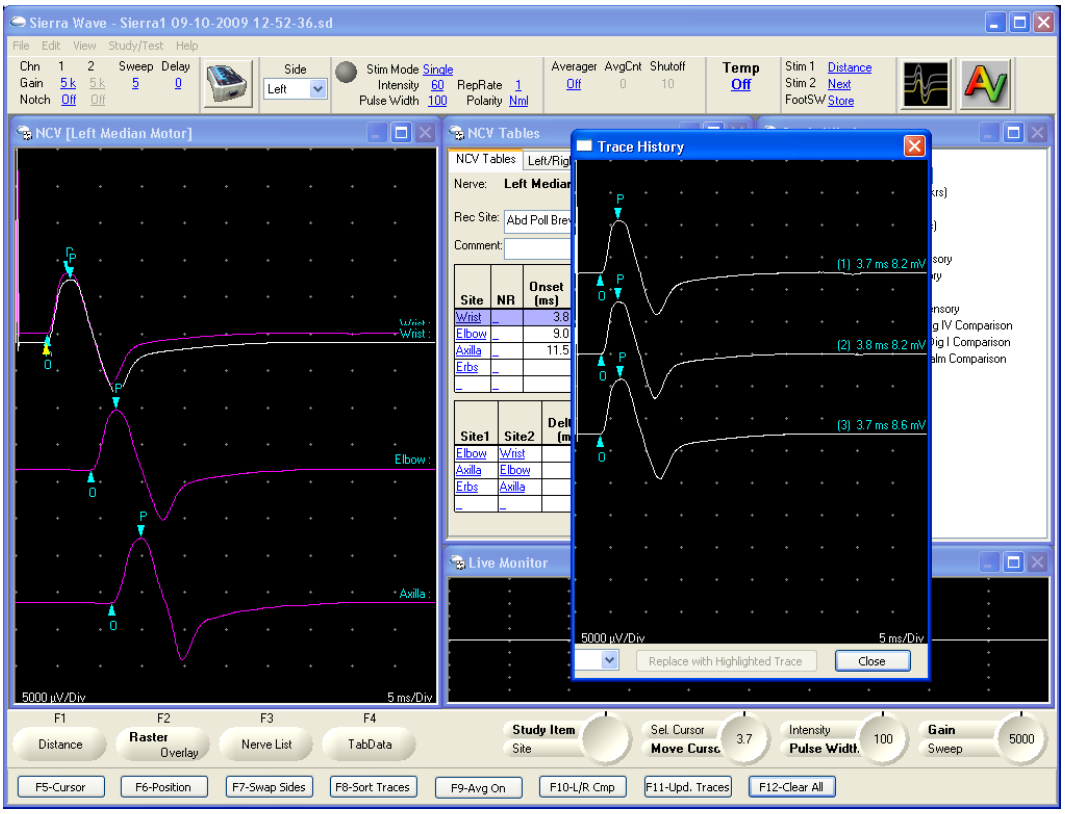
Steps for Re-stimulating a Site:

1. In the **Site Table**, click on the **Site** (i.e., the row) that you want to repeat. The row is highlighted and the active (white) trace goes to that position within the Trace window.



Wrist site has been selected for re-stimulation.

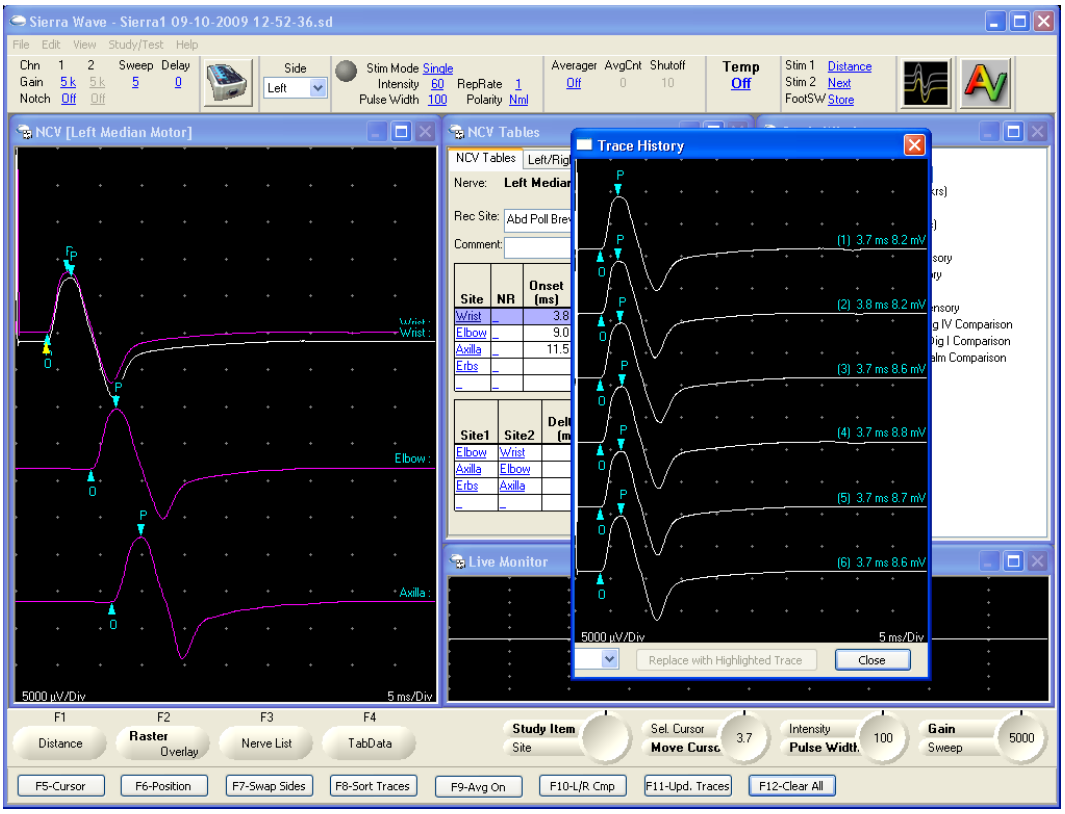
2. **Stimulate** the site. As soon as re-stimulation is delivered, the **Trace History** window is displayed. This window displays up to 30 traces for each stimulation site. This allows you to easily review previously acquired traces and replace your current trace with a better one from the history.



The Trace History window shows all previous traces acquired for this site (top two traces) as well as any re-stimulations (last trace in this example).

Note that the **latency and amplitude** of the response are included in the trace label.

3. **Continue to re-stimulate as needed**. After each stimulation the corresponding trace is added to the trace history.

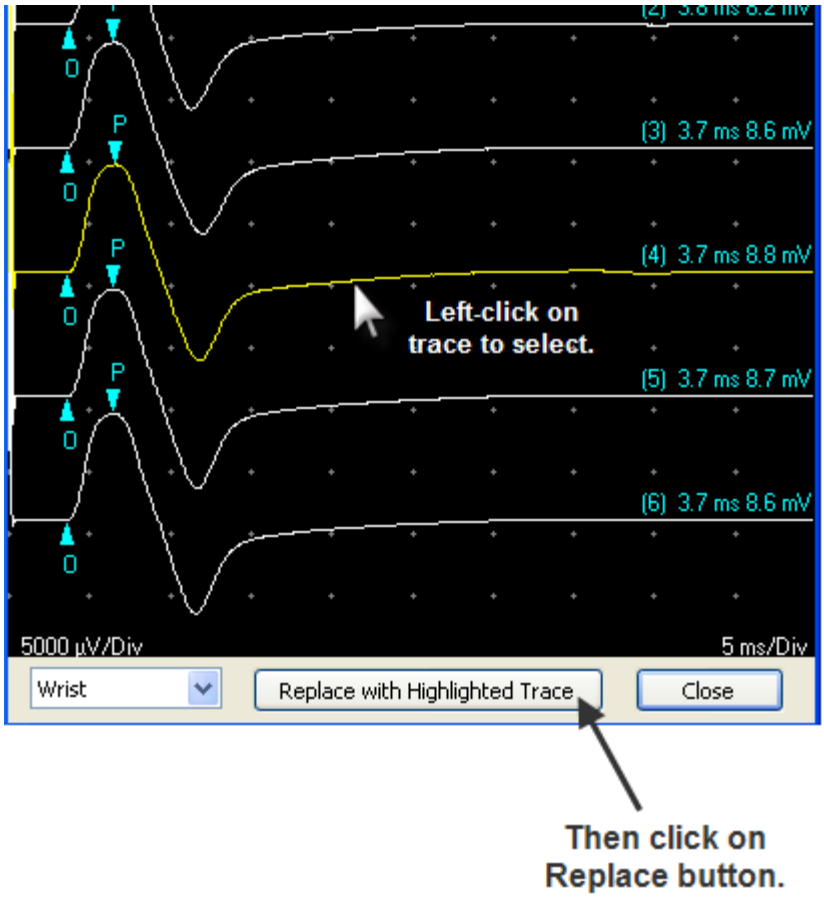


Four new traces (#3 - 6) have been add to the history for the Wrist stimulation site.

4. **Perform <u>one</u> of the following actions:**

   a. **Keep the most recent trace** by pressing the **Store button** on the electrical stimulator or the **Store key** on the base unit. The most recent trace will replace the previously stored trace for that site. Close the Trace History window by clicking on the **Close** button.

   b. **Select a trace from the history** by left-clicking on a trace with the mouse (trace becomes highlighted), and then click on the **Replace with Highlighted Trace** button. The current trace is replaced with the selected trace and the Trace History window is automatically closed.

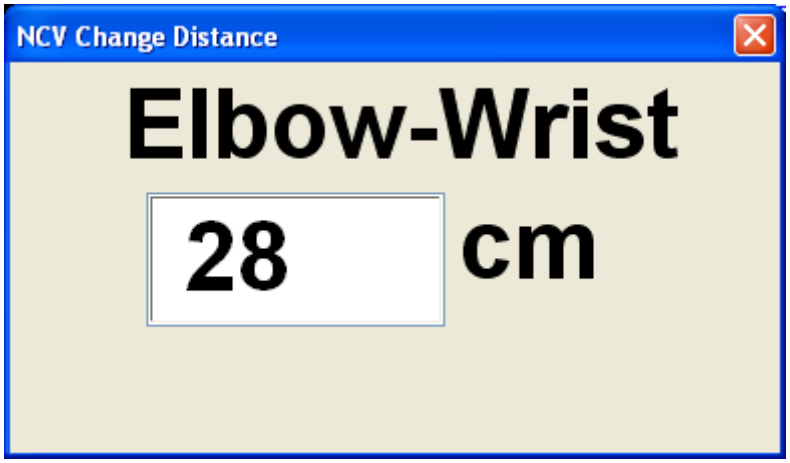


c. **Keep the original trace** for the site by clicking the **Close** button.

Distance

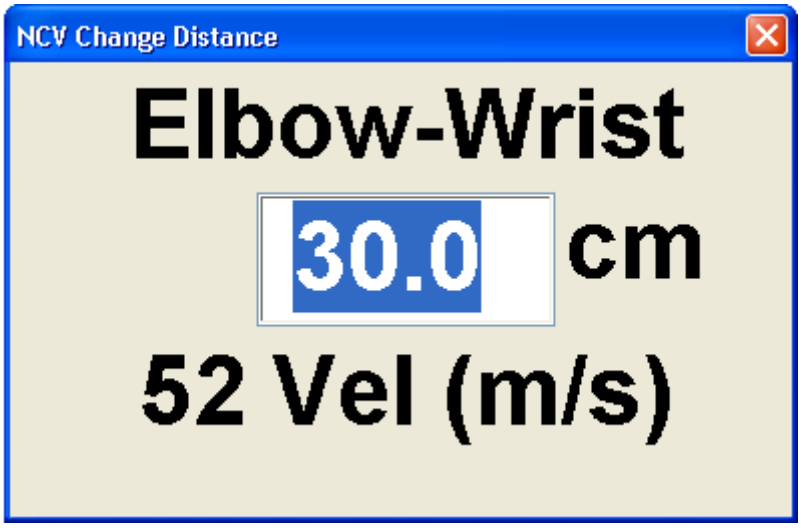
There are two ways to enter the distances into the NCV Segment table

- Press the **Distance key** on the **Sierra Wave base unit** or **click** on the appropriate distance field with the **mouse**. The first distance field will become activated and a small pop-up window is displayed showing the segment name and a place for the distance measurement, type the distance value and then press the **Enter key**. *You can also press the Distance key a second time instead of pressing the Enter key.*



Distance pop-up window.

- Press **Programmable button #1** on the **Electrical Stimulator handle**. A small pop-up window is displayed showing the segment name, distance value, and velocity. Now, **turn the wheel on the stimulator handle to increase or decrease the distance value in 0.5 cm increments**. When the correct distance value is reached, press **Programmable button #1** a second time or press the **Enter key**.



Distance pop-up window.

Repeat this process to enter distances for additional segments.

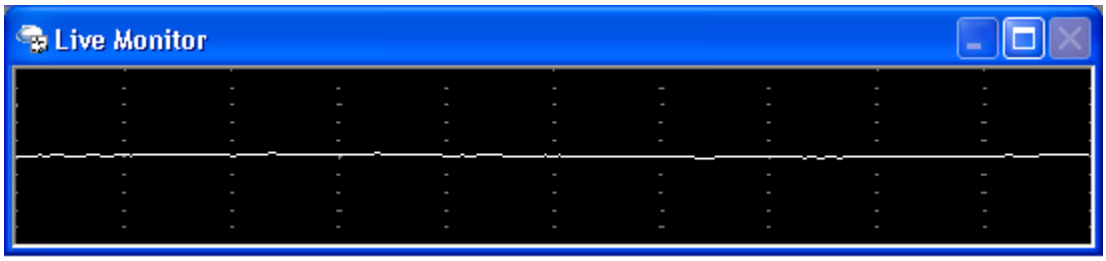
In order for the velocity calculation to be done correctly you must enter distance values in centimeters.

Live Monitor Window

A live monitor window is available in the NCV, F Wave, H-Reflex, Blink Reflex, and RNS test protocols.

When this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will return to displaying “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.



To Enable the Live Monitor window:

1. Start the Sierra Wave program.
2. Select a test protocol.
3. From the **Edit** menu, select **Current Test**.
4. Click on the **General Settings** tab.
5. Check the box labeled, **“Show Live Monitor”**.
6. Click **OK**.
7. Adjust the size and positions of the windows on the screen.
8. From the **Edit** menu, select **Save Test Parameters** to update the default settings for the test. From now on the test protocol will display the Live Monitor Window.

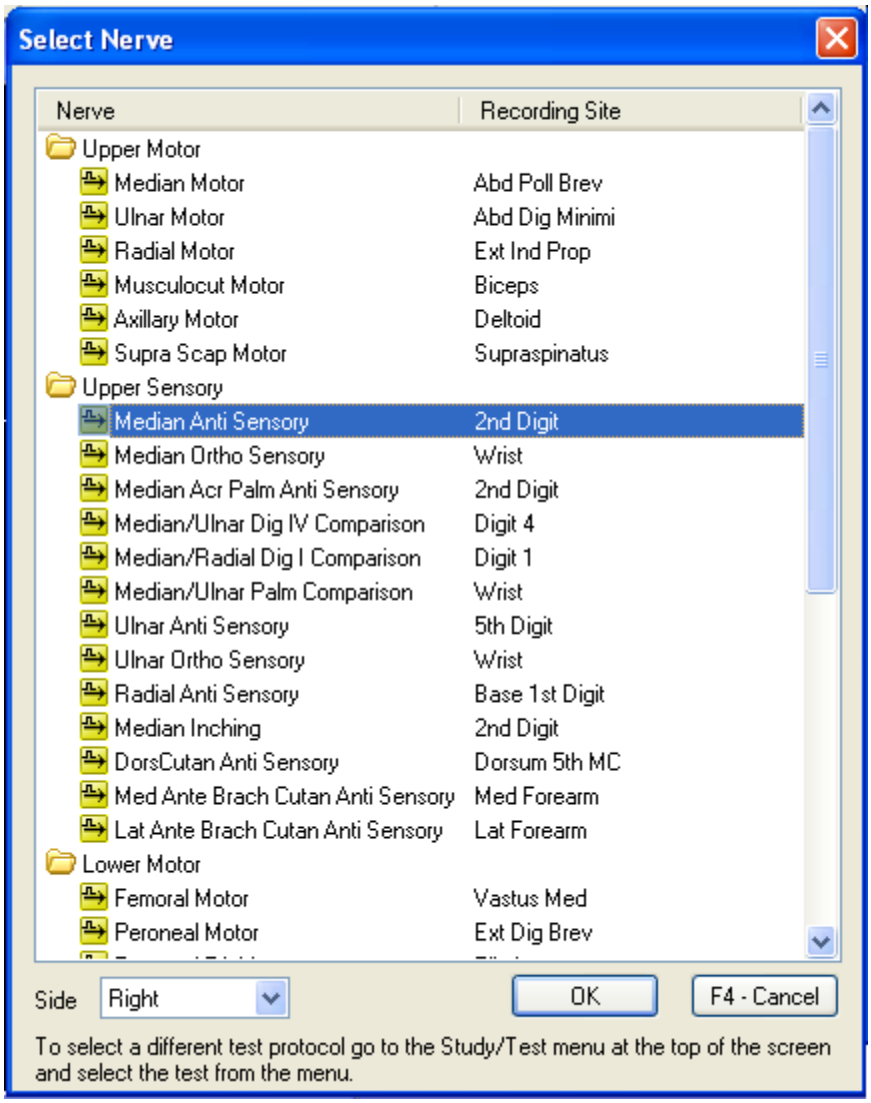
The Gain and Sweep Speed of the Live Monitor window are the same as the main Trace window.

Nerve List (F3)

The **F3 (Nerve List)** function key is a convenient way to add nerves to the Study window after a Study List has been selected or after the NCV Test Protocol has been loaded.

To Add a Nerve to the Study Window

1. From within the NCV Test Protocol, press the **F3 (Nerve List)** function key. The **Select Nerve** window will be displayed.



F3 - Select Nerve window.

2. To add a **single nerve**, perform one of the following.

   - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **verify the Side** parameter and then **double click** on the **nerve name**.

3. To add **multiple nerves**, perform one of the following.

   - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. Repeat this process until all of the nerves you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.
   - **Using the Mouse** - **single click** the mouse over the appropriate nerve names. Once all of the nerves have been selected, **verify the Side** parameter and then click **OK**.

Setting the **Side** parameter to **Left & Right** will add the nerve to the Study window twice, once for the Left side and once for the Right side.

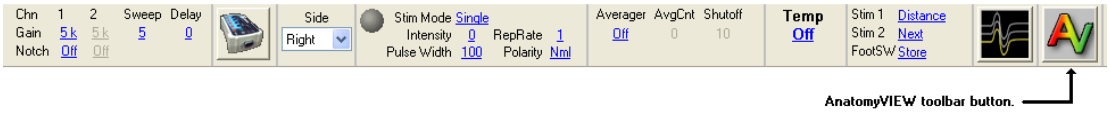
Adding nerves to the Study window in this manner is only temporary. To add nerves to a Study List permanently, review the help topic "Changing an Existing Study".

AnatomyVIEW - NCV

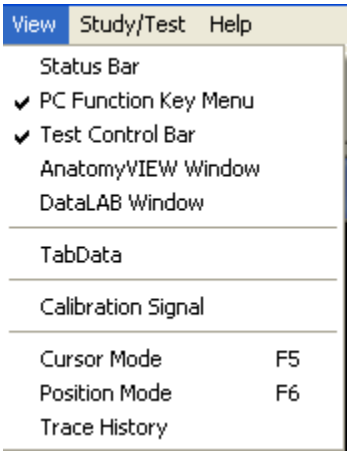
The AnatomyVIEW feature allows the NCV nerve segment data to be displayed on a 3D color-coded anatomical model. The AnatomyVIEW window can be included in reports.

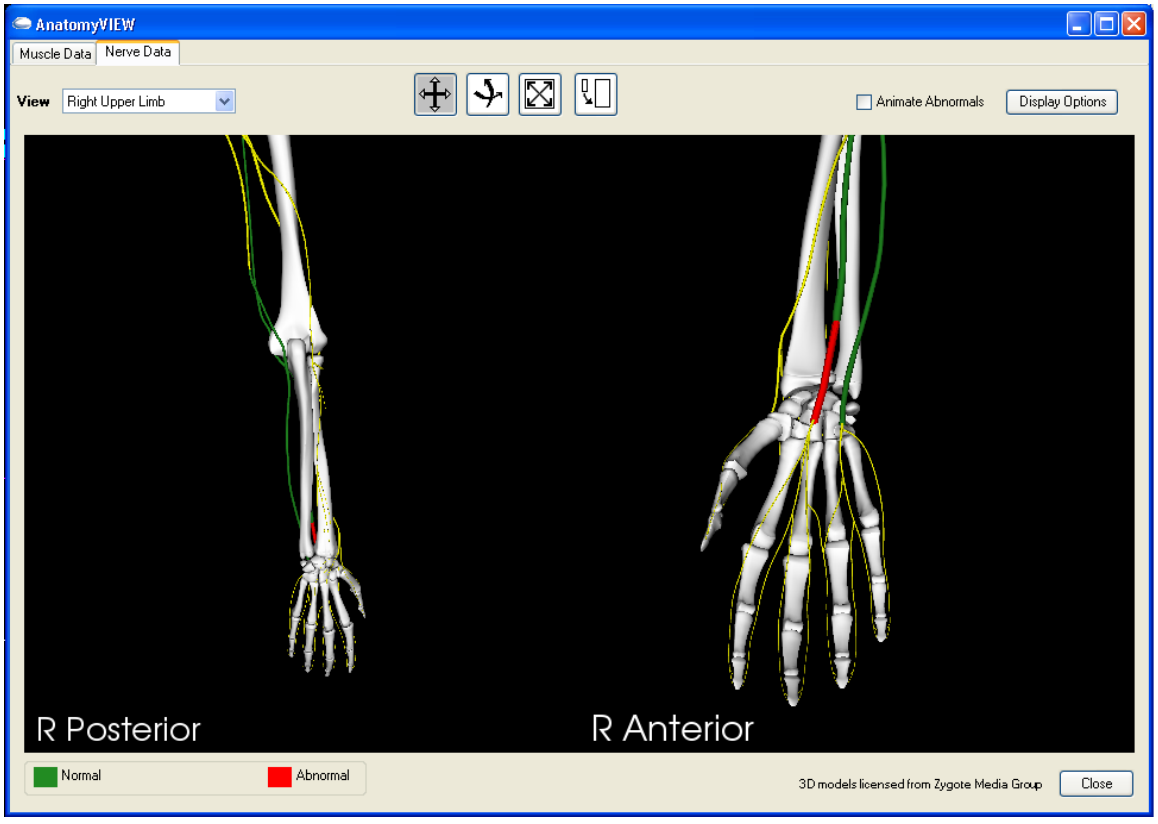
To open the AnatomyVIEW window, perform one of the following:

- Click on the **AnatomyVIEW button** in the NCV test controls toolbar.



- Select **AnatomyVIEW** from the **View menu**.





AnatomyVIEW window.

Site & Segment Tables

During NCV data acquisition you may need to make modifications to the NCV Site or Segment tables.

Site Table Changes:

Changing a site's name - To change the name of an existing site, simply click the mouse directly on the underlined site name. The box holding the site name will be changed into an edit mode, simply type the new name and then press Enter.

Site	NR	Onset (ms)	Norm Onset (ms)	O-P Amp (mV)	Norm Amp	Neg Dur (ms)
Wrist	_	2.3	<4.2	8.1	>3	6.09
B Elbow	_	7.5	_	7.5	_	6.25
A Elbow	_	10.5	_	7.0	_	6.41
Axilla	_		_		_	
_	_		_		_	

Axilla site name in Edit mode.

Adding a new site name to the last row - simply click the mouse in the site name box of the last row in the table. Type the name and then press Enter. The program always displays an empty row at the bottom of the site table to allow easy entry of additional sites.

Inserting a new site in between existing sites - right click the mouse over an existing row in the site table and select **Insert** from the pop-up menu. A new blank row will be inserted **above** the row that you right clicked on. Now click in the site name box, type the name for the new site and then press Enter.

Storing a Trace in an un-named site - if a trace is stored to an un-named site, the program will automatically insert a name for that site corresponding to the row's number within the site table.

Site	NR	Peak (ms)	Norm Peak (ms)	P-T Amp (µV)	Norm P-T Amp
Wrist	_	3.7	<3.6	40.7	>10
Elbow	_	9.3	_	11.9	_
_	_		_		_

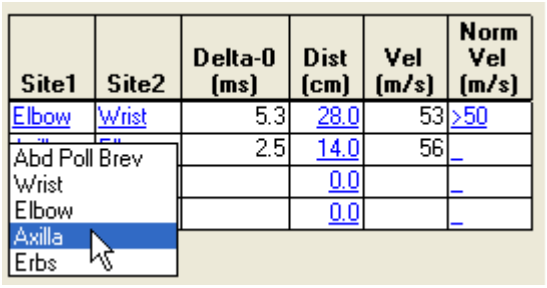
Original Site Table - two sites completed.

Site	NR	Peak (ms)	Norm Peak (ms)	P-T Amp (µV)	Norm P-T Amp
Wrist	_	3.7	<3.6	40.7	>10
Elbow	_	9.3	_	11.9	_
Site 3	_	3.7	_	27.3	_
Site 4	_	3.7	_	26.8	_
Site 5	_	3.6	_	24.9	_
_	_		_		_

Result of acquiring three addtional sites. New rows are automatically added and sites are labeled Site 3, Site 4, and Site 5.

Segment Table Changes:

Changing the sites within a segment - A nerve segment is composed of two sites. To change the sites that are being used to build a segment simply click the mouse over the Site 1 or Site 2 box you want to change, a pop-up list of the available site names and the recording site name will be displayed. Click on the desired name.



Clicking on the Elbow site produces a selection list.

Adding a new segment to the last row - simply click the mouse in the Site 1 box of the last row in the table. Select a name, now click within the Site 2 box for this row and select another name. The program always displays an empty row at the bottom of the segment table to allow easy entry of additional segments.

Inserting a new segment in between existing segments - right click the mouse over an existing row in the segment table and select **Insert** from the pop-up menu. A new blank row will be inserted **above** the row that you right clicked on. Now click in the Site 1 box, select the name for the first site, now click in the Site 2 box and select the name for Site 2.

Saving changes to the Site & Segment Tables:

To save any changes that were made to the Site or Segment table as the new defaults for the nerve,

- Select **Save Test Parameters** from the **Edit** menu.

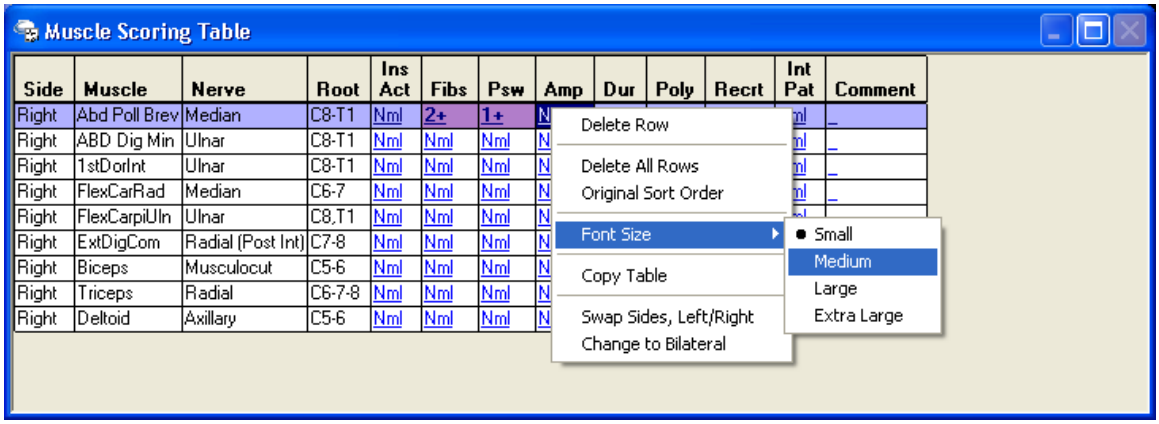
Changing the Columns that are displayed:

The columns that are displayed within the site and segment tables are specified in the NCV protocol's test setup parameters.

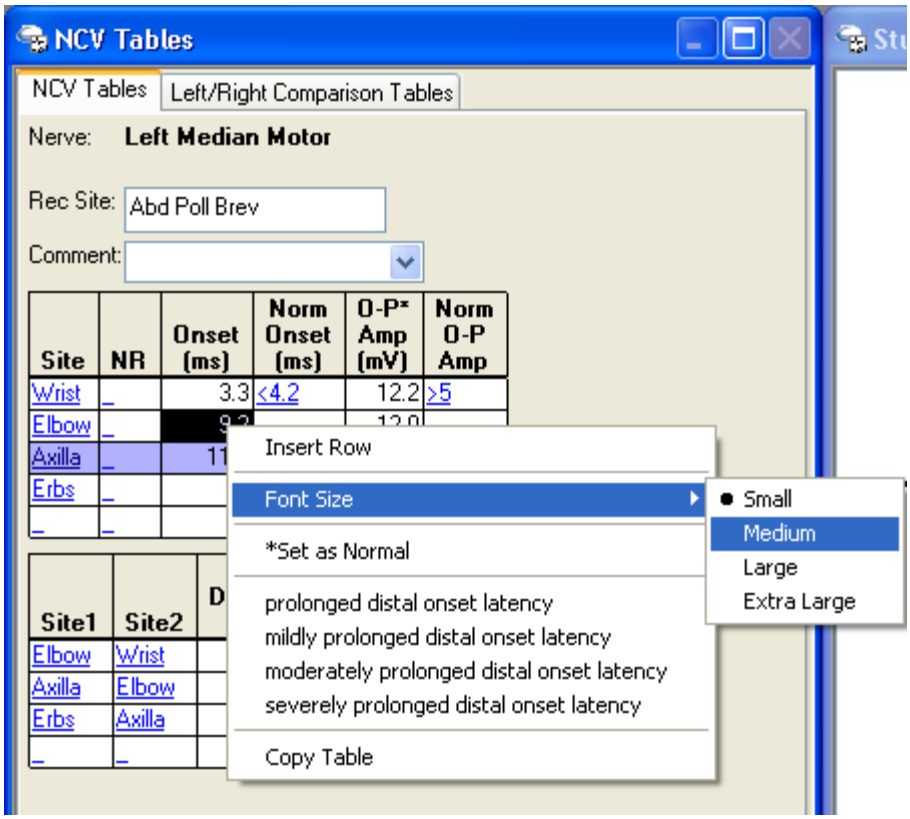
For information on **NCV Test Setup**, click here.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

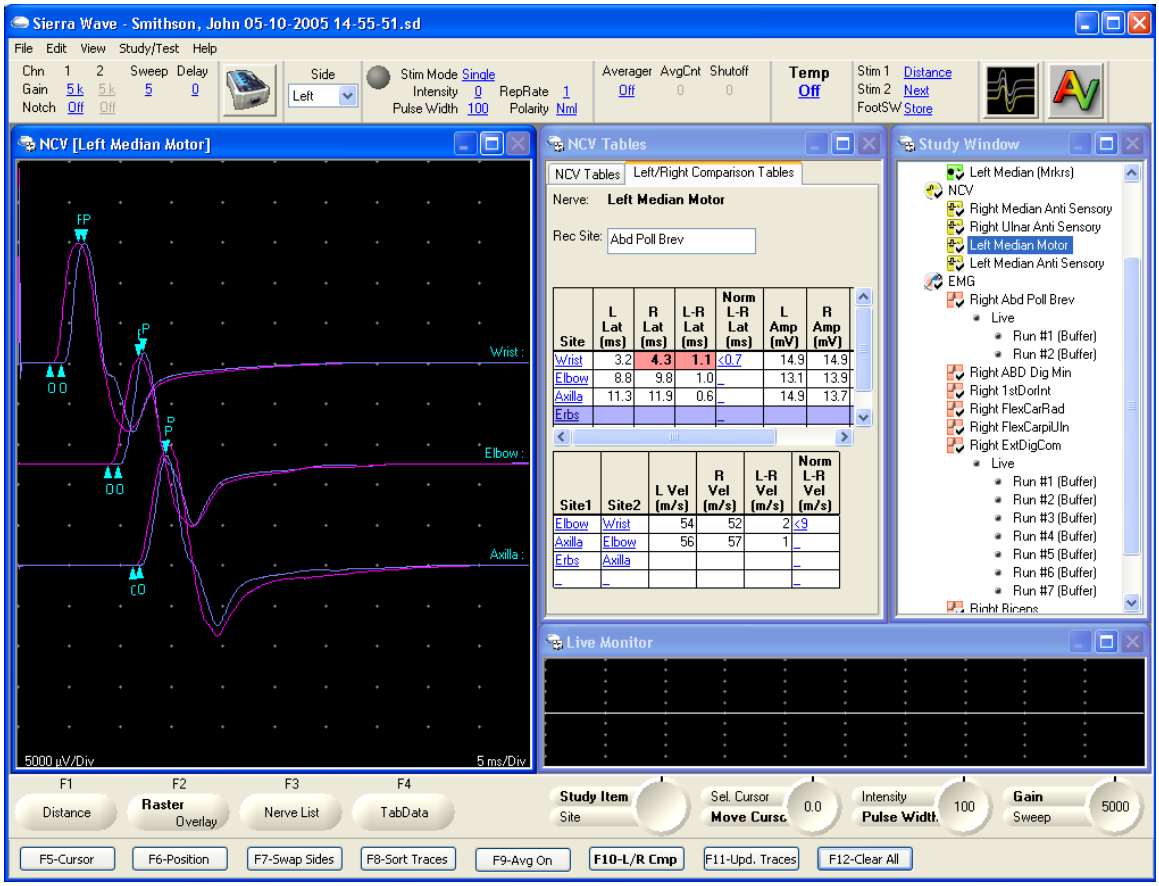
Compare Left vs. Right (NCV)

This feature allows for easy comparison of the latency, amplitude, and velocity differences between the left and right sides of a nerve. It also allows for a visual comparison of the traces obtained for each side.

To compare Left vs. Right sides perform one of the following.

- Press the **F10 - L/R Cmp** function key.
- Click on the **Left/Right Comparison Tables tab** in the NCV Tables window.

The Left/Right Comparison Tables will be displayed and the trace window will show the contralateral side's traces (in blue) overlayed on the current side's traces.



NCV test protocol showing the Left/Right Comparison Tables and the contralateral side's traces in blue.

Normal values can be entered for the side-to-side difference measurements with abnormal values flagged by the program.

Press the **F10 - L/R Cmp** function key a second time or click on the **NCV Tables tab** to return to the standard NCV display.

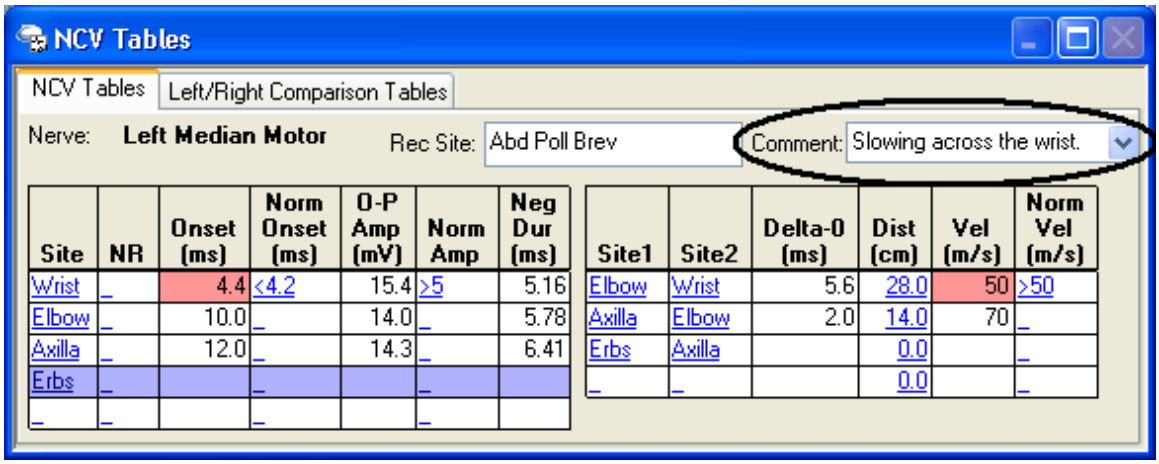
The contralateral traces can be toggled On/Off at any time by right-clicking over the trace window and selecting **Show Contralateral Traces**

Comment (NCV)

An optional comment can be entered on a per nerve basis. Simply click in the **Comment field** and enter the comment you would like to attach to the nerve.

The comment will appear in the TabData window and in reports.

The comment field will remember the last 20 comments that have been entered and these can be re-selected from a list using the drop-down arrow.



NCV Tables with a comment entered into the comment field.

Site	NR	Onset (ms)	Norm Onset (ms)	O-P Amp (mV)	Norm Amp	Neg Dur (ms)	Site1	Site2	Delta-0 (ms)	Dist (cm)	Vel (m/s)	Norm Vel (m/s)
Left Median Motor (Abd Poll Brev)							**Slowing across the wrist**					
Wrist		4.4	<4.2	15.4	>5	5.16	Elbow	Wrist	5.6	28.0	50	>50
Elbow		10.0		14.0		5.78	Axilla	Elbow	2.0	14.0	70	
Axilla		12.0		14.3		6.41						
Right Median Motor (Abd Poll Brev)												
Wrist		3.4	<4.2	14.3	>5	5.31	Elbow	Wrist	5.5	30.0	55	>50
Elbow		8.9		13.5		5.63	Axilla	Elbow	2.5	16.0	64	
Axilla		11.4		14.3		6.56						
Right Ulnar Motor (Abd Dig Minimi)												
Wrist		2.3	<4.2	8.1	>3	6.09	B Elbow	Wrist	5.2	28.0	54	>53
B Elbow		7.5		7.5		6.25	A Elbow	B Elbow	3.0	16.0	53	>53
A Elbow		10.5		7.0		6.41						

TabData table showing the comment on the same line as the nerve's name.

Repeat a Nerve

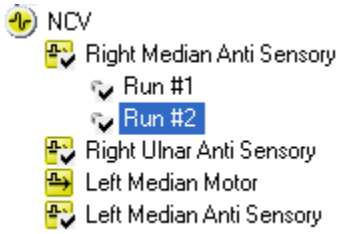
If you decide to repeat a nerve you have a choice of clearing the previously acquired data for the nerve or of keeping the previously acquired data.

To Clear the Previous Data & Repeat:

1. **Right click** the mouse **in the Trace window** over the previously acquired traces for the nerve. From the pop-up menu select **Delete All Stored Trials**.
2. A confirmation message will be displayed. Click **OK** and all previous data for the nerve is cleared.
3. **Acquire new data** for the nerve in the normal fashion.

To Keep the Previous Data & Repeat:

1. **Right click** the mouse over the **nerve's name** in the **Study window**. From the pop-up menu select **Start New Run**.
2. A second run node will be displayed under the nerve's name.
3. Acquire new data for the nerve in the normal fashion.
4. To view the first run done on the nerve select **Run #1** from the Study window. To view the second run done on the nerve select **Run #2**.



Two separate runs have been acquired for the Right Median Anti Sensory nerve.

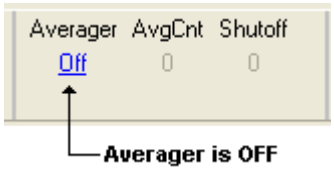
5. If you want **to delete one of the runs** for the nerve, simply **right click** over the run you want to delete and select **Delete** from the pop-up menu. A confirmation message will be displayed, click **OK** to delete the run.

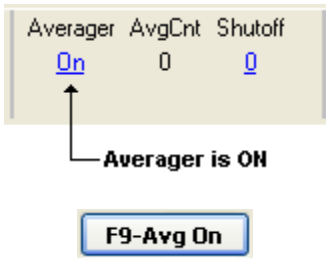
Averaging

Signal averaging can be used on difficult to obtain nerves and helps to produce a more stable baseline by improving the signal to noise ratio.

To Turn On the Signal Averager

1. In the **NCV Controls** toolbar, change the **Averager** setting from **Off to On** by clicking on it, or press the **F9 - Avg On** function key.





F9 - Avg On function key, bold text indicates the signal averager is On.

2. Stimulate the nerve by pressing the **Stim button** on the electrical stimulator handle or by pressing the **Single key** on the Sierra Wave base unit. With each subsequent stimulation the averaged response will be updated and displayed in the Trace window.
3. Once a satisfactory response has been obtained, press the **Store button** on the electrical stimulator handle or the **Store key** on the Sierra Wave base unit.

The averager will automatically return to the **Off** state when advancing to the next stimulus site.

You can also stimulate repetitively by pressing the **Run/Stop** button on the Sierra Wave keyboard. In this mode the program will stimulate the nerve until it reaches the predefined **Shutoff Count.**

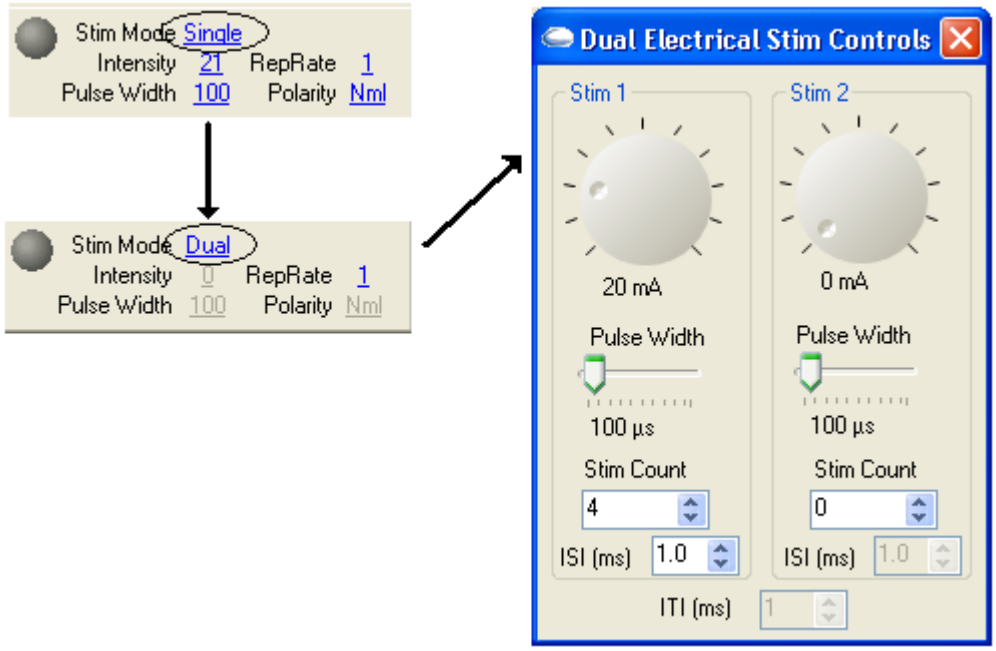
Collision Study

Train Stimulation and Collision Study Option

Train stimulation can be performed using the standard Sierra Wave electrical stimulator, performing Collision Studies requires the use of the ES2 dual output stimulus splitter box.

To perform Train Stimulation using the standard electrical stimulator:

1. Select the **NCV test protocol**.
2. In the stimulator section of the parameter toolbar - change the stimulus mode from **Single** to **Dual** mode. The **Dual Electrical Stim Controls** window will be displayed.

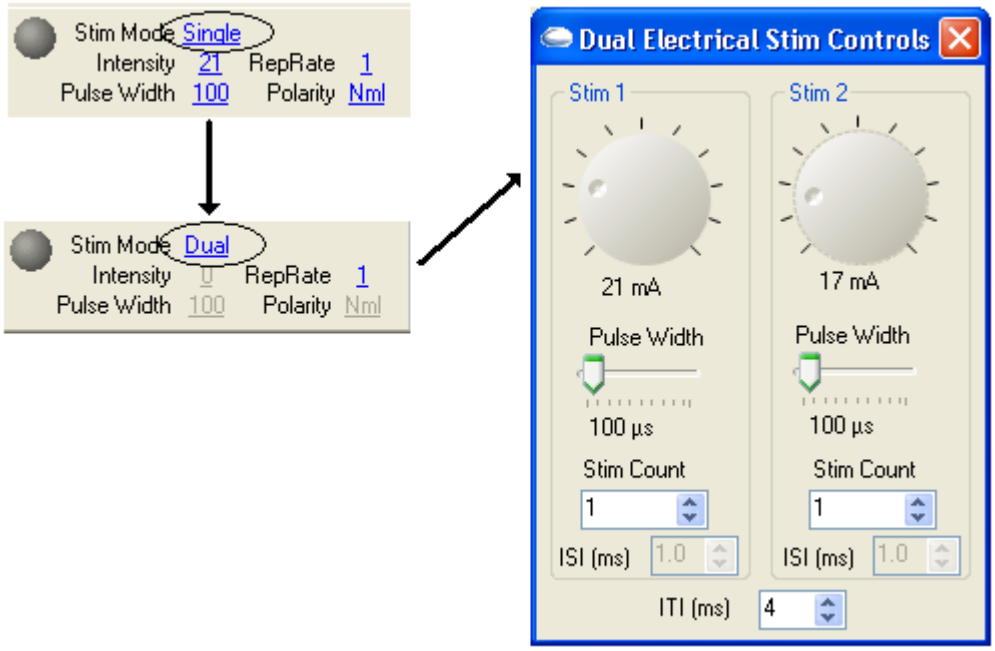


Train of 4 pulses configured for stimulator #1.

3. Set the **Stim Count** for stimulator #1.
4. Set the **ISI** value for stimulator #1 (if the Stim Count is more than 1).
5. Set the **Pulse Width** and **Intensity** for stimulator #1.
6. Position the stimulator.
7. Stimulate by pressing the **Stim button** on the handheld electrical stimulator or by pressing the **Single key** on the Sierra Wave base unit.

To perform Collision Studies using the ES2 stimulus splitter box:

1. Connect the **ES2** stimulus splitter box.
2. Select the **NCV test protocol**.
3. In the stimulator section of the parameter toolbar - change the stimulus mode from **Single** to **Dual**. The Dual Electrical Stim Controls window will be displayed.



One pulse from each stimulus output separated by 4 msec.

4. Set the **Stim Count** for stimulator #1 and for stimulator #2.
5. Set the **ISI** value for stimulator #1 and for stimulator #2 (if Stim Count is more than 1).
6. Set the **Pulse Width** and **Intensity** for stimulator #1.
7. Set the **Pulse Width** and **Intensity** for stimulator #2.
8. Apply stimulus leads to the patient and connect the leads to the #1 and #2 outputs on the **ES2**.
9. Stimulate by pressing the **Single key** on the Sierra Wave base unit.

Specifications for Train and Collision Study stimulation:

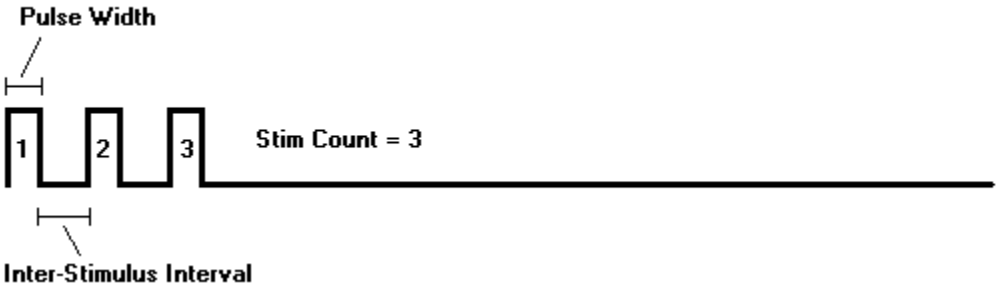
Single Train Mode (Stim #1 output only)

Stim Count: 1 to10

ISI (inter-stimulus interval): 1.0 to 20 milliseconds

Pulse Width: 50 to 1000 microseconds

Intensity: 0 to 100 milliamps



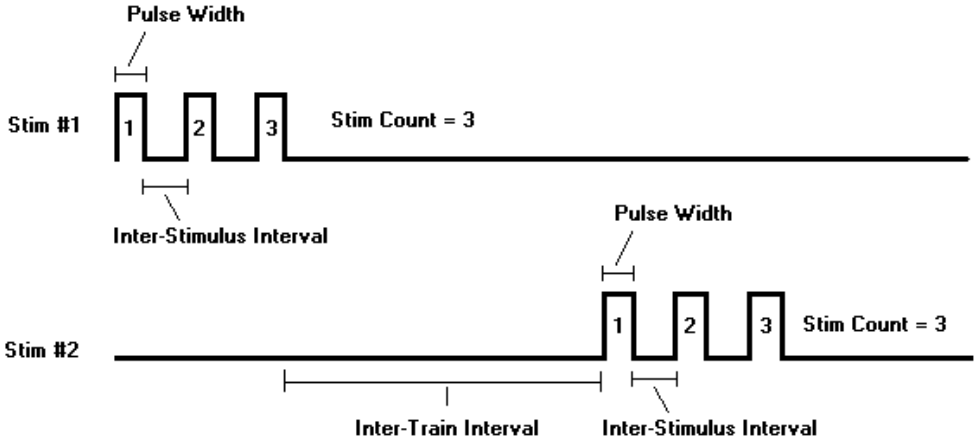
Collision (Dual Train) Mode: (Requires ES2 Stimulus Splitter Box)

Stim Count: 1 to 10 for each stimulator

ISI (inter-stimulus interval): 1.0 to 20 milliseconds each stimulator

ITI (inter-train interval): 1.0 to 65 milliseconds

Pulse Width: 50 to 500 microseconds each stimulator



Please contact the **Cadwell Customer Service Department** if you are interested in purchasing the ES2 stimulus splitter box.

ES2 dual output stimulus splitter box.

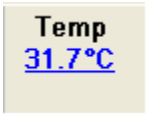
Recording Temperature

Using the Surface Temperature Probe:

The patient's temperature can be measured and recorded using the optional skin surface temperature probe.

Connect the temperature probe to the connector labeled "Temp" on the back of the Sierra Wave base unit.

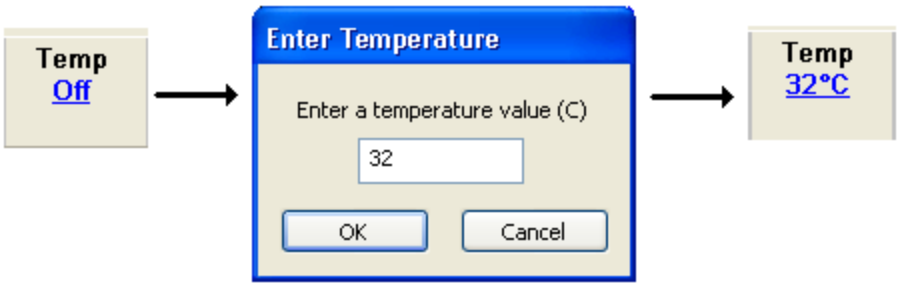
The temperature is displayed in the Controls window or Controls Toolbar as follows;



To turn the temperature reading **Off**, simply **click on the underlined temperature value**. You don't need to disconnect the temperature probe.

Without a Surface Temperature Probe:

Simply click on the **Temp Off** control at the top of the screen, enter the temperature value in the pop-up window and click **OK**. The entered value will remain on the screen until you click on the value and clear it, which sets the control back to the Off state.

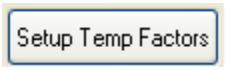


Temperature Corrected Velocity

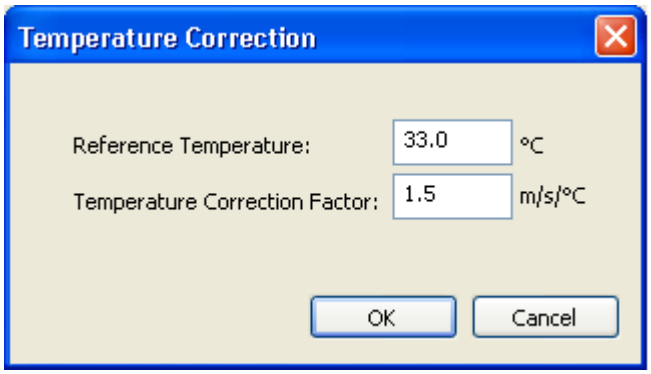
Individual nerves can be configured to apply a temperature correction factor to the patient's measured velocity. This is done in the NCV Test Setup window.

To use Temperature Corrected Velocity:

1. From the **Edit** menu, select **Test Menu**.
2. Click on the **NCV** test protocol in the **Test List**.
3. Select a **Nerve** in the **Nerve List.**
4. Click on the **Setup Temp Factors** button.



5. Enter the **Reference Temperature** (in °C), and the **Correction Factor** (meters/sec per °C) for the selected nerve.



6. Click **OK**.
7. Check the box **"Use Temp Correction"**.

If the patient's measured temperature is below the reference temperature -- for every degree that is below the reference temperature the program will add the

correction factor to the displayed velocity value. This will be indicated by the letter "T" after the velocity value.

Using the above reference temperature and correction factor:

If the patient's temperature was measured at 30°C, the program would add 4.5 (1.5 x 3) to the velocity value.

8. Repeat steps 3 to 7 for other nerves in the nerve list.
9. Click **OK** to close the Test Menu window and save your changes to the Nerve's settings.

Clear All Traces

There may be times when you want to clear all the traces that have been acquired for a nerve.

To Clear All Traces for a Nerve:

Perform one of the following.

- **Right click** the mouse **in the Trace window** over the previously acquired traces for the nerve. From the pop-up menu select **Delete All Stored Trials**.
- **Press** the **F12-Clear All** function key.

A confirmation message will be displayed. Click **OK** and all previous data for the nerve is cleared.

Delete a Selected Trace

There may be times when you want to delete only an individual trace for a nerve while keeping the rest of the traces.

To Delete a selected NCV trace, perform one of the following.

- **Using the Mouse** - **select the trace** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trace color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trace will be deleted.
- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #3 (Sel Trace / Delete)** until the trace you want to

delete is selected, a selected trace is displayed in yellow. **Press the knob to delete** the selected trace. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

Delete a Nerve

To delete a nerve from the Study window,

- **Right click** the mouse over the nerve name in the Study window. From the pop-up menu select **Delete**.

Trace Positioning

There are several methods of changing the vertical positions of the NCV traces within the Trace window.

Using the Mouse:

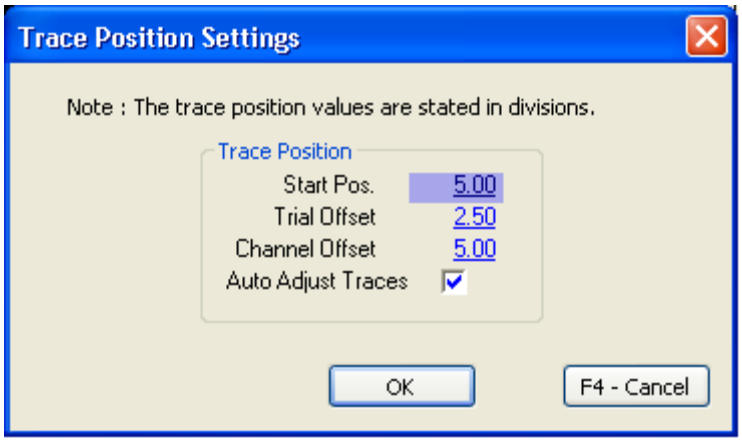
Left click on the trace you want to move **and drag** the trace to it's new location. Press the **F11-Upd. Traces** function key to update the Site table based on the new trace positions.

Using the Knobs:

1. Enter the **Position mode** by pressing the **F6** function key on the PC's keyboard.
2. Turn **Knob #1 (Sel Trace / Move)** until the trace you want to move is selected. A selected trace is displayed in yellow rather than purple.
3. **Press the knob** to activate the **Move** mode, now turn the knob to move the selected trace up or down.
4. Press the knob a second time to return to the **Sel Trace** mode.

Using the Trace Position Settings:

1. **Right click** over the **NCV Trace** window.
2. From the pop-up menu, select **Trace Position Settings**. The Trace Position Settings window will be displayed.



Trace Position Settings window.

3. Change the listed parameters, then click **OK**.

   Start Position: This is the default trace position for the first trace in the window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

   Trial Offset: This setting determines how much space will separate each stored NCV trace. In this example the setting is 2.5 divisions, therefore the second NCV trace will be displayed 2.5 divisions below the first trace. If a third NCV trace is acquired it will be displayed 2.5 divisions below the second NCV trace and so on.

   Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the two Live channels.

   Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the Trace window.

Stimulator Polarity

Press the **Reverse Polarity (+/-) button** on the electrical stimulator handle to select the Cathode (i.e., the negative stimulus probe). A green LED indicates the probe that is the Cathode. **For routine nerve conduction, RNS, and Blink Studies the Cathode (-) should be oriented closest to the recording electrodes.**

Clicking on the **Polarity field** in the **Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., Normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe

the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

Change Gain of a Selected Trace

To change the gain of a selected NCV trace, perform the following.

1. **Select the Trace** you want to change.
    - **Using the Mouse** - simply left click the mouse over the trace, when selected the trace will be displayed in yellow rather than purple.

- **Using the Knobs** - enter **Position mode** by pressing the **F6** function key on the PC's keyboard. Turn **Knob #1 (Sel Trace / Move)** until the desired trace is selected.

2. Now, **turn Knob #4 (Gain)**, the selected trace will be changed and it's current gain value will be displayed on the knob's icon.

 To change the gain of **all the NCV traces** at one time, simply turn **Knob #4 (Gain / Sweep)**.

Smooth Traces

High frequency noise can be removed from the NCV traces by applying a digital smoothing filter.

To Smooth All Traces:

- **Using the Mouse** - **right click** over the NCV Trace window and select **Smooth All** from the pop-up menu.
- **Using the Knobs** - enter **Position** mode by pressing the **F6** function key on the PC's keyboard. Now press the **F2 (Smooth All)** function key.

To Smooth a Selected Trace:

- **Using the Mouse** - select the trace you want to smooth by **left clicking** the mouse over it. When selected, the trace will be displayed in yellow. Now, **right click** the mouse and select **Smooth** from the pop-up menu.
- **Using the Knobs** - there is no method for performing this function using the knobs.

To Remove Smoothing:

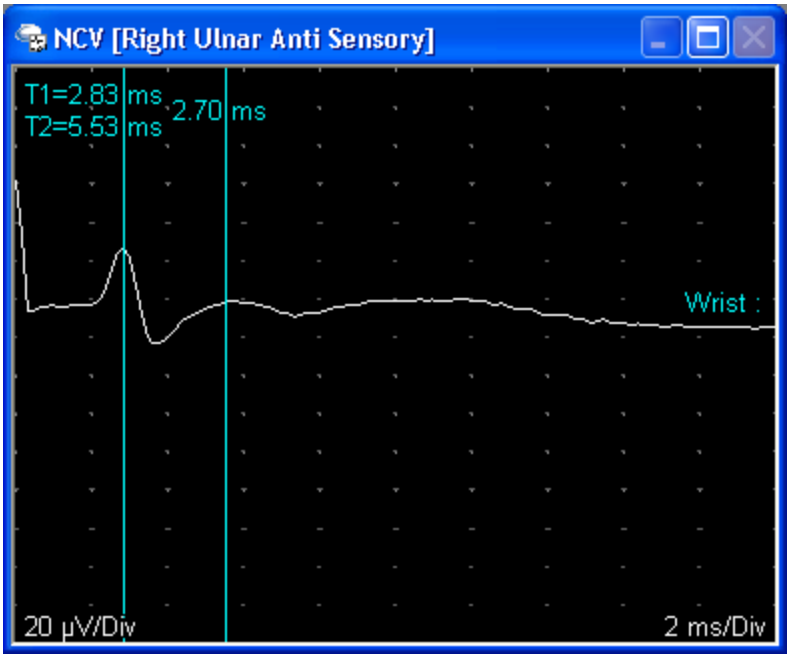
Right click the mouse over the NCV Trace window. Select **Unsmooth All** from the pop-up menu.

Time & Amplitude Marker

To quickly measure the latency or amplitude of a nerve response, use the Time & Amplitude Markers.

Using the Time Markers

- **Right click** over the **NCV Trace window** and **select Time Markers** from the pop-up menu. Two vertical time markers will be displayed.
- **Move** the markers **by clicking** on them with the mouse **and dragging** them across the window.
- The **latency**, in milliseconds (from the left edge of the Trace window), is displayed for each Time Marker in the **upper left hand** corner of the Trace window. The **difference** between the two time markers is also indicated.
- To **remove** the Time Markers from the window, **right click** over the **NCV Trace window** and **de-select Time Markers** from the pop-up menu.

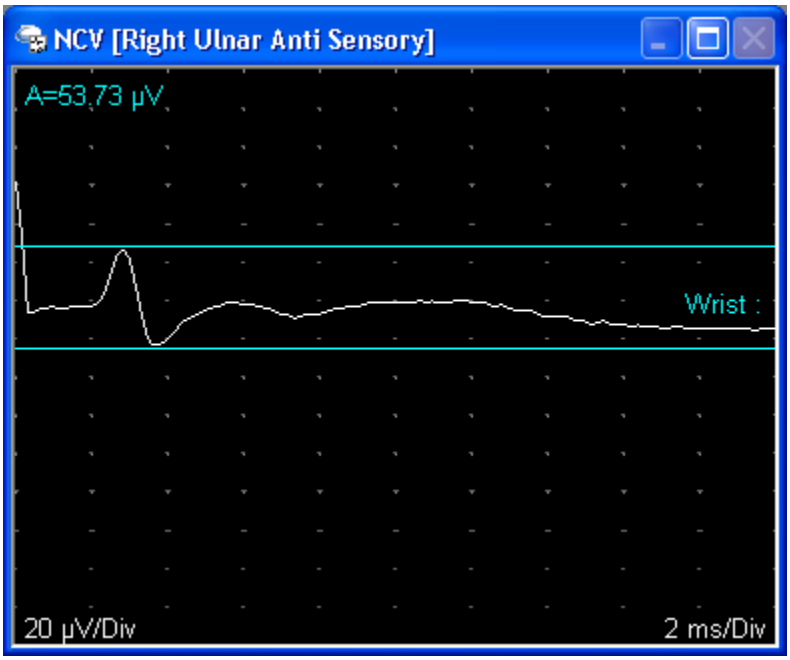


NCV Trace window with Time Markers.

Using the Amplitude Markers

- **Right click** over the **NCV Trace window** and **select Amplitude Markers** from the pop-up menu. Two horizontal amplitude markers will be displayed.
- **Move** the markers **by clicking** on them with the mouse **and dragging** them up or down in the window.
- The **amplitude**, in microvolts, between the two amplitude markers is shown in the **upper left hand** corner.

- To **remove** the Amplitude Markers from the window, **right click** over the **NCV Trace window** and **de-select Amplitude Markers** from the pop-up menu.



NCV Trace window with Amplitude Markers.

Time & Amplitude Marker values are not displayed in the NCV Site Table.

Saving Changes to NCV Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the Nerve.

- Select **Save Test Parameters** from the **Edit** menu.

F Wave (Markers)

F Wave (Markers) Basics

This topic is a repeat of the basic F Wave steps found in the **Getting Started** chapter.

Select the F Wave Test:

- **If a Study has already been selected**, simply click on an F Wave nerve name (i.e., Right Median) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual F Wave protocol from the **Study/Test** menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing a routine F Wave (Markers mode) data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

Typical Settings

	Gain (uV/Div)	Split Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
F Wave	5k	500	10k	20	5.0 or 10.0

2. **Electrode Placement**

   Attach the electrodes to the patient.

3. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

4. **Check Stimulator Polarity**

   For F Wave Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **F Wave Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate the Nerve

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit, or the **Single button** in the F Wave Controls window, can also be used to deliver a single stimulus.

 **Repetitive stimulation** can be delivered by pressing the **Run/Stop button** on the Sierra Wave base unit or by clicking on the **Run button** in the F Wave Controls window.

In general, F Waves are performed with supramaximal stimulus intensity.

If the M Wave or F Wave response amplitude is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change the gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain M / Gain F)** on the Sierra Wave base unit.

6. Store the Response

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

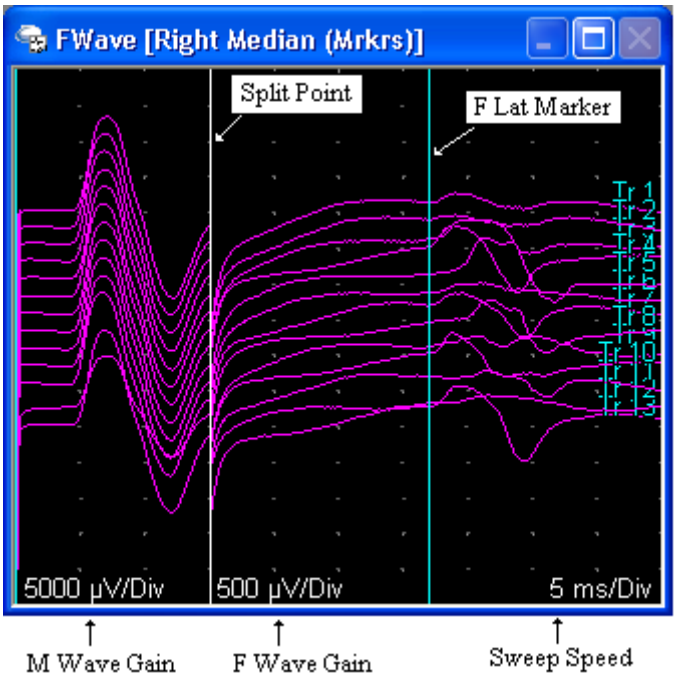
Stored traces will be displayed in "purple" color on the screen.

7. Continue to Stimulate and Store until 10 or 20 responses have been acquired.

8. Adjust Latency Marker

To adjust the latency marker, perform one of the following:

- Turn **Knob #2 (F Wave Lat / M Wave Lat)** on the Sierra Wave base unit to move the F latency marker to the minimal F Wave latency. Changing the **F2 (Raster / Overlay)** function key to **Overlay mode** can be helpful when positioning the latency marker. The latency value is displayed in the **F Wave Table** window.
- Press the **F8 (Auto F-Lat)** function key. The program will automatically move the latency marker to the earliest onset latency. In addition, a pop-up window will show the latency value and the wheel on the stimulator handle can be used to adjust the position of the marker. Once the marker has been positioned, press the F8 function key a second time to exit this mode.



Example F Wave Trace window.

9. Compare Left vs. Right side Traces (optional)

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side.

The traces for each side are displayed in separate windows, stacked vertically on the screen. The top window contains the traces for the current side.

Press the **F10 - L/R Cmp** function key a second time to return to the standard F Wave display.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for summary Tables (i.e., F Wave Markers, Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another F Wave nerve in the **Study** window.
- **Click** on another F Wave nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (F Wave Markers)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

FWave Lat / MWave Lat - this knob defaults to the **FWave Lat** mode and can be used to move the F Wave latency marker across the trace window to the minimal F Wave latency. Press the knob to activate the **MWave Lat** mode and turn to move a second latency marker to the onset of the M Wave.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press the knob to activate the **Pulse Width** mode and then turn to adjust the pulse duration of the stimulus (in microseconds).

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Manual / Autostore - In **Manual** mode the Store key must be pressed after each stimulation. In **Auto-Store** mode the program will automatically store each trace after stimulation. The initial status of this key can be programmed in the Test Menu Editor.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key

switches to **Overlay** mode which will superimpose all traces on top of one another.

Nerve List - opens the F Wave Nerve List window which allows you to select and add nerves to your Study window.

TabData - opens the TabData Summary window.

PC Function Keys (F5-F12)

F5-Cursor - enables Cursor mode (see below).

F6-Position - enables Position mode (see below).

F7-Swap Sides - press to swap the side parameter for the nerve.

F8 - Auto F-Lat - press to have the program automatically move the F-Latency marker to the minimum onset latency.

F10-L/R Cmp - press to display the opposite side's traces.

F12-Clear All - press to delete all traces for the nerve.

Cursor mode (F5)

Knobs

F Lat / M Lat - this knob defaults to the **F Lat** mode and can be used to move the latency marker on the F Wave side of the Trace window. Press the knob to activate the **M Lat** mode and turn to move the latency marker on the M Wave side of the Trace window.

Amp 1 / Amp 2 - this knob defaults to the **Amp 1** mode and can be used to move amplitude marker #1 within the F Wave side of the Trace window. Press the knob to activate the **Amp 2** mode and turn to move amplitude marker #2 within the F Wave side of the Trace window. *Prior to moving these markers you will need to press the F3 function key to toggle the amplitude markers from Off to On.*

Split Pt - turn this knob to move the gain split point indicator within the Trace window.

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to

activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

AmpMrk On / Off - defaults to **AmpMrk Off** mode. Press this key to turn the amplitude markers On.

Lat Mrk On / Off - defaults to **LatMrk On** mode. Press this key to turn the latency markers Off.

Position mode (F6)

Knobs

Sel Trace / Move - defaults to the **Sel Trace** mode, turn this knob to select a stored F Wave trace. When selected, the trace will be displayed in yellow color. Press the knob to activate the **Move** mode and then turn to move the selected trace up or down within the Trace window.

Sel Trace / Delete - defaults to the **Sel Trace** mode, turn this knob to select a stored F Wave trace. When selected, the trace will be displayed in yellow color. Press the knob to **Delete** the selected trace.

Split Pt - turn this knob to move the gain split point indicator within the Trace window.

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Smooth All - each time this key is pressed the traces will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

F Wave Test Setup

F Wave test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here to go to this topic.

Normal Values (F Wave)

From the **Edit menu** select **Test Menu**. When the Test Menu Setup window is displayed click on the **F Wave** test protocol in the test list. The F Wave test protocol settings will be displayed on the right hand side of the screen.

In the **Nerve List**, select the nerve you want to make changes to.

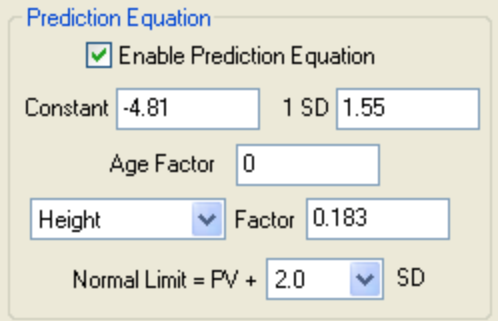
There are two methods for entering normal values; **Simple Value Limit** or **Prediction Equation**.

- **Simple Value Limit:**

  Click in the normal value column of the nerve list and type the desired value. For example, <33.0.

- **Prediction Equation:**

  The normal F wave latency can be predicted using the patient's **Age** and **Height**. To use the prediction equation, check the box labeled **Enable Prediction Equation**. You can then input the factors for Age, Height, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. If the equation is enabled, the normal value in the nerve list is ignored and the norm will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height** have been input in the Patient Information window.



The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

If the standard deviation is known then:

Normal Value = Predicted Value + 'x' Standard Deviations

Typically:

F Wave Latency Norm = Predicted Value + 2 SD

To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background.** Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

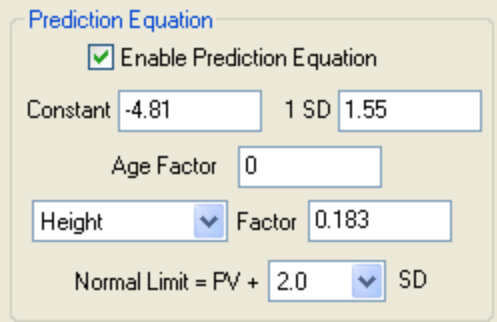
There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

Using Prediction Equation (F Wave markers)

Normal values can be predicted using the patient's **Age** and **Height**. This topic will outline the steps needed to enable the prediction equation for the Median (markers) F Wave test. Follow these same steps to program equations for other nerves in the nerve list.

Setup Steps:

1. From the **Edit menu**, select **Test Setup**.
2. Select the **F Wave** test.
3. Select a nerve in the **Nerve List** (i.e., Median markers). You will see a section in the setup parameters called **Prediction Equation**.
4. To enable the prediction equation, **check the box** next to **Enable Prediction Equation**.
5. Enter the appropriate values for Constant, Age Factor, Height Factor, and one Standard Deviation.



To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

6. Repeat steps 1-5 for other nerves.
7. Click **OK** to close the Test Setup window.

Data Acquisition Mode:

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background.** Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

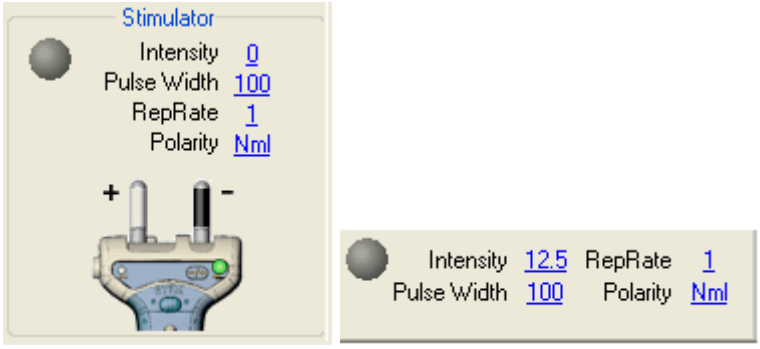
Stimulator Polarity

For F Wave Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **F Wave Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

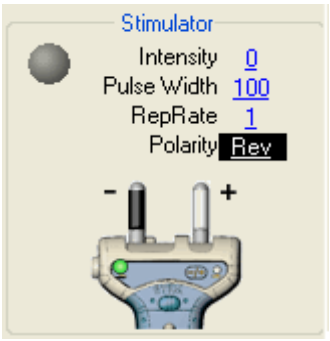
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

Swap Sides

To swap the side parameter on a nerve, perform one of the following.

- **Right click** the mouse over the **nerve name** in the **Study window**. From the pop-up menu select **Swap Sides**.
- Press the **F7 function key** on the PC's keyboard. In the F Wave test protocol the F7 key is always assigned the Swap Sides function.

If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

If the side you are swapping to already has stored traces, then a second run will be automatically added to that existing nerve.

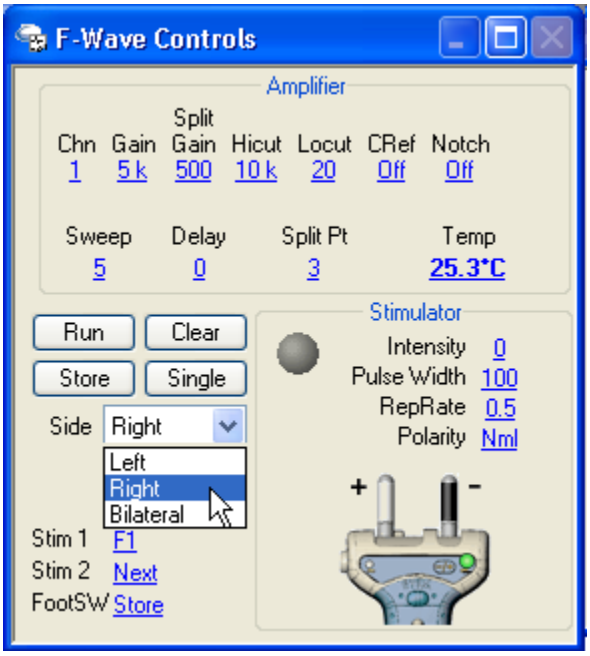
Change Sides

Changing the Side parameter for a nerve is different than Swapping Sides. When you change sides, the highlight in the Study window simply moves to that nerve in the Study window. No traces are transferred.

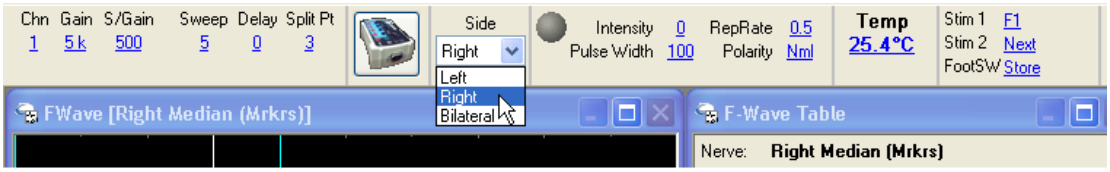
If the nerve corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **F Wave Controls window**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



In the **Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.

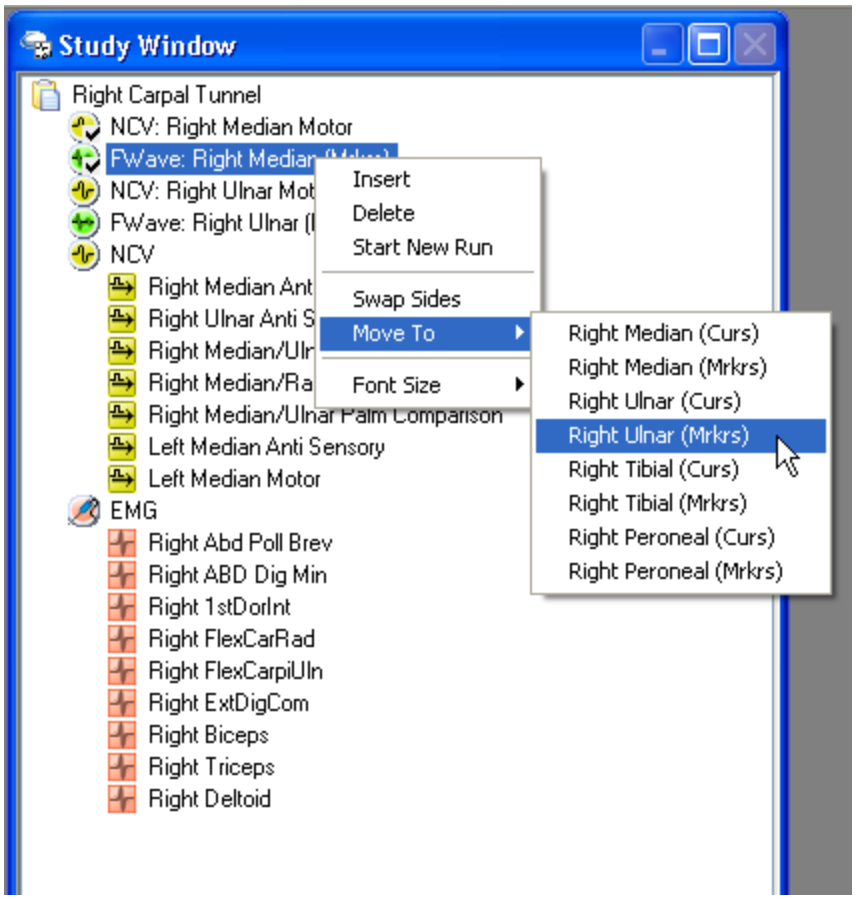


Move To

This feature allows the F Wave traces to be moved to a different nerve. For example, median nerve traces can be moved to any other nerve in your F Wave nerve list.

To Move the traces to another nerve:

- **Right click** the mouse over the nerve in the Study window.
- Select **Move To** from the pop-up menu.
- Select a nerve from the displayed list.



The position of the latency marker is not moved with the traces, you will have to reset its position after the move.

No Response

If no response can be obtained you can indicate this using the **NR** column in the F Wave Table.

Simply click within the **NR column** just to the left of the F Wave Latency. The text "NR" will be displayed and any latency values for the site will be cleared.

Nerve: **Right Median (Mrkrs)** Rec Site: Abd Poll Brev

NR	F-Lat (ms)	Lat Norm (ms)	Contra F-Lat (ms)	L-R F-Lat (ms)	L-R Lat Norm	Distance	F-Velocity
NR		<33			<2.2		

F Wave Table with no response indicated.

If you mistakenly mark the test as no response, click on the "NR" text and it will be removed and the latency marker values will be restored.

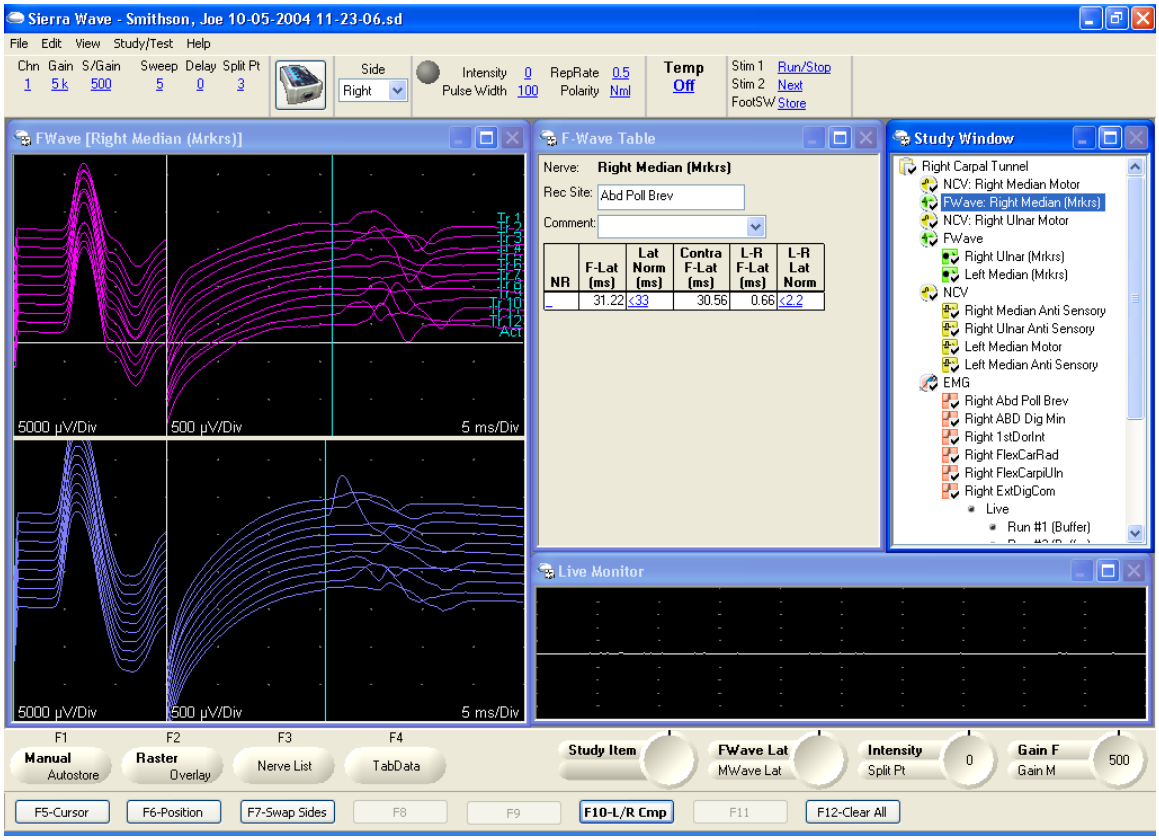
Compare Left vs. Right (F Wave)

This feature allows for a visual comparison of the traces obtained for each side.

To compare Left vs. Right sides.

- Press the **F10 - L/R Cmp** function key.

The trace window will show the current side's traces in the top window and the contralateral side's traces (in blue) in the bottom window.



F Wave test protocol, left side traces in top window, right side traces in bottom window.

Press the **F10 - L/R Cmp** function key a second time to return to the standard F Wave display.

The F Wave Table always shows the **Contra F Latency**, **L-R F Latency**, and **L-R Latency Norm** (if entered for the nerve).

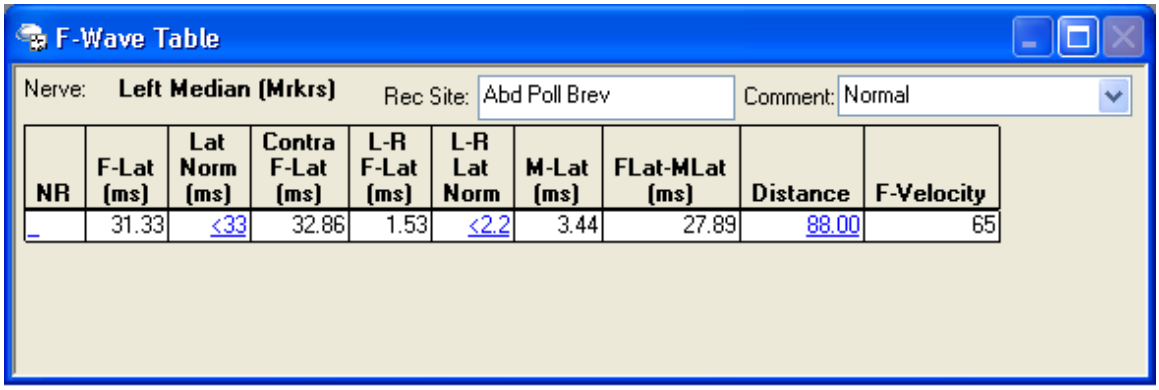
The contralateral traces can be toggled On/Off at any time by right-clicking over the trace window and selecting **Show Contralateral Traces**

Comment (F Wave)

An optional comment can be entered on a per nerve basis. Simply click in the **Comment field** and enter the comment you would like to attach to the nerve.

The comment will appear in the TabData window and in reports.

The comment field will remember the last 20 comments that have been entered and these can be re-selected from a list using the drop-down arrow.



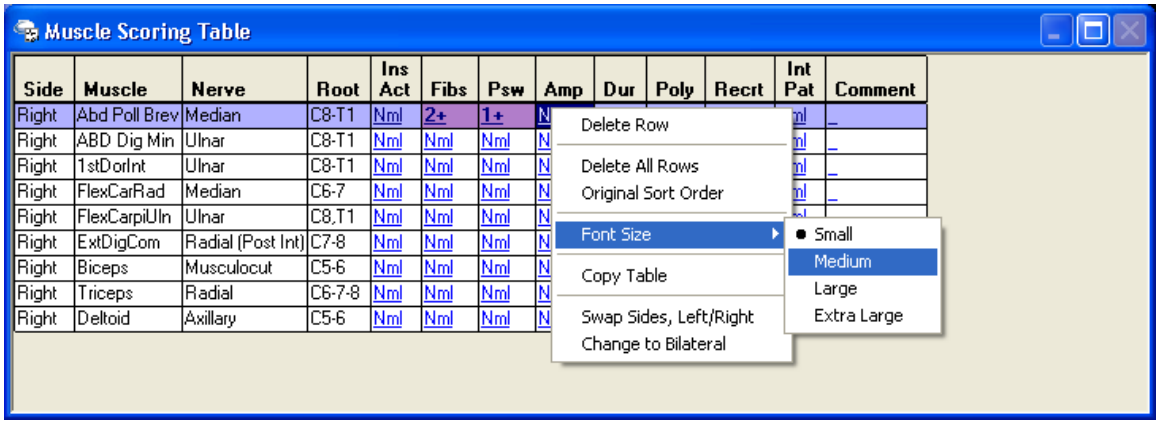
F Wave Table with a comment entered into the comment field.

NR	F-Lat (ms)	Lat Norm (ms)	Contra F-Lat (ms)	L-R F-Lat (ms)	L-R Lat Norm	M-Lat (ms)	FLat-MLat (ms)	Distance	F-Velocity
Left Median (Mrkrs) (Abd Poll Brev) 30.6°C Normal									
	31.33	<33	32.86	1.53	<2.2	3.44	27.89	88.00	65
Right Median (Mrkrs) (Abd Poll Brev) 30.6°C									
	32.86	<33	31.33	1.53	<2.2	3.44	29.42	88.00	62
Right Ulnar (Mrkrs) (Abd Dig Min) 30.7°C									
	30.67	<36			<2.5				

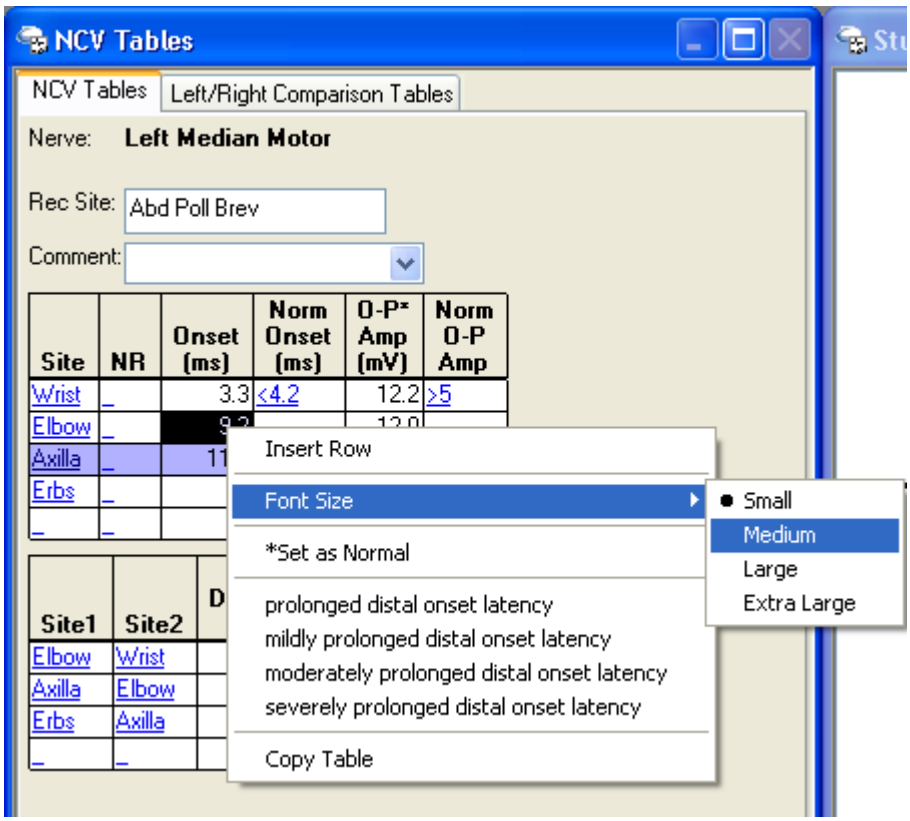
TabData table showing the comment on the same line as the nerve's name.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

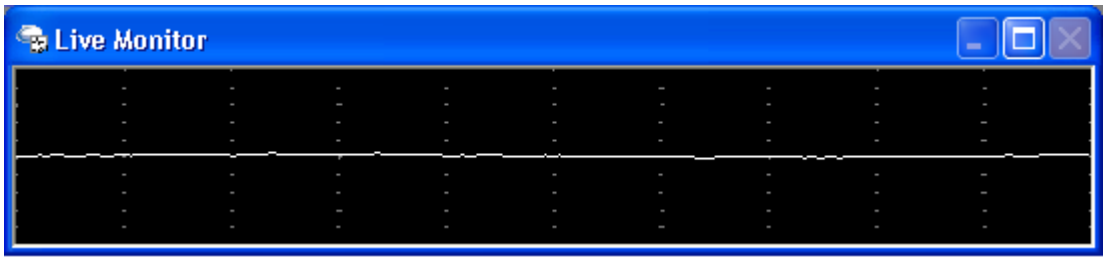
The selected font size is also applied to that table in the TabData window.

Live Monitor Window

A live monitor window is available in the NCV, F Wave, H-Reflex, Blink Reflex, and RNS test protocols.

When this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will return to displaying “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.



To Enable the Live Monitor window:

1. Start the Sierra Wave program.
2. Select a test protocol.
3. From the **Edit** menu, select **Current Test**.
4. Click on the **General Settings** tab.
5. Check the box labeled, **“Show Live Monitor”**.
6. Click **OK**.
7. Adjust the size and positions of the windows on the screen.
8. From the **Edit** menu, select **Save Test Parameters** to update the default settings for the test. From now on the test protocol will display the Live Monitor Window.

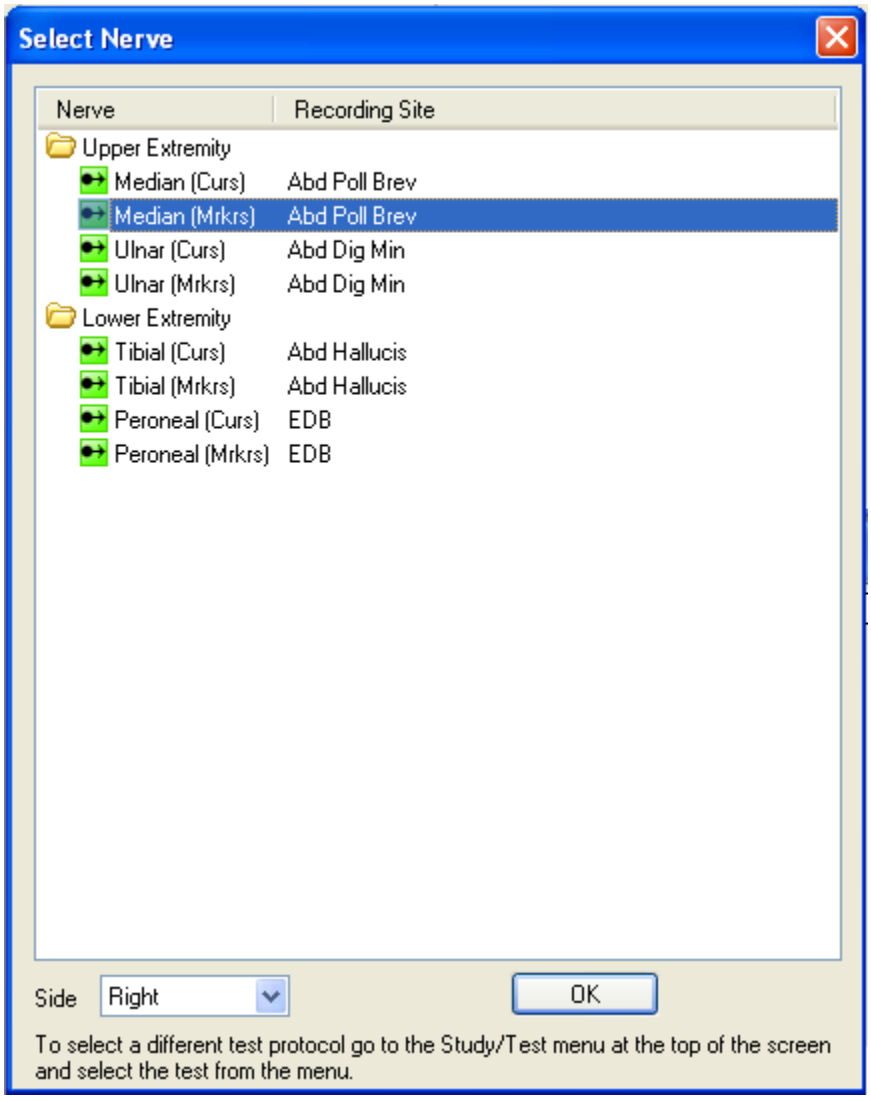
The Gain and Sweep Speed of the Live Monitor window are the same as the main Trace window.

Nerve List (F3)

The **F3 (Nerve List)** function key is a convenient way to add nerves to the Study window after a Study List has been selected or after the F Wave Test Protocol has been loaded.

To Add a Nerve to the Study Window

1. From within the F Wave Test Protocol, press the **F3 (Nerve List)** function key. The **Select Nerve** window will be displayed.



F Wave Select Nerve window.

2. To add a **single nerve**, perform one of the following.

   - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **verify the Side** parameter and then **double click** on the **nerve name**.

3. To add **multiple nerves**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. Repeat this process until all of the nerves you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.
    - **Using the Mouse** - **single click** the mouse over the appropriate nerve names. Once all of the nerves have been selected, **verify the Side** parameter and then click **OK**.

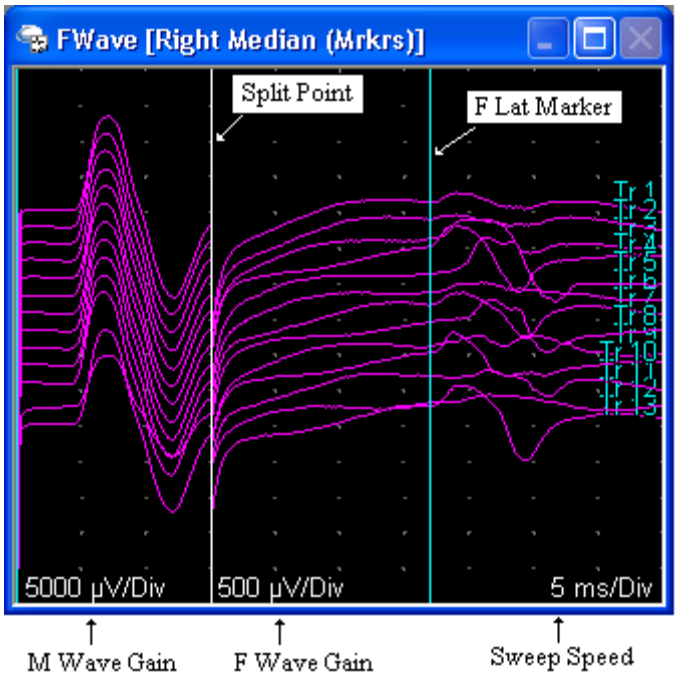
 Setting the **Side** parameter to **Left & Right** will add the nerve to the Study window twice, once for the Left side and once for the Right side.

 Adding nerves to the Study window in this manner is only temporary. To add nerves to a Study List permanently, review the help topic "Changing an Existing Study".

Split Gain Position

The F Wave Trace window is divided in two by a vertical Split Gain marker. The left side of the window is assigned an M Wave gain setting, the right side of the window is assigned an F Wave gain setting.

By moving the Split Point indicator you can give more or less space to either side of the Trace window.



To Move the Split Point Indicator

Click on the split point indicator line with the mouse and drag the indicator line left or right within the Trace window.

The default position of the Split Pt indicator can be programmed in the F Wave Test Menu Editor.

Manual / Auto Store

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

Stored traces will be displayed in "purple" color on the screen.

 The default state of the F1 function key can be programmed in the Test Menu Editor.

Latency Markers

The F Wave (Markers) test protocol uses two latency markers to mark the Minimal F Wave Latency and the M Wave Latency.

To move the latency markers, perform one of the following.

- **Using the Mouse** - click on the marker you want to move using the left mouse button and drag the marker across the Trace window.
- **Using the Knobs** - use Knob #2 (FWave Lat / MWave Lat). This knob defaults to the **FWave Lat** mode, turn the knob to move the F Wave latency marker across the trace window to the minimal F Wave latency. Press the knob to activate the **MWave Lat** mode and turn to move a second latency marker to the onset of the M Wave.

Auto F Wave Latency

- Press the **F8 (Auto F-Lat)** function key. The program will automatically move the Minimal F Wave latency marker to the earliest onset latency. In addition, a pop-up window will show the latency value and the wheel on the stimulator handle can be used to adjust the position of the marker. Once the marker has been positioned, press the F8 function key a second time to exit this mode.

Amplitude Markers

In the F Wave (Markers) test protocol the amplitude markers can be used to measure the amplitude of one M Wave and one F Wave trace.

To measure both M & F Wave amplitude, perform the following.

- **Using the Mouse** - **right click** the mouse over the Trace window and select **Amplitude Markers** from the pop-up menu. Two horizontal markers will be displayed on each side of the split point. Click and drag the markers to the appropriate positions. The amplitude (in microvolts) between the two markers is displayed in the F Wave Table.

To measure only F Wave amplitude, perform the following.

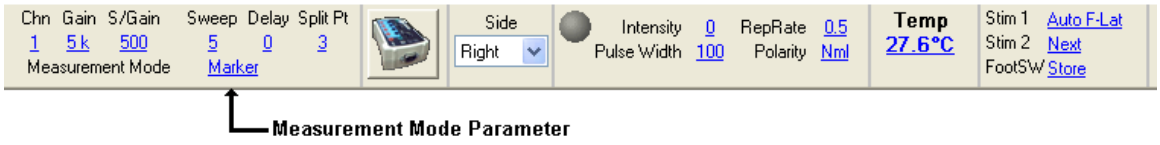
- **Using the Knobs** - press the **F5** function key to enter **Cursor** mode. Press the **F3** function key to turn the F Wave Amplitude markers **On**. Now use **Knob #2 (Amp 1 / Amp 2)** to move the two markers. The amplitude (in microvolts) between the two markers is displayed in the F Wave Table and on the Knob #2 icon.

Change to Auto Cursor Mode

After performing an F Wave study in the (Markers) mode you can easily switch to (Auto Cursor) mode for more detailed analysis.

To change from Markers to Auto Cursor mode:

Click on the **Measurement Mode** parameter in the Controls Toolbar at the top of the screen. The parameter will switch from Marker to Auto Cursor.



Distance & Velocity

F Wave Velocity can be calculated by entering a Distance value into the F Wave Table.

The following calculation is used for F Wave Velocity:

Velocity (in meters per second) = ((Distance) x 10) x 2 / (FLat - MLat) - 1

where,

D = distance from stimulating cathode (-) to C7 or T12, in centimeters.

FLat = F Wave latency.

MLat = M Wave latency.

To Enter a Distance value:

Simply click in the Distance field of the F Wave Table, type the value and press Enter.

The Distance field can be programmed as Show or Hide in the F Wave Test Menu Editor.

Deleting Traces

To Delete a selected F Wave trace, perform one of the following.

- **Using the Mouse** - **select the trace** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trace color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trace will be deleted.
- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #2 (Sel Trial / Delete)** until the trace you want to delete is selected, a selected trace is displayed in yellow. **Press the knob to delete** the selected trace. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

Saving Changes to F Wave Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the F Wave nerve.

- Select **Save Test Parameters** from the **Edit** menu.

F Wave (Cursors)

F Wave (Cursors) - Basic Steps

Select the F Wave Test:

- **If a Study has already been selected**, simply click on an F Wave nerve name (i.e., Right Median) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual F Wave protocol from the **Study/Test** menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing a routine F Wave (Cursors mode) data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

Typical Settings

	Gain (uV/Div)	Split Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
F Wave	5k	500	10k	20	5.0 or 10.0

2. **Electrode Placement**

   Attach the electrodes to the patient.

3. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

4. **Check Stimulator Polarity**

   For F Wave Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

   The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **F Wave Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate the Nerve

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical

stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit, or the **Single button** in the F Wave Controls window, can also be used to deliver a single stimulus.

 **Repetitive stimulation** can be delivered by pressing the **Run/Stop button** on the Sierra Wave base unit or by clicking on the **Run button** in the F Wave Controls window.

In general, F Waves are performed with supramaximal stimulus intensity.

If the M Wave or F Wave response amplitude is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change the gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain M / Gain F)** on the Sierra Wave base unit.

6. Store the Response

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

Stored traces will be displayed in "purple" color on the screen.

7. Continue to Stimulate and Store until 10 or 20 responses have been acquired.

8. If necessary, Adjust Auto Cursors

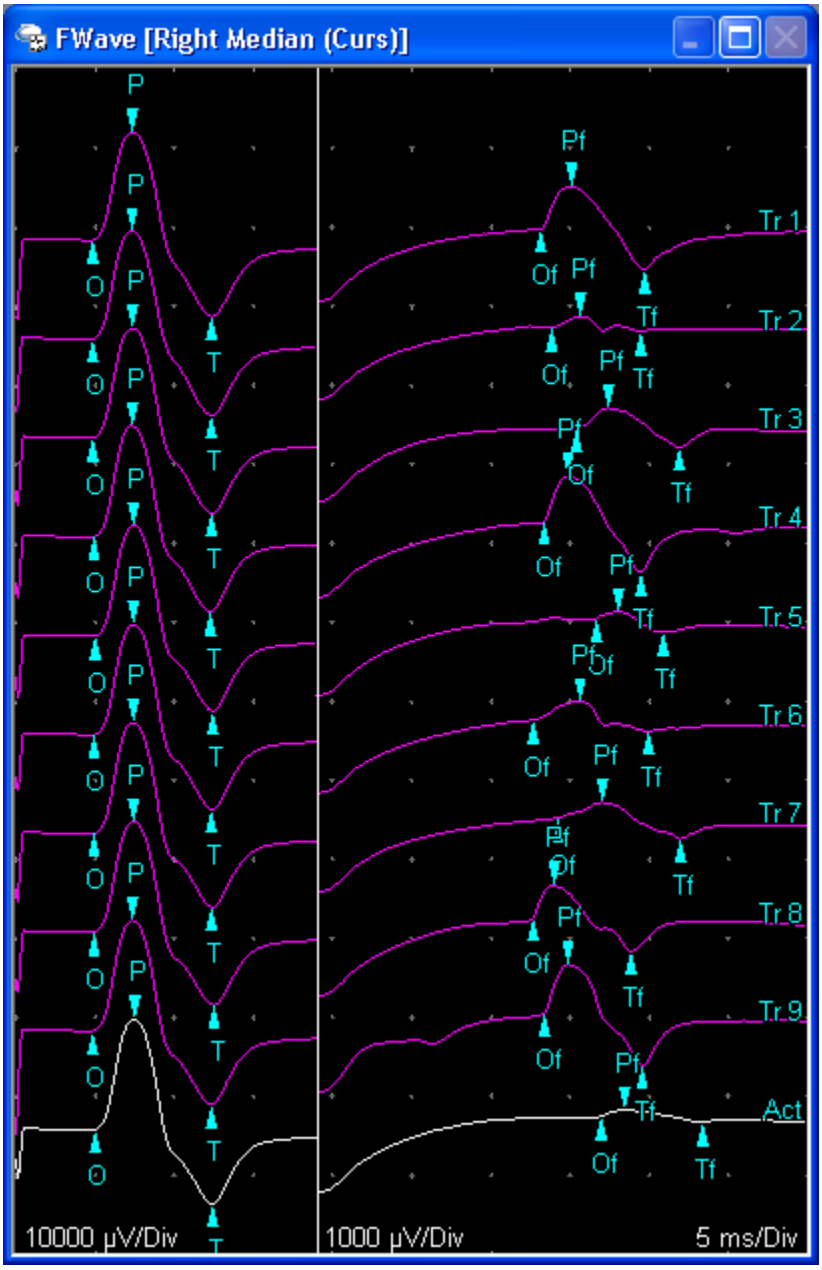
Auto Cursors are placed on the response as soon as it is displayed. Three cursors are place on the M Wave, they are **Onset (O)**, **Peak (P)**, and **Trough (T)**. The F Wave also receives three cursors, the are **F Onset (Of)**, **F Peak (Pf),** and **F Trough (Tf)**.

The F Wave Table window shows the M Wave latency **(M-Lat)** and M Wave amplitude **(M-Amp)** as well as the F Wave latency **(F-Lat)** and F Wave amplitude **(F-Amp)** for each stored trial.

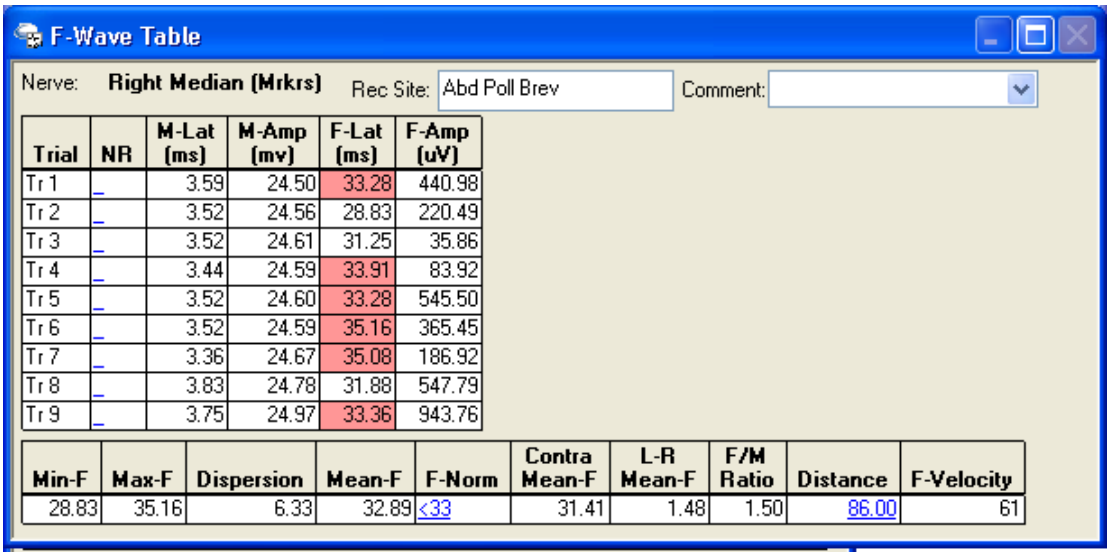
The minimum F Wave latency **(Min-F)**, maximum F Wave latency **(Max-F)**, **Dispersion** (Max-F minus Min-F), Mean F latency **(Mean-F)**, F wave norm **(F-norm)**, F wave vs. M wave ratio **(F/M ratio)**, **Distance**, and F Wave velocity **(F-Velocity)** are all displayed in a summary table below the trial table.

The positions of the cursors on a trace can be easily adjusted by following one of the methods below.

- **Using the mouse** - simply left click on the appropriate cursors blue triangle and drag the cursor along the trace to its new location. While the cursor is being moved the blue triangle is replaced with a yellow triangle.
- **Using Knob #2 (Of / Pf)** - this knob defaults to the **Of** mode and can be used to move the F Wave Onset cursor on the active (white) trace. Press this knob to switch to **Pf** mode which will allow you to move the F Wave Peak cursor on the active (white) trace.
- **Using the F5-Cursor mode** - press the F5 key on the PC's keyboard to change the base unit's knob and functions keys to cursor mode. See the Knobs & F Key Controls topic for further information.



F Wave (Cursors) example.



F-Wave Table

Nerve: Right Median (Mrkrs) Rec Site: Abd Poll Brev Comment:

Trial	NR	M-Lat (ms)	M-Amp (mv)	F-Lat (ms)	F-Amp (uV)
Tr 1	_	3.59	24.50	33.28	440.98
Tr 2	_	3.52	24.56	28.83	220.49
Tr 3	_	3.52	24.61	31.25	35.86
Tr 4	_	3.44	24.59	33.91	83.92
Tr 5	_	3.52	24.60	33.28	545.50
Tr 6	_	3.52	24.59	35.16	365.45
Tr 7	_	3.36	24.67	35.08	186.92
Tr 8	_	3.83	24.78	31.88	547.79
Tr 9	_	3.75	24.97	33.36	943.76

Min-F	Max-F	Dispersion	Mean-F	F-Norm	Contra Mean-F	L-R Mean-F	F/M Ratio	Distance	F-Velocity
28.83	35.16	6.33	32.89	<33	31.41	1.48	1.50	86.00	61

F Wave (Cursors) Table.

9. Compare Left vs. Right side Traces (optional)

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side.

The traces for each side are displayed in separate windows, stacked vertically on the screen. The top window contains the traces for the current side.

Press the **F10 - L/R Cmp** function key a second time to return to the standard F Wave (Curs) display.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., F Wave Cursors, Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another F Wave nerve in the **Study** window.
- **Click** on another F Wave nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (F Wave Cursors)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Of / Pf - this knob defaults to the **Of** mode and can be used to move the F Wave Onset cursor on the active (white) trace. Press this knob to switch to **Pf** mode which will allow you to move the F Wave Peak cursor on the active (white) trace.

Intensity / Pulse Width- this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press the knob to activate the **Pulse Width** mode and then turn to adjust the pulse duration of the stimulus (in microseconds).

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

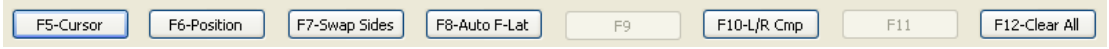
Manual / Autostore - In **Manual** mode the Store key must be pressed after each stimulation. In **Auto-Store** mode the program will automatically store each trace after stimulation. The initial status of this key can be programmed in the Test Menu Editor.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Nerve List - opens the F Wave Nerve List window which allows you to select and add nerves to your Study window.

TabData - opens the TabData Summary window.

PC Function Keys (F5-F12)



F5-Cursor - enables Cursor mode (see below).

F6-Position - enables Position mode (see below).

F7-Swap Sides - press to swap the side parameter for the nerve.

F8-Auto F-Lat - not available in Cursors mode.

F10-L/R Cmp - press to display the opposite side's traces.

F12-Clear All - press to delete all traces for the nerve.

Cursor mode (F5)

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cur** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press this knob to switch to **Move Cur** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cur** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trace - turn this knob to select an F Wave trace. When selected, the trace will be displayed in yellow.

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trace.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trace.

All On / All Off - defaults to **All On** mode. Press to hide all cursors (turn Off) on all traces.

Position mode (F6)

Knobs

Sel Trace / Move - defaults to the **Sel Trace** mode, turn this knob to select a stored F Wave trace. When selected, the trace will be displayed in yellow color. Press the knob to activate the **Move** mode and then turn to move the selected trace up or down within the Trace window.

Sel Trace / Delete - defaults to the **Sel Trace** mode, turn this knob to select a stored F Wave trace. When selected, the trace will be displayed in yellow color. Press the knob to **Delete** the selected trace.

Split Pt - turn this knob to move the gain split point indicator within the Trace window.

Gain F / Gain M - this knob defaults to the **Gain F** mode and can be used to change the gain of the F Wave side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Smooth All - each time this key is pressed the traces will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

F Wave Cursors - Test Setup

F Wave test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here to go to this topic.

Normal Values (F Wave)

From the **Edit menu** select **Test Menu**. When the Test Menu Setup window is displayed click on the **F Wave** test protocol in the test list. The F Wave test protocol settings will be displayed on the right hand side of the screen.

In the **Nerve List**, select the nerve you want to make changes to.

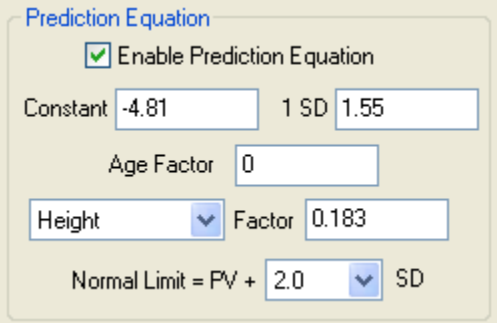
There are two methods for entering normal values; **Simple Value Limit** or **Prediction Equation**.

- **Simple Value Limit:**

  Click in the normal value column of the nerve list and type the desired value. For example, <33.0.

- **Prediction Equation:**

  The normal F wave latency can be predicted using the patient's **Age** and **Height**. To use the prediction equation, check the box labeled **Enable Prediction Equation**. You can then input the factors for Age, Height, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. If the equation is enabled, the normal value in the nerve list is ignored and the norm will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height** have been input in the Patient Information window.



The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

If the standard deviation is known then:

Normal Value = Predicted Value + 'x' Standard Deviations

Typically:

F Wave Latency Norm = Predicted Value + 2 SD

To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background.** Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

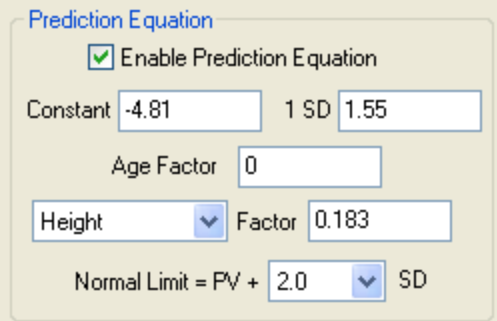
There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

Using Prediction Equation (F Wave cursors)

Normal values can be predicted using the patient's **Age** and **Height**. This topic will outline the steps needed to enable the prediction equation for the Median (cursors) F Wave test. Follow these same steps to program equations for other nerves in the nerve list.

Setup Steps:

1. From the **Edit menu**, select **Test Setup**.
2. Select the **F Wave** test.
3. Select a nerve in the **Nerve List** (i.e., Median markers). You will see a section in the setup parameters called **Prediction Equation**.
4. To enable the prediction equation, **check the box** next to **Enable Prediction Equation**.
5. Enter the appropriate values for Constant, Age Factor, Height Factor, and one Standard Deviation.



To use the prediction equation the patient's height must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

6. Repeat steps 1-5 for other nerves.
7. Click **OK** to close the Test Setup window.

Data Acquisition Mode:

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background.** Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

Min-F	Max-F	Dispersion	Mean-F	F-Norm	L-R Mean-F	L-R Mean-F Norm	F/M Ratio	Distance	F-Velocity
				<0.0		<2.2			

After entering patient's height.

Min-F	Max-F	Dispersion	Mean-F	F-Norm	L-R Mean-F	L-R Mean-F Norm	F/M Ratio	Distance	F-Velocity
				<33.4		<2.2			

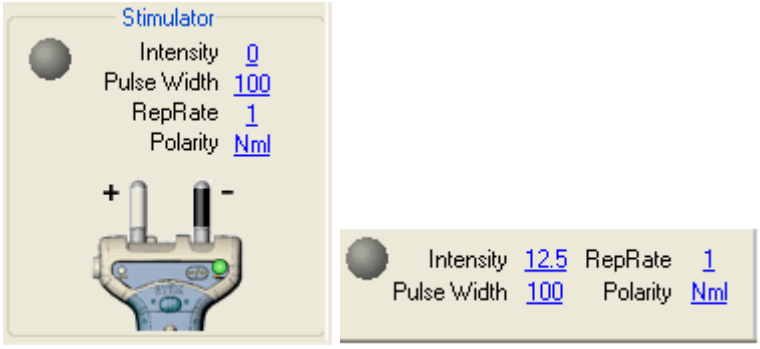
Stimulator Polarity

For F Wave Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **F Wave Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

Swap Sides

To swap the side parameter on a nerve, perform one of the following.

- **Right click** the mouse over the **nerve name** in the **Study window**. From the pop-up menu select **Swap Sides**.
- Press the **F7 function key** on the PC's keyboard. In the F Wave test protocol the F7 key is always assigned the Swap Sides function.

If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

If the side you are swapping to already has stored traces, then a second run will be automatically added to that existing nerve.

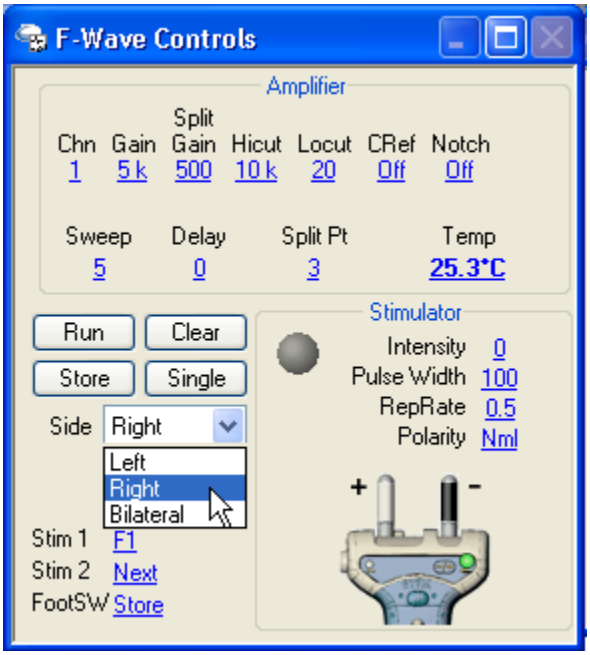
Change Sides

Changing the Side parameter for a nerve is different than Swapping Sides. When you change sides, the highlight in the Study window simply moves to that nerve in the Study window. No traces are transferred.

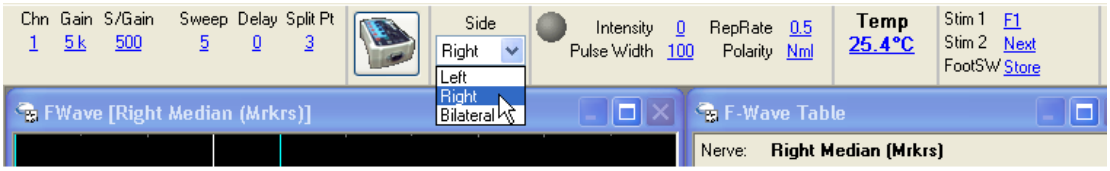
If the nerve corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **F Wave Controls window**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



In the **Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.

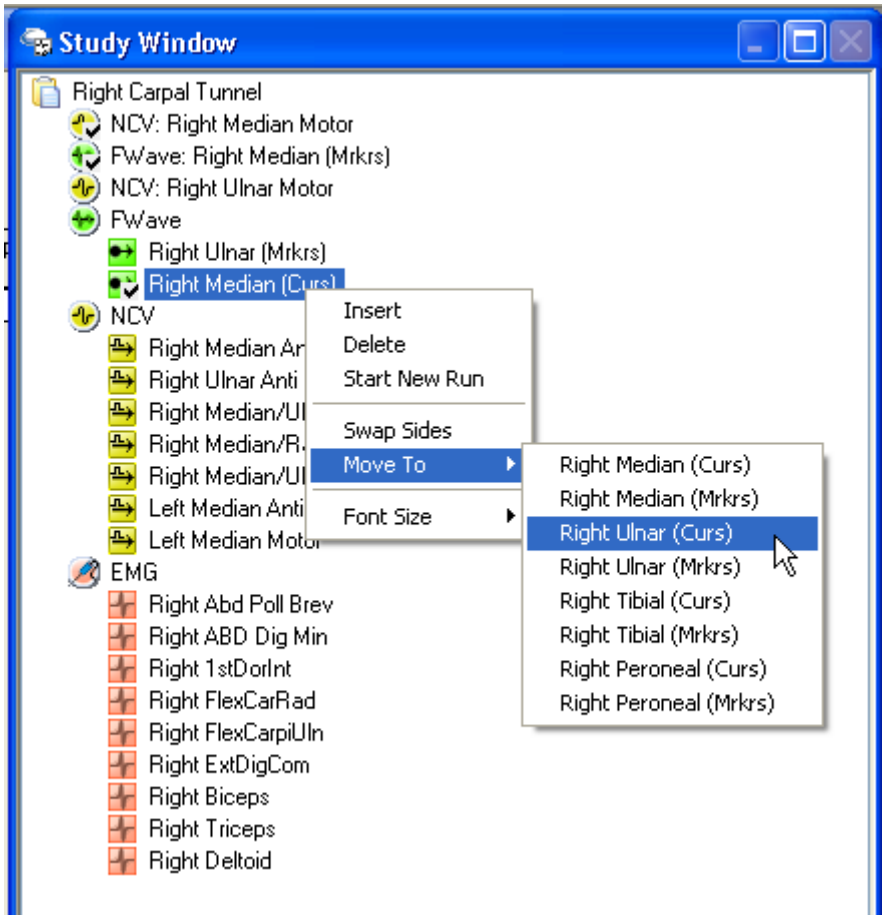


Move To

This feature allows the F Wave traces to be moved to a different nerve. For example, median nerve traces can be moved to any other nerve in your F Wave nerve list.

To Move the traces to another nerve:

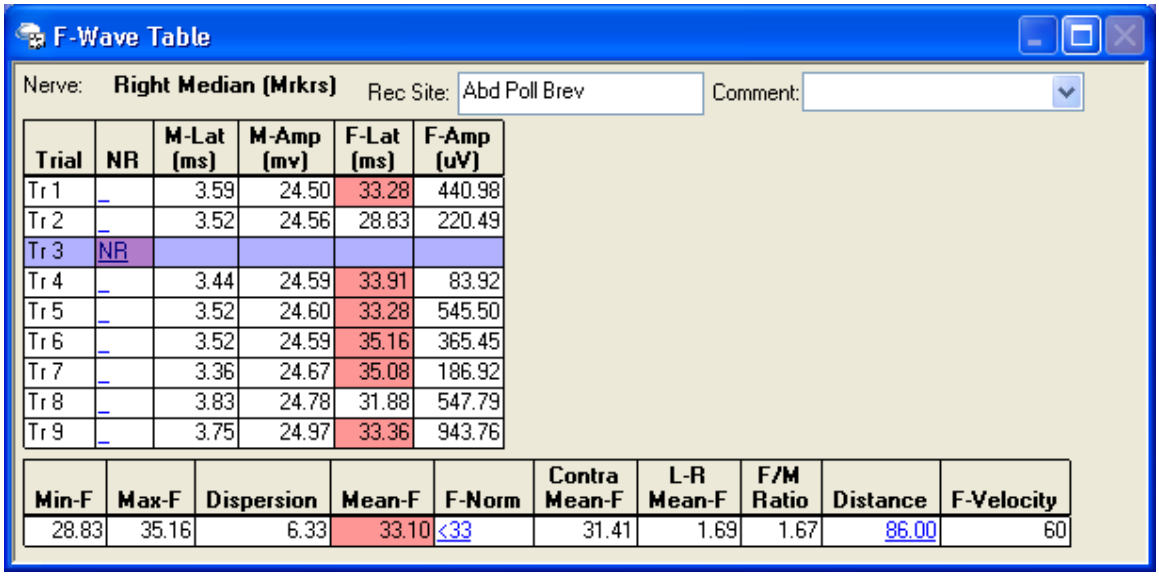
- **Right click** the mouse over the nerve in the Study window.
- Select **Move To** from the pop-up menu.
- Select a nerve from the displayed list.



No Response (F Wave Cursors)

If no response can be obtained for a stimulation you can indicate this using the **NR** column in the F Wave Table.

Simply click within the **NR column** just to the right of the trial number. The text "NR" will be displayed for that trial and any cursor values for the trial will be cleared. Rows that have been marked as No Response are not included in the Min, Max, Mean calculations.



No Response indicated for Trial #3.

If you mistakenly click in the wrong box, click on the "NR" text and it will be removed and the cursor values will be restored.

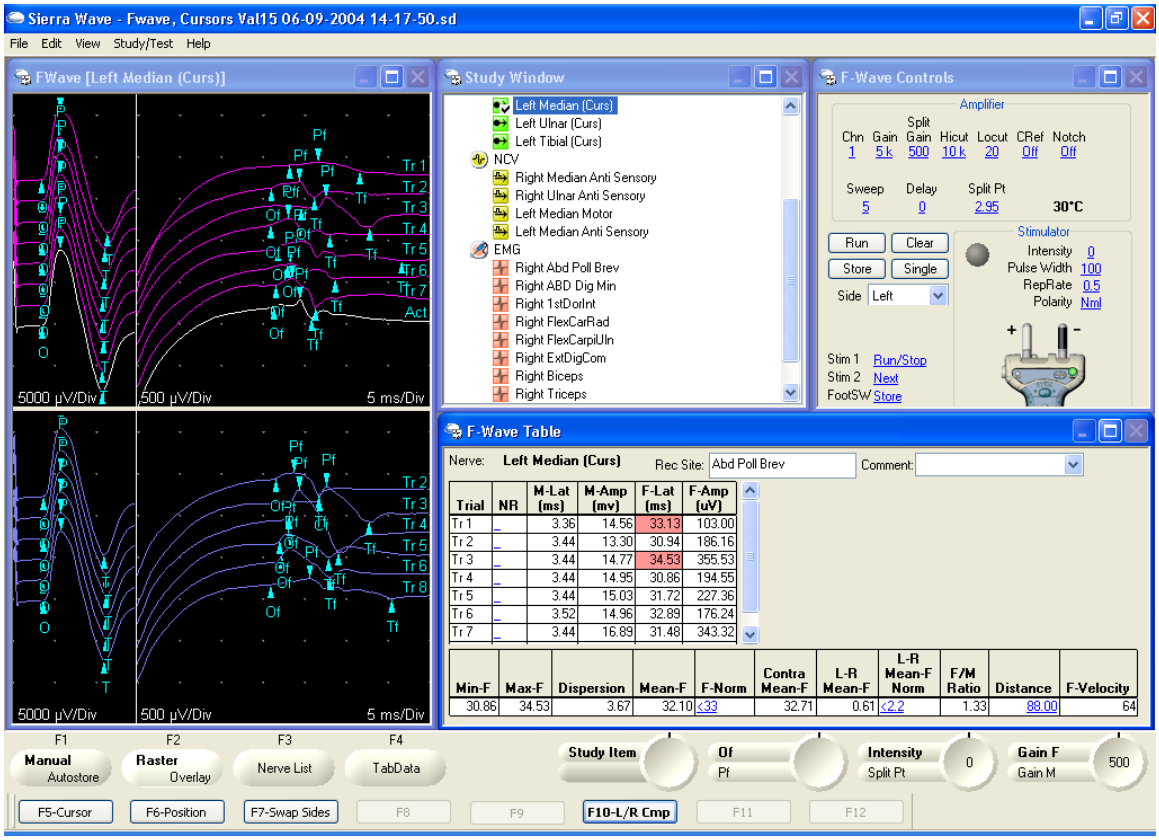
Compare Left vs. Right (F Wave Cursors)

This feature allows for a visual comparison of the traces obtained for each side.

To compare Left vs. Right sides.

- Press the **F10 - L/R Cmp** function key.

The trace window will show the current side's traces in the top window and the contralateral side's traces (in blue) in the bottom window.



F Wave (Cursor) test protocol, left side traces in top window, right side traces in bottom window.

Press the **F10 - L/R Cmp** function key a second time to return to the standard F Wave (Curs) display.

The F Wave Table always shows the **Contra Mean F Latency**, **L-R Mean Latency**, and **L-R Mean Latency Norm** (if entered for the nerve).

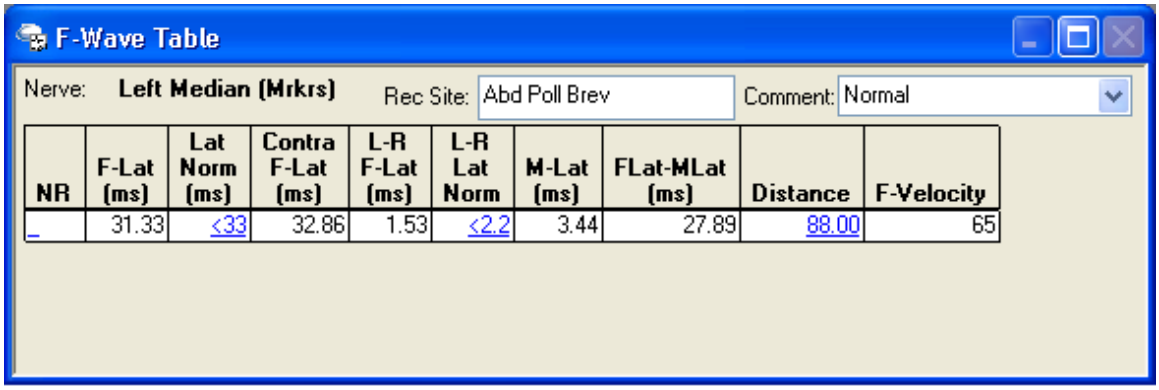
The contralateral traces can be toggled On/Off at any time by right-clicking over the trace window and selecting **Show Contralateral Traces**

Comment (F Wave)

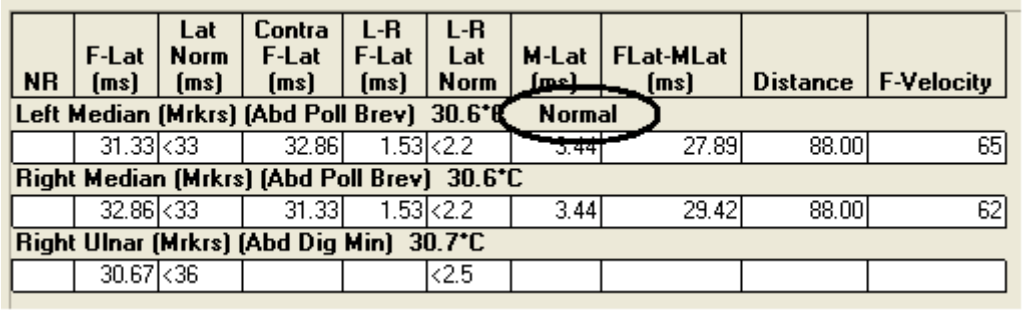
An optional comment can be entered on a per nerve basis. Simply click in the **Comment field** and enter the comment you would like to attach to the nerve.

The comment will appear in the TabData window and in reports.

The comment field will remember the last 20 comments that have been entered and these can be re-selected from a list using the drop-down arrow.



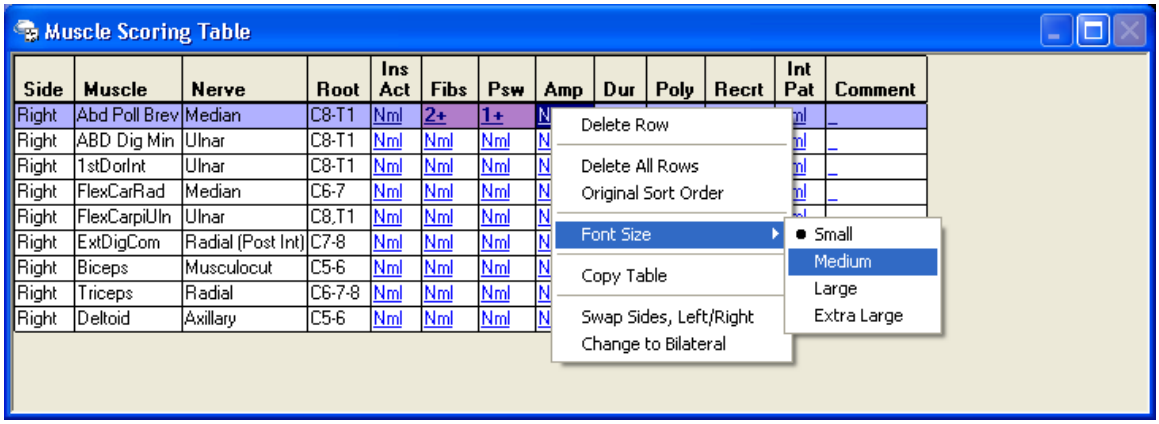
F Wave Table with a comment entered into the comment field.



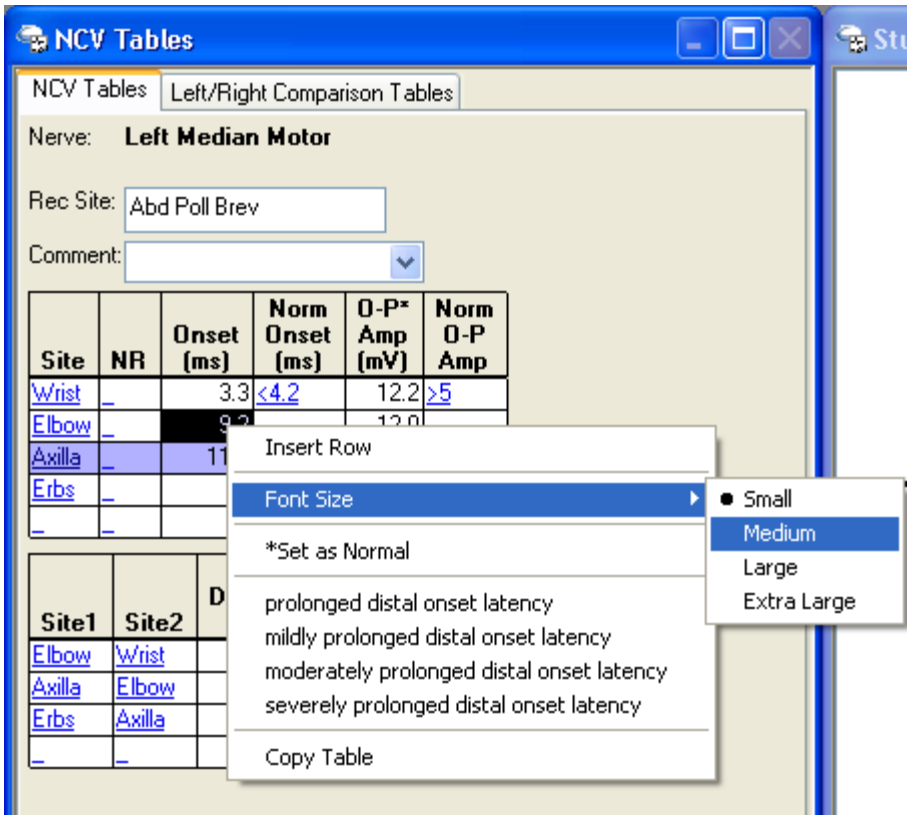
TabData table showing the comment on the same line as the nerve's name.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

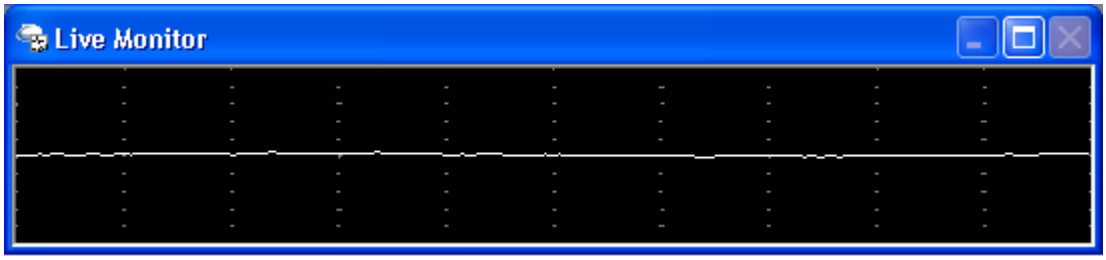
The selected font size is also applied to that table in the TabData window.

Live Monitor Window

A live monitor window is available in the NCV, F Wave, H-Reflex, Blink Reflex, and RNS test protocols.

When this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will return to displaying “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.



To Enable the Live Monitor window:

1. Start the Sierra Wave program.
2. Select a test protocol.
3. From the **Edit** menu, select **Current Test**.
4. Click on the **General Settings** tab.
5. Check the box labeled, **"Show Live Monitor"**.
6. Click **OK**.
7. Adjust the size and positions of the windows on the screen.
8. From the **Edit** menu, select **Save Test Parameters** to update the default settings for the test. From now on the test protocol will display the Live Monitor Window.

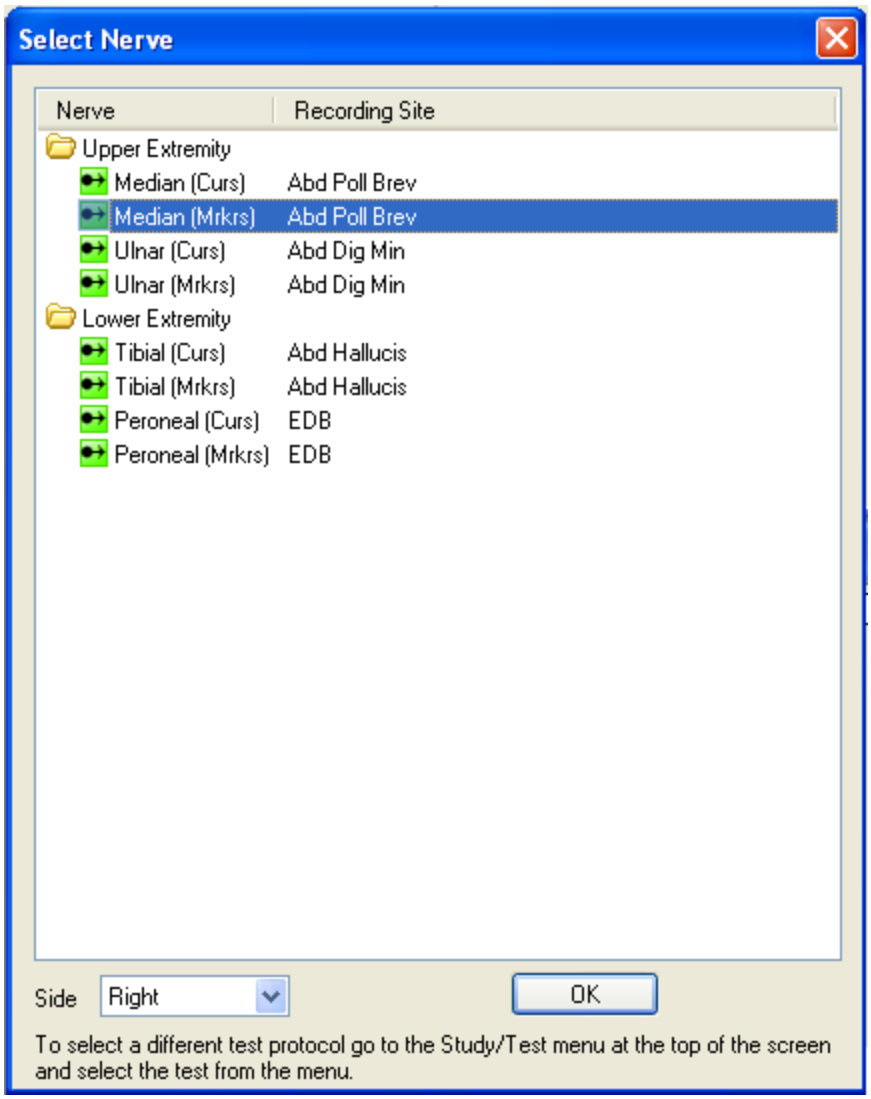
The Gain and Sweep Speed of the Live Monitor window are the same as the main Trace window.

Nerve List (F3)

The **F3 (Nerve List)** function key is a convenient way to add nerves to the Study window after a Study List has been selected or after the F Wave Test Protocol has been loaded.

To Add a Nerve to the Study Window

1. From within the F Wave Test Protocol, press the **F3 (Nerve List)** function key. The **Select Nerve** window will be displayed.



F Wave Select Nerve window.

2. To add a **single nerve**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **nerve name**.

3. To add **multiple nerves**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted

line drawn around the nerve name. **Press** the knob to **highlight** the nerve. Repeat this process until all of the nerves you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate nerve names. Once all of the nerves have been selected, **verify the Side** parameter and then click **OK**.

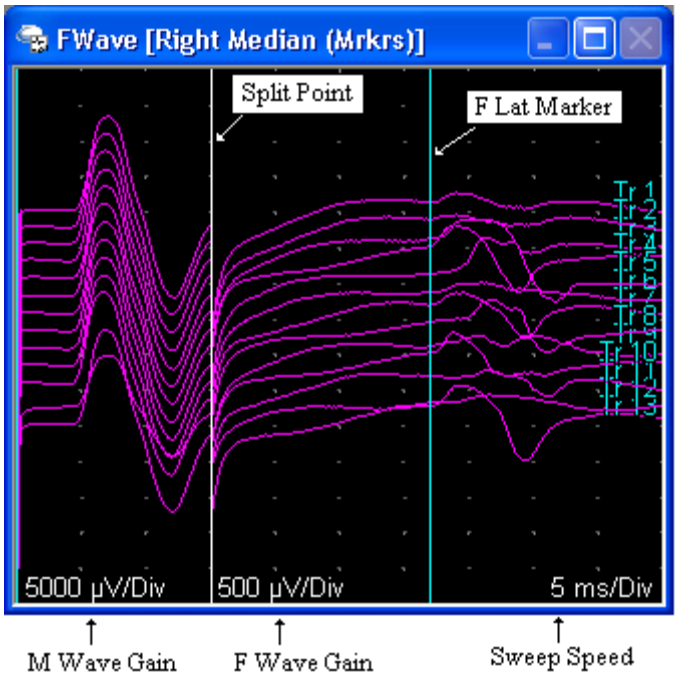
 Setting the **Side** parameter to **Left & Right** will add the nerve to the Study window twice, once for the Left side and once for the Right side.

 Adding nerves to the Study window in this manner is only temporary. To add nerves to a Study List permanently, review the help topic "Changing an Existing Study".

Split Gain Position

The F Wave Trace window is divided in two by a vertical Split Gain marker. The left side of the window is assigned an M Wave gain setting, the right side of the window is assigned an F Wave gain setting.

By moving the Split Point indicator you can give more or less space to either side of the Trace window.



To Move the Split Point Indicator

Click on the split point indicator line with the mouse and drag the indicator line left or right within the Trace window.

The default position of the Split Pt indicator can be programmed in the F Wave Test Menu Editor.

Manual / Auto Store

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

Stored traces will be displayed in "purple" color on the screen.

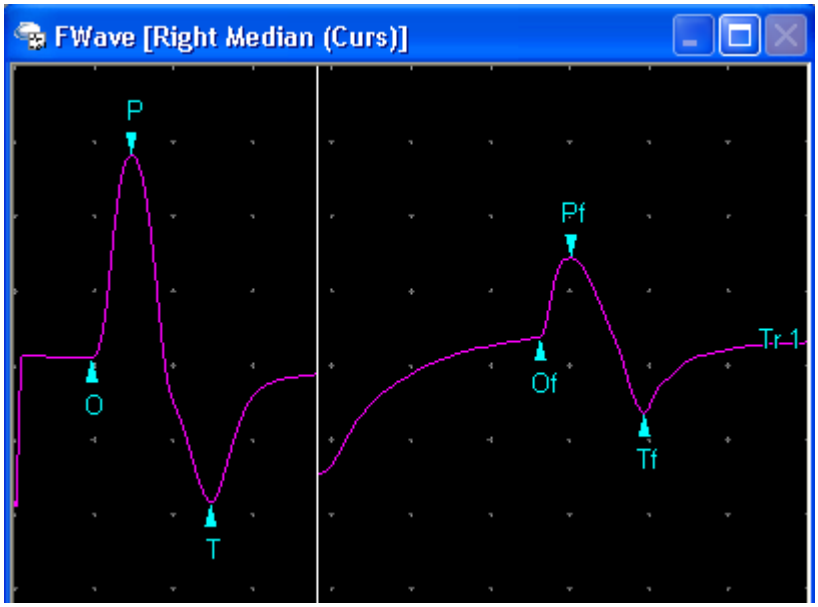
The default state of the F1 function key can be programmed in the Test Menu Editor.

Auto Cursors (F Wave)

In the F Wave (Cursors) Test Protocol, if the response is of sufficient amplitude, cursors are automatically placed on both the M Wave and F Wave trace.

Three cursors are placed on the M Wave trace, they are **Onset (O)**, **Peak (P)**, and **Trough (T).**

The F Wave trace also gets the same cursors but with slightly different labels, they are **Onset F (Of)**, **Peak F (Pf)**, and **Trough F (Tf)**.



F Wave (Cursors) example trace.

Adjusting Cursor Positions

The positions of the cursors on a trace can be easily adjusted by following one of the methods below.

- **Using the mouse** - simply left click on the appropriate cursors blue triangle and drag the cursor along the trace to its new location. While the cursor is being moved the blue triangle is replaced with a yellow triangle.
- **Using Knob #2 (Of / Pf)** - this knob defaults to the **Of** mode and can be used to move the F Wave Onset cursor on the active (white) trace.

Press this knob to switch to **Pf** mode which will allow you to move the F Wave Peak cursor on the active (white) trace.

- **Using the F5-Cursor mode** - press the F5 key on the PC's keyboard to change the base unit's knob and functions keys to cursor mode. See the Knobs & F Key Controls topic for further information.

How can I place cursors on a trace that was stored without them?

If you store a trace without cursors and later determine that there is a response present, you can easily add cursors to the trace.

Here is one simple method to accomplish this.

1. **Left click** on **the trace** to select it, the trace will change from **purple color to yellow**.

2. Now, **right click** the mouse on **the trace** and select **Auto Place Cursors** from the pop-up menu.

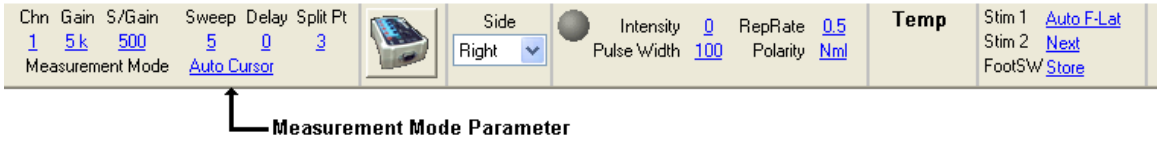
3. Adjust the cursor positions as needed.

Change to Markers Mode

After performing an F Wave study in the (Auto Cursor) mode you can easily switch to (Marker) mode for a simpler display.

To change from Auto Cursor to Marker mode:

Click on the **Measurement Mode** parameter in the Controls Toolbar at the top of the screen. The parameter will switch from Auto Cursor to Marker.



Distance & Velocity

F Wave Velocity can be calculated by entering a Distance value into the F Wave Table.

The following calculation is used for F Wave Velocity:

Velocity (in meters per second) = ((Distance) x 10) x 2 / (FLat - MLat) - 1

where,

D = distance from stimulating cathode (-) to C7 or T12, in centimeters.

FLat = F Wave latency.

MLat = M Wave latency.

To Enter a Distance value:

Simply click in the Distance field of the F Wave Table, type the value and press Enter.

 The Distance field can be programmed as Show or Hide in the F Wave Test Menu Editor.

Deleting Traces

To Delete a selected F Wave trace, perform one of the following.

- **Using the Mouse** - **select the trace** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trace color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trace will be deleted.
- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #2 (Sel Trial / Delete)** until the trace you want to delete is selected, a selected trace is displayed in yellow. **Press the knob to delete** the selected trace. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

Saving Changes to F Wave Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the F Wave nerve.

- Select **Save Test Parameters** from the **Edit** menu.

H Reflex

H Reflex Basic Steps

This topic is a repeat of the basic H Reflex steps found in the **Getting Started** chapter.

Select the H Reflex Test:

- **If a Study has already been selected**, simply click on an H Reflex nerve name (i.e., Right Tibial) within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the nerve name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual H Reflex test protocol from the **Study/Test** menu, a nerve list will be displayed allowing you to pick the nerve or nerves that you will be testing on the patient.

Once the nerve has been selected. Follow these steps for performing routine H Reflex data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

Typical Settings

	Gain (uV/Div)	Split Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
H Reflex	2 - 5k	500	10k	20	10.0

2. **Electrode Placement**

   Attach the electrodes to the patient.

3. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

4. **Check Stimulator Polarity**

   For H-Reflex Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **H Reflex Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate the Nerve

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit, or the **Single button** in the H Reflex Controls window, can also be used to deliver a single stimulus.

 **Repetitive stimulation** can be delivered by pressing the **Run/Stop button** on the Sierra Wave base unit or by clicking on the **Run button** in the H Reflex Controls window.

In general, H Reflex maximum amplitude occurs with sub-maximal stimulation intensity.

If the M Wave or H Reflex response amplitude is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change the gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain M / Gain H)** on the Sierra Wave base unit.

6. Store the Response

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.
- Click on the **Store button** in the **H Reflex Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

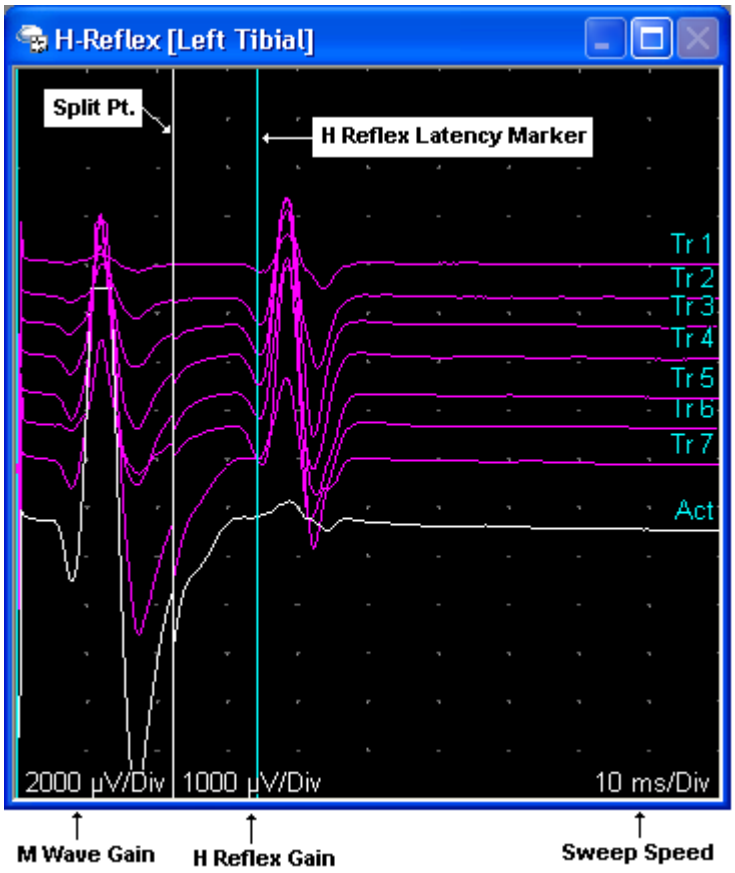
Stored traces will be displayed in "purple" color on the screen.

7. Continue to Stimulate and Store until 10 or 20 responses have been acquired.

8. Adjust Latency Marker

To adjust the latency marker, perform one of the following:

- Turn **Knob #2 (H Lat / M Wave Lat)** on the Sierra Wave base unit to move the H Reflex latency marker to the H Reflex onset latency. Changing the **F2 (Raster / Overlay)** function key to **Overlay mode** can be helpful when positioning the latency marker. The latency value is displayed in the **H Reflex Table** window.
- Press the **F8 (Auto H-Lat)** function key. The program will automatically move the latency marker to the earliest onset latency. In addition, a pop-up window will show the latency value and the wheel on the stimulator handle can be used to adjust the position of the marker. Once the marker has been positioned, press the F8 function key a second time to exit this mode.



Example H Reflex Trace window.

9. Compare Left vs. Right side Traces (optional)

Press the **F10 - L/R Cmp** function key to view the traces acquired for each side.

The traces for each side are displayed in separate windows, stacked vertically on the screen. The top window contains the traces for the current side.

Press the **F10 - L/R Cmp** function key a second time to return to the standard H Reflex display.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., H Reflex, F Wave Markers, Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Nerve or Test

To advance to the Next Nerve:

- Use **Knob #1 (Study Item / Site)** to highlight another H Reflex nerve in the **Study** window.
- **Click** on another H Reflex nerve in the **Study** window using the **mouse**.
- **Press** the **F3 (Nerve List)** function key on the **Sierra Wave base unit** and select another nerve from the nerve list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (H Reflex)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

H Lat / MWave Lat - this knob defaults to the **H Lat** mode and can be used to move the H Reflex latency marker across the trace window to the onset of the H Reflex. Press the knob to activate the **MWave Lat** mode and turn to move a second latency marker to the onset of the M Wave.

Intensity / Split Pt - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press the knob to activate the **Pulse Width** mode and then turn to adjust the pulse duration of the stimulus (in microseconds).

Gain H / Gain M - this knob defaults to the **Gain H** mode and can be used to change the gain of the H Reflex side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Manual / Autostore - In **Manual** mode the Store key must be pressed after each stimulation. In **Auto-Store** mode the program will automatically

store each trace after stimulation. The initial status of this key can be programmed in the Test Menu Editor.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Nerve List - opens the H Reflex Nerve List window which allows you to select and add nerves to your Study window.

TabData - opens the TabData Summary window.

PC Function Keys (F5-F12)

F5-Cursor - enables Cursor mode (see below).

F6-Position - enables Position mode (see below).

F7-Swap Sides - press to swap the side parameter for the nerve.

F8-Auto H-Lat - press to have the program automatically move the H-Latency marker to the minimum onset.

F10-L/R Cmp - press to display the opposite side's traces.

F12-Clear All - press to delete all traces for the nerve.

Cursor mode (F5)

Knobs

H Lat / M Lat - this knob defaults to the **H Lat** mode and can be used to move the latency marker on the H Reflex side of the Trace window. Press the knob to activate the **M Lat** mode and turn to move the latency marker on the M Wave side of the Trace window.

Amp 1 / Amp 2 - this knob defaults to the **Amp 1** mode and can be used to move amplitude marker #1 within the H Reflex side of the Trace window. Press the knob to activate the **Amp 2** mode and turn to move amplitude marker #2 within the H Reflex side of the Trace window. *Prior to moving these markers you will need to press the F3 function key to toggle the amplitude markers from Off to On.*

Split Pt - turn this knob to move the gain split point indicator within the Trace window.

Gain H / Gain M - this knob defaults to the **Gain H** mode and can be used to change the gain of the H Reflex side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

AmpMrk On / Off - defaults to **AmpMrk Off** mode. Press this key to turn the amplitude markers On.

Lat Mrk On / Off - defaults to **LatMrk On** mode. Press this key to turn the latency markers Off.

Position mode (F6)

Knobs

Sel Trace / Move - defaults to the **Sel Trace** mode, turn this knob to select a stored H Reflex trace. When selected, the trace will be displayed in yellow color. Press the knob to activate the **Move** mode and then turn to move the selected trace up or down within the Trace window.

Sel Trace / Delete - defaults to the **Sel Trace** mode, turn this knob to select a stored H Reflex trace. When selected, the trace will be displayed in yellow color. Press the knob to **Delete** the selected trace.

Split Pt - turn this knob to move the gain split point indicator within the Trace window.

Gain H / Gain M - this knob defaults to the **Gain H** mode and can be used to change the gain of the H Reflex side of the split point. Press the knob to activate the **Gain M** mode and then turn to change the gain of the M Wave side of the split point.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Smooth All - each time this key is pressed the traces will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

H Reflex Test Setup

H Reflex test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here, to go to this topic.

Normal Values (H Reflex)

From the **Edit menu** select **Test Menu**. When the Test Menu Setup window is displayed click on the **H Reflex** test protocol in the test list. The H Reflex test protocol settings will be displayed on the right hand side of the screen.

In the **Nerve List**, select the nerve you want to make changes to.

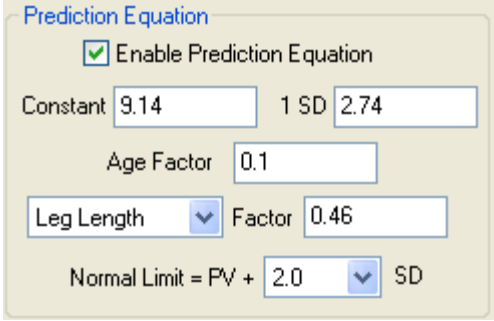
There are two methods for entering normal values; **Simple Value Limit** or **Prediction Equation**.

- **Simple Value Limit:**

  Click in the normal value column of the nerve list and type the desired value. For example, <37.0.

- **Prediction Equation:**

  The normal H Reflex latency can be predicted using the patient's **Age** and either **Height**, **Leg Length** or **Arm Length**. To use the prediction equation, check the box labeled **Enable Prediction Equation**. You can then input the factors for Age, Height or Leg/Arm Length, Constant, and Standard Deviation needed by the prediction equation; this is done on a per nerve basis. If the equation is enabled, the normal value in the nerve list is ignored and the norm will instead be calculated and displayed on the data acquisition screen once the patient's **Date of Birth (i.e., Age)** and **Height or Leg/Arm Length** have been input.



The prediction equation used is:

Predicted Value = Constant + (Age x Age Factor) + (Height x Height Factor)

Leg or Arm Length and appropriate Factor can be substituted for Height.

If the standard deviation is known then:

Normal Value = Predicted Value + 'x' Standard Deviations

Typically:

H Reflex Latency Norm = Predicted Value + 2 SD

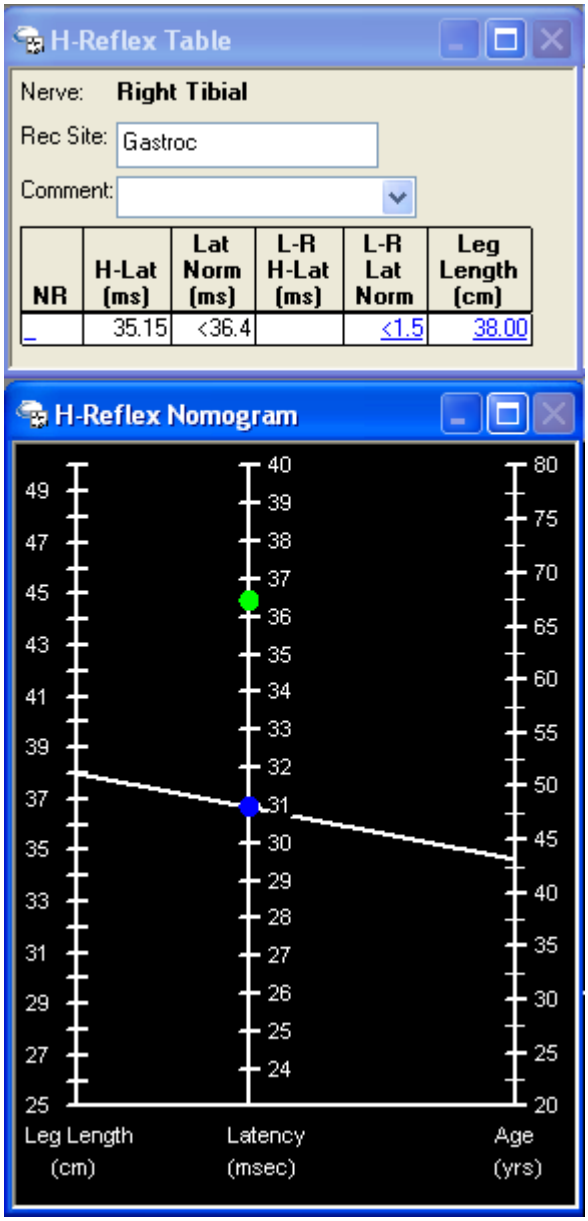
To use the prediction equation the patient's height or leg/arm length must be entered in **centimeters**.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

If the patient's Date of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background**. Once the Date of Birth and/or Height have been entered the predicted normal value will be displayed.

There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

If **Leg Length** is selected for the Tibial H Reflex, the standard **H Reflex Nomogram** will be displayed on the acquisition screen and a Leg Length field will be shown in the measurement table. After entering the patient's leg length in the table a line will be drawn in the nomogram to indicate the predicted normal latency, the **blue dot** marks the predicted value and the **green dot** marks the upper limit of normal based on the specified standard deviation.



H Reflex Nomogram

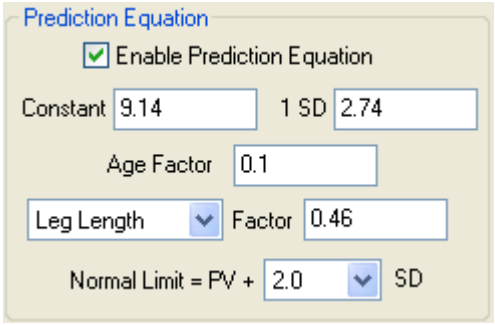
Using Prediction Equation (H Reflex)

Normal values can be predicted using the patient's **Age** and **Height or Leg/Arm Length**. This topic will outline the steps needed to enable the prediction equation for the Tibial (markers) H Reflex test. Follow these same steps to program equations for other nerves in the nerve list.

Setup Steps:

1. From the **Edit menu**, select **Test Setup**.

2. Select the **H Reflex** test in the Test List.
3. Select a nerve in the **Nerve List** (i.e., Tibial markers). You will see a new section in the setup parameters called Prediction Equation.
4. To enable the prediction equation, **check the box** next to **Enable Prediction Equation**.
5. Enter the appropriate values for Constant, Age Factor, Height or Leg/Arm Length Factor, and one Standard Deviation.



To use the prediction equation the patient's height or leg/arm length must be entered in centimeters.

Sometimes the Age or Height factor is not used, in this case leave the factor set to zero.

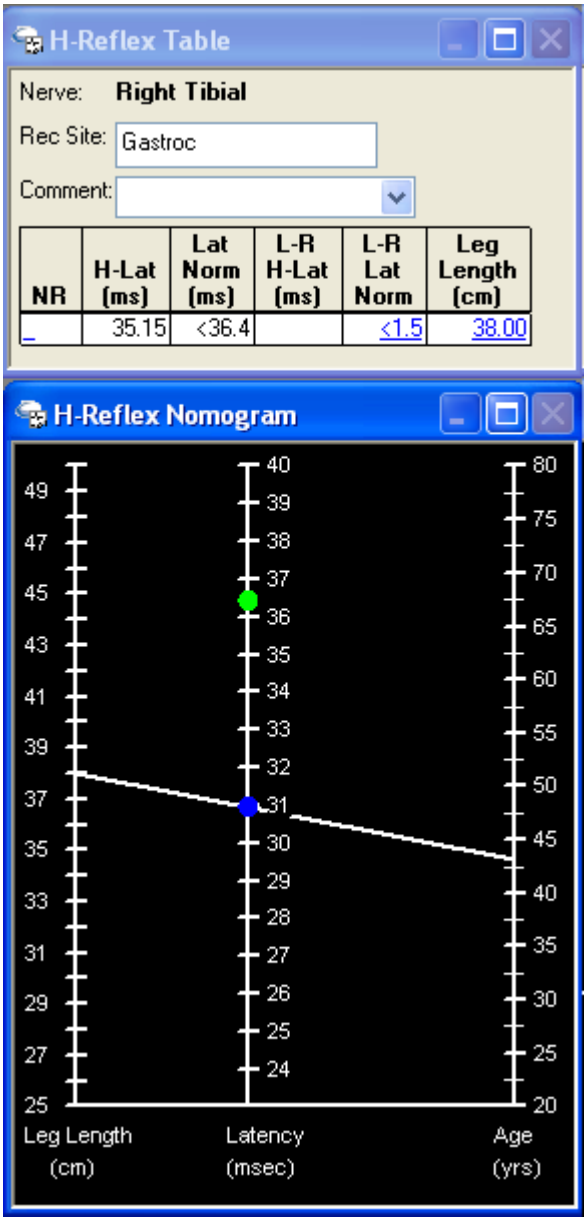
There is a document on the Sierra Wave software installation CD containing a compilation of many published factors for predicting normal values.

6. Repeat steps 1-5 for other nerves.
7. Click **OK** to close the Test Setup window.

Data Acquisition Mode:

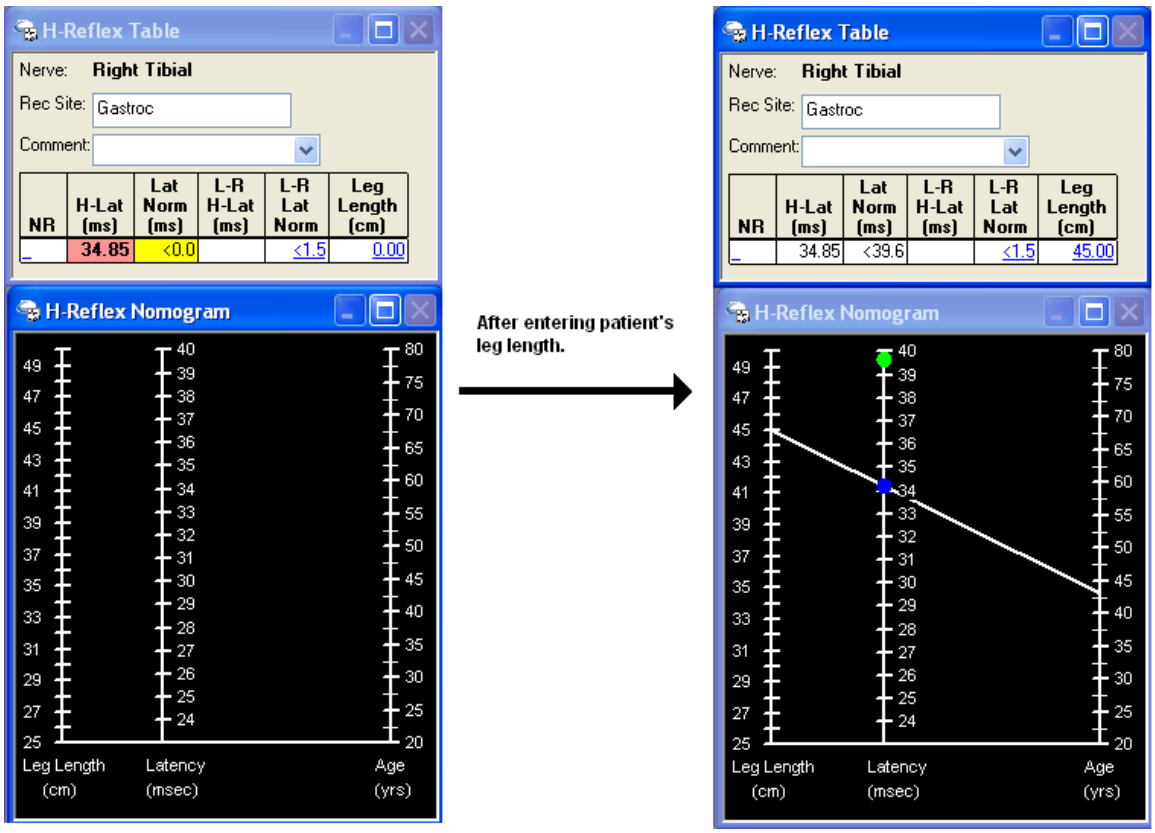
If **Leg Length** is selected for the Tibial H Reflex, the standard **H Reflex Nomogram** will be displayed on the acquisition screen and a Leg Length field will be shown in the measurement table. After entering the patient's leg length in the table a line will be drawn in the nomogram to indicate the predicted normal latency, the **blue dot** marks the predicted value and the

green dot marks the upper limit of normal based on the specified standard deviation.



H Reflex Nomogram

If the patient's Date Of Birth and/or Height have not been entered prior to loading the test protocol the normal value will be shown as **<0.0 with a yellow background**. Once the Date of Birth and/or Height/Leg Length have been entered the predicted normal value will be displayed.



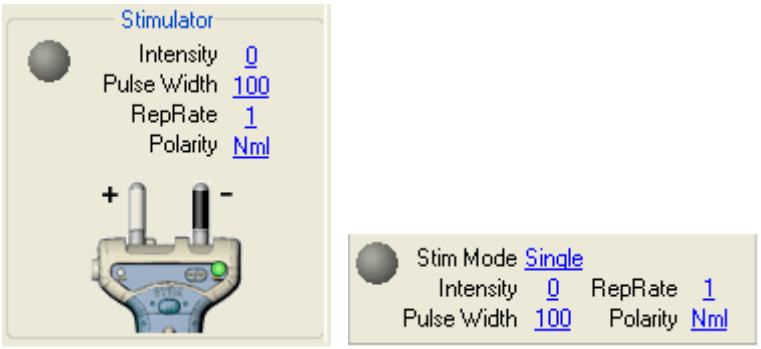
Stimulator Polarity

For H Reflex Studies, the **Cathode (-)** should be oriented **away from the recording electrodes** (i.e., Cathode proximal, Anode distal).

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **H Reflex Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

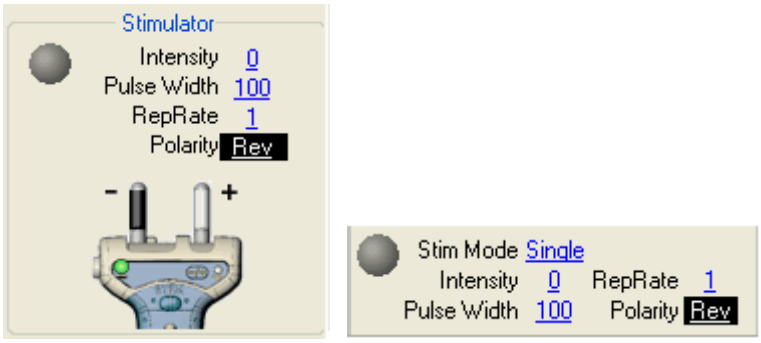
In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the Cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the Cathode (-). The polarity field on the screen will indicate **Rev**.



Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

Swap Sides

To swap the side parameter on a nerve, perform one of the following.

- **Right click** the mouse over the **nerve name** in the **Study window**. From the pop-up menu select **Swap Sides**.
- Press the **F7 function key** on the PC's keyboard. In the H Reflex test protocol the F7 key is always assigned the Swap Sides function.

If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

If the side you are swapping to already has stored traces, then a second run will be automatically added to that existing nerve.

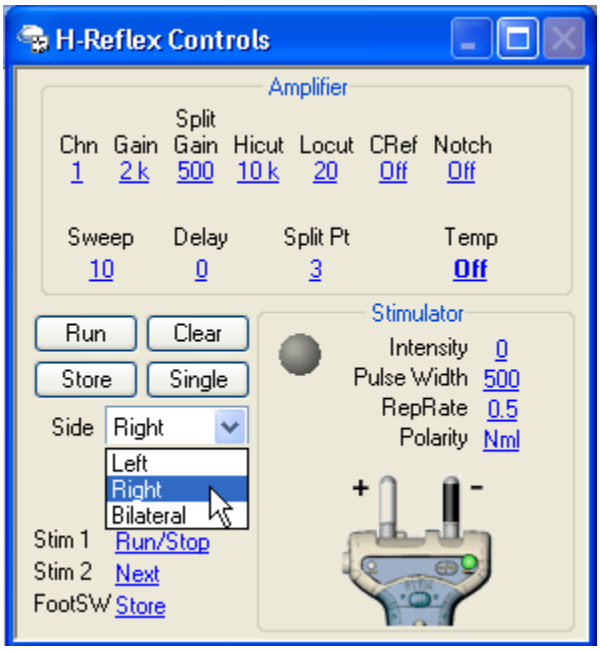
Change Sides

Changing the Side parameter for a nerve is different than Swapping Sides. When you change sides, the highlight in the Study window simply moves to that nerve in the Study window. No traces are transferred.

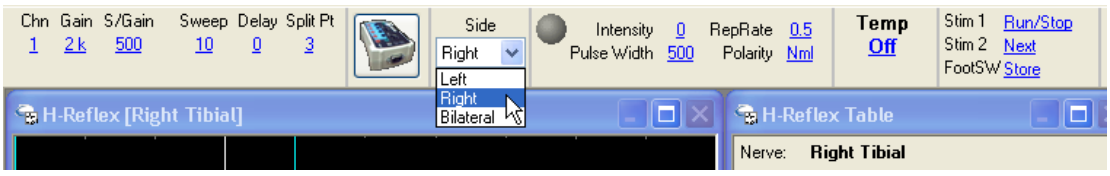
If the nerve corresponding to the selected side is not listed in the Study window, it is automatically added to the window.

To change the side parameter:

In the **H Reflex Controls** window, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.



In the **Controls Toolbar**, click the **down arrow** for the **Side** parameter control. Select the appropriate side from the drop-down list.

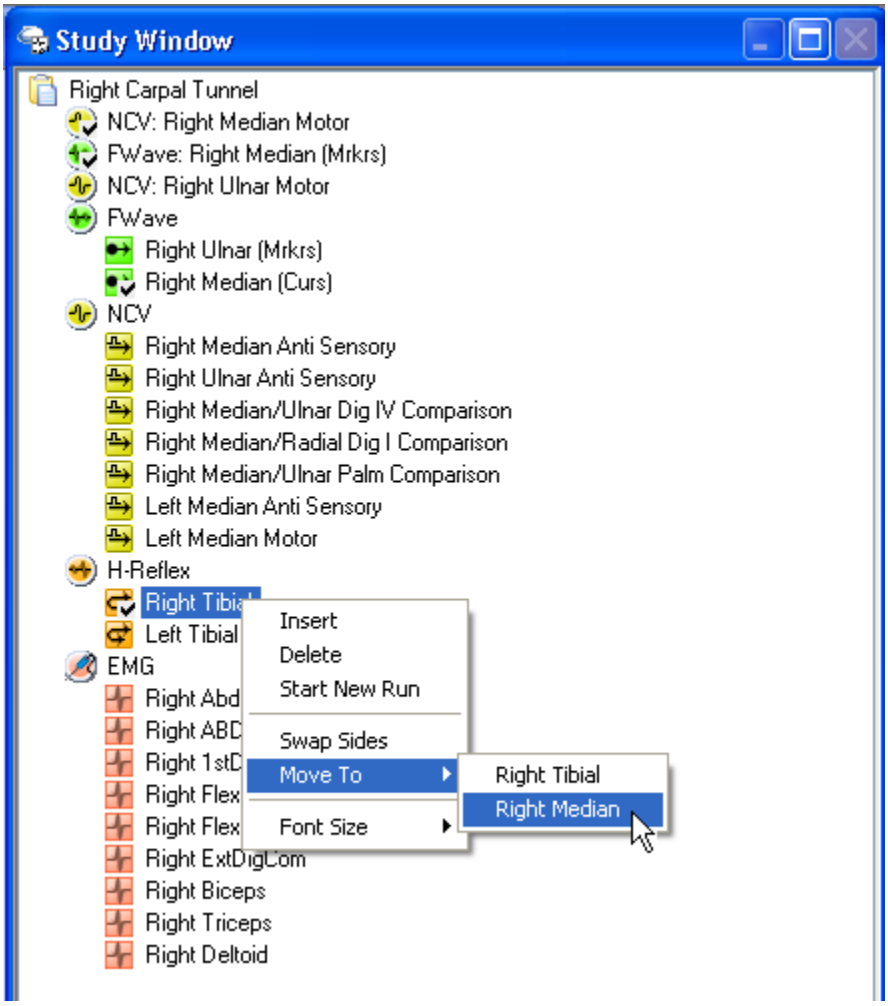


Move To

This feature allows the H Reflex traces to be moved to a different nerve. For example, tibial nerve traces can be moved to any other nerve in your H Reflex nerve list.

To Move the traces to another nerve:

- **Right click** the mouse over the nerve in the Study window.
- Select **Move To** from the pop-up menu.
- Select a nerve from the displayed list.



The position of the latency marker is not moved with the traces, you will have to reset its position after the move.

No Response

If no response can be obtained you can indicate this using the **NR** column in the H Reflex Table.

Simply click within the **NR column** just to the left of the H Reflex Latency. The text "NR" will be displayed and any latency values for the site will be cleared.

H Reflex Table with no response indicated.

If you mistakenly mark the test as no response, click on the "NR" text and it will be removed and the latency marker values will be restored.

Compare Left vs. Right (H Reflex)

This feature allows for a visual comparison of the traces obtained for each side.

To compare Left vs. Right sides.

- Press the **F10 - L/R Cmp** function key.

The trace window will show the current side's traces in the top window and the contralateral side's traces (in blue) in the bottom window.

Press the F10 - L/R Cmp function key a second time to return to the standard H Reflex display.

The H Reflex Table always shows the **Contra H Latency**, **L-R H Latency**, and **L-R Latency Norm** (if entered for the nerve).

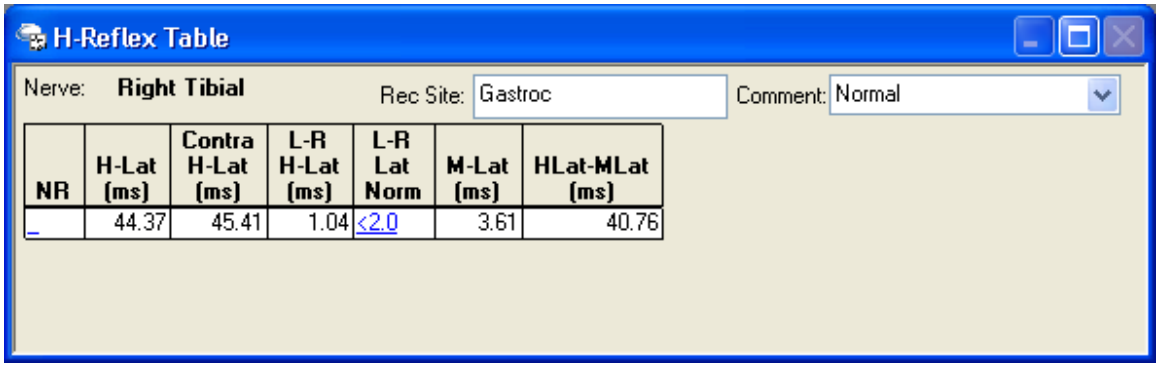
The contralateral traces can be toggled On/Off at any time by right-clicking over the trace window and selecting **Show Contralateral Traces**

Comment (H Reflex)

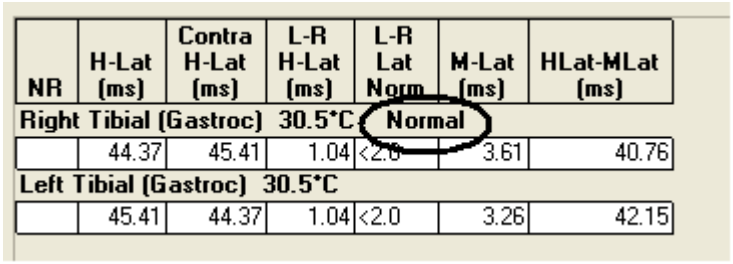
An optional comment can be entered on a per nerve basis. Simply click in the **Comment field** and enter the comment you would like to attach to the nerve.

The comment will appear in the TabData window and in reports.

The comment field will remember the last 20 comments that have been entered and these can be re-selected from a list using the drop-down arrow.



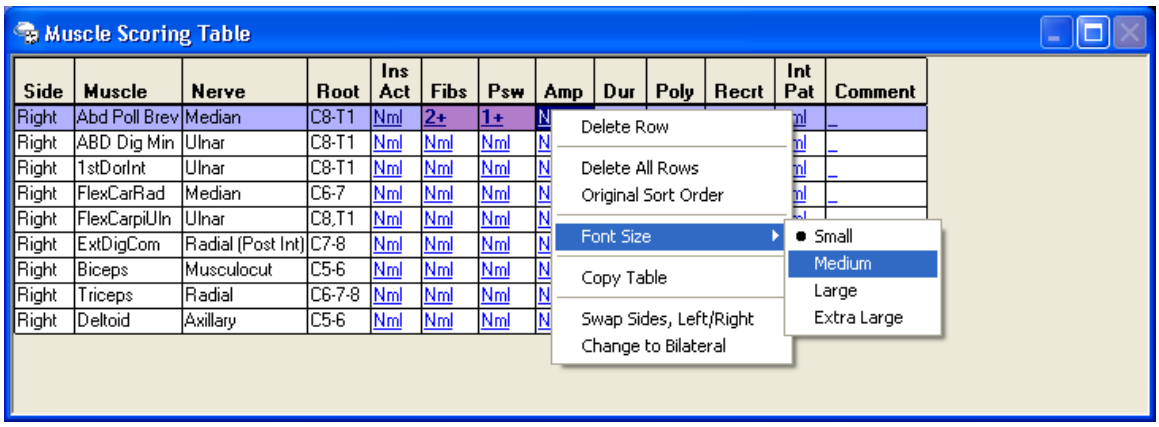
H-Reflex Table with a comment entered into the comment field.



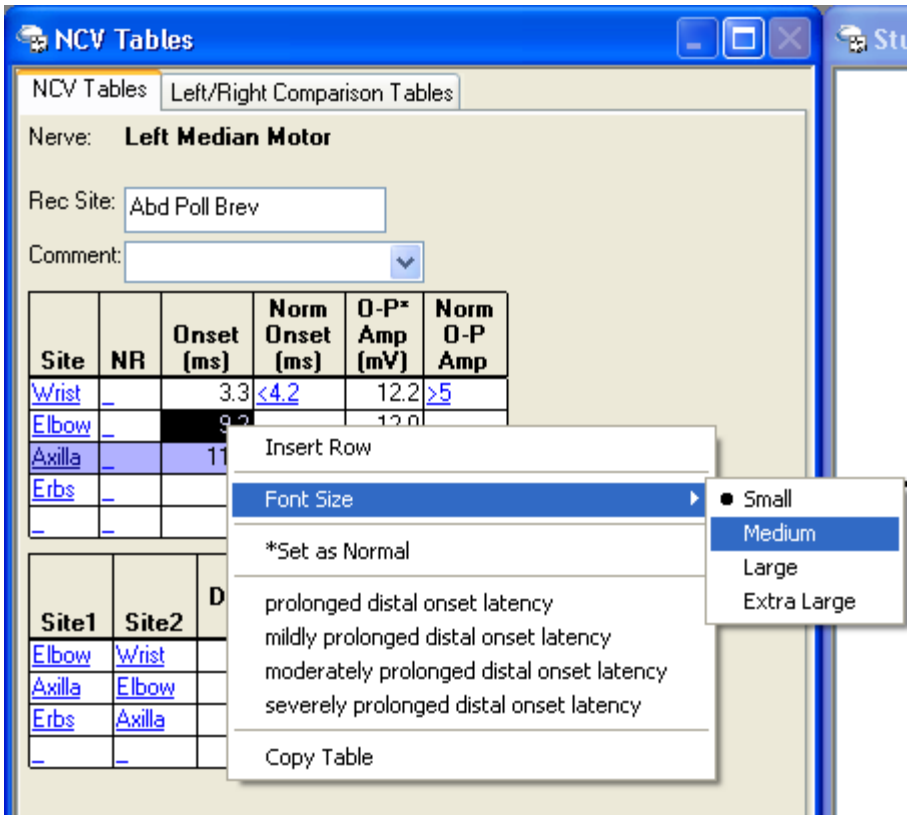
TabData table showing the comment on the same line as the nerve's name.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

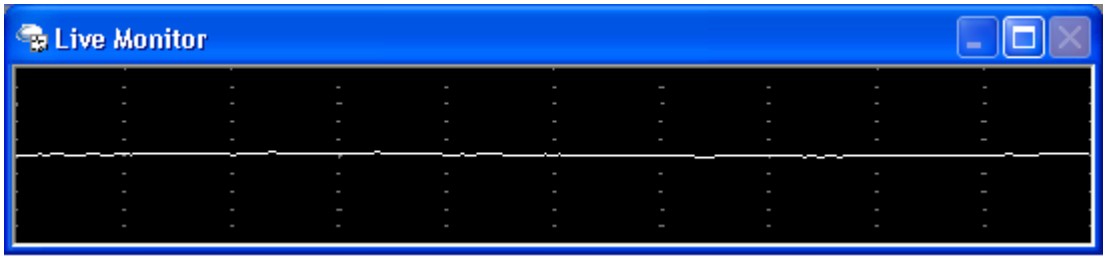
The selected font size is also applied to that table in the TabData window.

Live Monitor Window

A live monitor window is available in the NCV, F Wave, H-Reflex, Blink Reflex, and RNS test protocols.

When this window is enabled it displays the “Live” activity coming from the recording electrodes. When electrical stimulation occurs, the window will briefly display a stimulus-triggered waveform, and then will return to displaying “Live” activity after one second.

This window can be positioned, sized, and saved as part of the default settings for the test protocol.



To Enable the Live Monitor window:

1. Start the Sierra Wave program.
2. Select a test protocol.
3. From the **Edit** menu, select **Current Test**.
4. Click on the **General Settings** tab.
5. Check the box labeled, **"Show Live Monitor"**.
6. Click **OK**.
7. Adjust the size and positions of the windows on the screen.
8. From the **Edit** menu, select **Save Test Parameters** to update the default settings for the test. From now on the test protocol will display the Live Monitor Window.

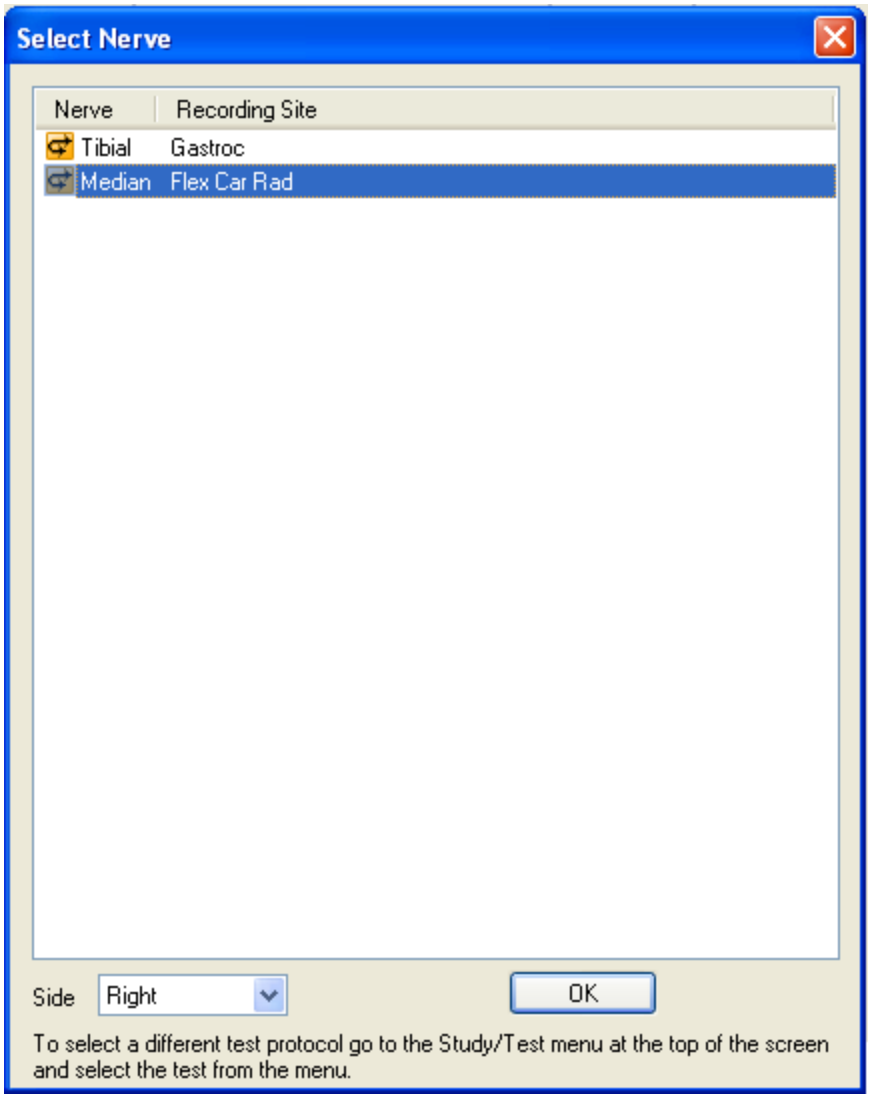
The Gain and Sweep Speed of the Live Monitor window are the same as the main Trace window.

Nerve List (F3)

The **F3 (Nerve List)** function key is a convenient way to add nerves to the Study window after a Study List has been selected or after the H Reflex Test Protocol has been loaded.

To Add a Nerve to the Study Window

1. From within the H Reflex Test Protocol, press the **F3 (Nerve List)** function key. The **Select Nerve** window will be displayed.



H Reflex Select Nerve window.

2. To add a **single nerve**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted line drawn around the nerve name. **Press** the knob to **highlight** the nerve. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **nerve name**.

3. To add **multiple nerves**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Nerve Sel / Toggle)** until the appropriate **nerve name** is selected, this is indicated by a dotted

line drawn around the nerve name. **Press** the knob to **highlight** the nerve. Repeat this process until all of the nerves you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate nerve names. Once all of the nerves have been selected, **verify the Side** parameter and then click **OK**.

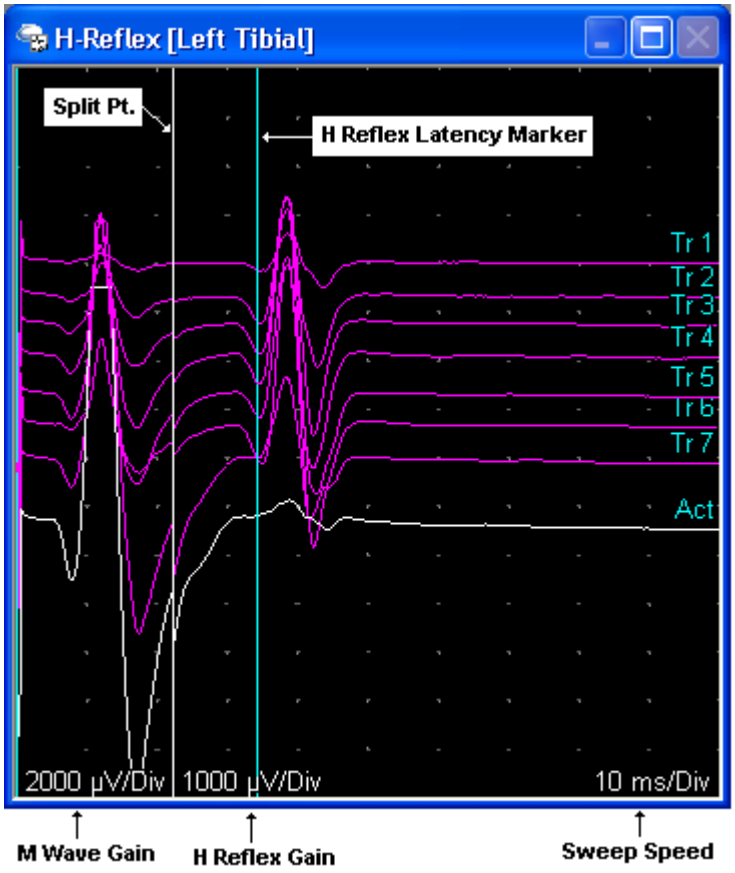
 Setting the **Side** parameter to **Left & Right** will add the nerve to the Study window twice, once for the Left side and once for the Right side.

 Adding nerves to the Study window in this manner is only temporary. To add nerves to a Study List permanently, review the help topic "Changing an Existing Study".

Split Gain Position

The H Reflex Trace window is divided in two by a vertical Split Gain marker. The left side of the window is assigned an M Wave gain setting, the right side of the window is assigned an H Reflex gain setting.

By moving the Split Point indicator you can give more or less space to either side of the Trace window.



To Move the Split Point Indicator

Click on the split point indicator line with the mouse and drag the indicator line left or right within the Trace window.

The default position of the Split Pt indicator can be programmed in the H Reflex Test Menu Editor.

Manual / Auto Store

If the **F1 (Manual / AutoStore)** function key is set to the **Manual** mode you will need to store the response by performing one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Footswitch** pedal.
- Press the **Store button** on the Sierra Wave **base unit**.

- Click on the **Store button** in the **F/H Controls** window.

If the **F1 (Manual / AutoStore)** function key is set to the **AutoStore** mode, the trace will automatically be stored immediately after it is acquired.

Stored traces will be displayed in "purple" color on the screen.

 The default state of the F1 function key can be programmed in the Test Menu Editor.

Latency Markers

The H Reflex test protocol uses two latency markers to mark the H Reflex Onset Latency and the M Wave Onset Latency.

To move the latency markers, perform one of the following.

- **Using the Mouse** - click on the marker you want to move using the left mouse button and drag the marker across the Trace window.
- **Using the Knobs** - use **Knob #2 (H Lat / MWave Lat)**. This knob defaults to the **H Lat** mode, turn the knob to move the H Reflex latency marker across the trace window to the onset of the H Reflex. Press the knob to activate the **MWave Lat** mode and turn to move a second latency marker to the onset of the M Wave.

Auto H-Reflex Latency

- Press the **F8 (Auto H-Lat)** function key. The program will automatically move the Minimal H-Reflex latency marker to the earliest onset latency. In addition, a pop-up window will show the latency value and the wheel on the stimulator handle can be used to adjust the position of the marker. Once the marker has been positioned, press the F8 function key a second time to exit this mode.

Amplitude Markers

In the H Reflex test protocol the amplitude markers can be used to measure the amplitude of one M Wave and one H Reflex trace.

To measure both M Wave & H Reflex amplitude, perform the following.

- **Using the Mouse** - **right click** the mouse over the Trace window and select **Amplitude Markers** from the pop-up menu. Two horizontal markers will be displayed on each side of the split point. Click and drag the markers to the appropriate positions. The amplitude (in microvolts) between the two markers is displayed in the H Reflex Table.

To measure only H Reflex amplitude, perform the following.

- **Using the Knobs** - press the **F5** function key to enter **Cursor** mode. Press the **F3** function key to turn the H Reflex Amplitude markers **On**. Now use **Knob #2 (Amp 1 / Amp 2)** to move the two markers. The amplitude (in microvolts) between the two markers is displayed in the H Reflex Table and on the Knob #2 icon.

Deleting Traces

To Delete a selected H Reflex trace, perform one of the following.

- **Using the Mouse** - **select the trace** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trace color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trace will be deleted.
- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #2 (Sel Trial / Delete)** until the trace you want to delete is selected, a selected trace is displayed in yellow. **Press the knob to delete** the selected trace. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

Saving Changes to H Reflex Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the H Reflex nerve.

- Select **Save Test Parameters** from the **Edit** menu.

RNS (Myasthenia)

RNS Basic Steps

This topic is a repeat of the basic RNS (Repetitive Nerve Stimulation) steps found in the **Getting Started** chapter.

Select the RNS Test:

- **If a Study has already been selected**, simply click on the RNS muscle name within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the RNS test protocol from the Study/Test menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient.

Once the muscle has been selected. Follow these steps for performing RNS data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed. RNS typically uses the same settings as a motor NCV.

2. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Electrode Placement**

   Attach the electrodes to the patient.

   Active 1 Input: Belly of the muscle.

   Reference 1 Input: Tendon of the muscle.

   Ground Electrode: On stimulated limb or forehead.

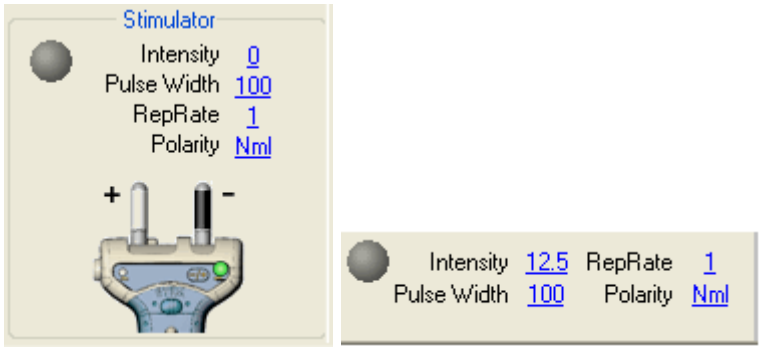
4. **Check Stimulator Polarity**

   For RNS Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

   The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **RNS Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the Normal mode, the electrical stimulator image on the screen will show the Right-side probe as the cathode (-). The polarity field on the screen will indicate **Nml**.



Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the Reversed mode, the electrical stimulator image on the screen will show the Left-side probe as the cathode (-). The polarity field on the screen will indicate **Rev**.

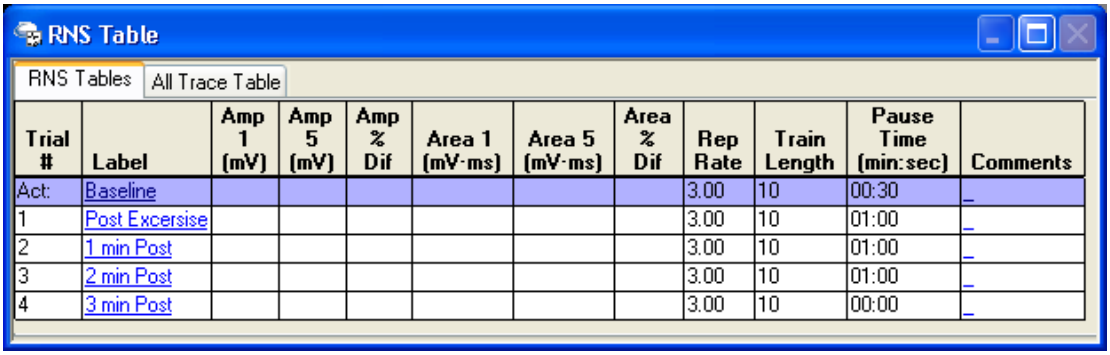
Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Check the RNS Table

The RNS test protocol supports a preprogrammed stimulus train table. This table controls the number of stimuli presented in each train, the repetition rate for the stimuli, the amount of time to pause before proceeding to the next stimulus train, and it also provides a convenient way to label each stimulus train.

The program allows for either manual or automatic delivery of the stimulus train table.



Trial #	Label	Amp 1 (mV)	Amp 5 (mV)	Amp % Dif	Area 1 (mV-ms)	Area 5 (mV-ms)	Area % Dif	Rep Rate	Train Length	Pause Time (min:sec)	Comments
Act:	Baseline							3.00	10	00:30	
1	Post Excersise							3.00	10	01:00	
2	1 min Post							3.00	10	01:00	
3	2 min Post							3.00	10	01:00	
4	3 min Post							3.00	10	00:00	

RNS Table.

If your stimulus train table is undefined, select **Current Test** from the **Edit** menu. Fill in the **Sequencer Setup** table in the lower left corner of the setup window, then click **OK**.

6. Check the General and Stimulator Settings

General Settings

Mode: Choices are **Train** or **Single**.

- **Train** - When the Stim button on the handheld stimulator or the Run/Stop button is pressed, a train of stimuli, corresponding to the highlighted row in the RNS Table, will be delivered.
- **Single** - When the Stim button on the hand held stimulator or the Single button is pressed, a single stimulus will be delivered. This mode is useful for determining supramaximal stimulation prior to delivering a train of stimuli.

Train #: The total number of stimuli that will be delivered to the patient when the program is set to the Train mode. The typical setting is four to eight. The maximum setting is 150. This value is updated from the RNS Table.

Spread: This is the distance (in horizontal divisions) that will separate the individual traces within the train. If this value is set to zero, the traces will be superimposed upon one another.

Response 1: Select the first response in the train that will be analyzed for amplitude and area measurements. Typically this is always set to number 1.

Response 2: Select the second response in the train that will be analyzed for amplitude and area measurements. In addition, the

percentage difference between this response and the trace selected for Response 1 will be computed. This is typically set to number 4 or 5.

Auto Seq: Allows for either manual or automatic sequencing through the RNS Table. When set to **On**, the program will automatically deliver the trains specified in the RNS table (automatically pausing for the specified time after each train). When set to **Off**, the user must manually start each train after the appropriate pause time, by pressing the Run/Stop key for each train.

Stimulator Settings

Pulse Width: Set the electrical stimulus pulse width, also known as pulse duration, in microseconds (*u*sec).

Rep Rate: Set the repetitive stimulus rate, in pulses per second (Hz). This is typically set to 3 Hz. This setting only applies when delivering repetitive (i.e., Train) stimulation, it does not apply during manual Single stimulus delivery.

7. Check Recording Setup

Press the **F1 (Train/Single)** function key to select **Single** mode. Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator controls section. Once you have reached an appropriate starting intensity apply the stimulator to the patient and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

 The **Single key** on the Sierra Wave base unit or the **Single button** within the on-screen RNS Controls window can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

Continue to increase the intensity level and stimulate until a supra-maximal response is acquired. If the response is large and "clips" at the top or bottom, decrease the amplifier sensitivity by adjusting the Gain setting. For example, change gain from 2k to 5k and re-stimulate. Gain can be adjusted easily by using **Knob #4 (Gain /Sweep)** on the Sierra Wave base unit.

8. Deliver Stimulus Trains

Press the **F1 (Train/Single)** function key to select **Train** mode. Follow the instructions below for either Manual or Automatic Stimulus Train delivery.

Manual Stimulus Train Delivery:

Press the **Stim button** on the electrical stimulator handle. A train of stimuli will be delivered to the patient and a trace will be displayed for each stimulus within the train. The traces are stacked in a horizontal fashion (see Spread setting above).

After the Train is completed the program will automatically store the train and it will be displayed in a "purple" color.

 The **Run/Stop key** on the Sierra Wave base unit or the **Run button** within the on-screen RNS Controls window can also be used to deliver a train of stimuli.

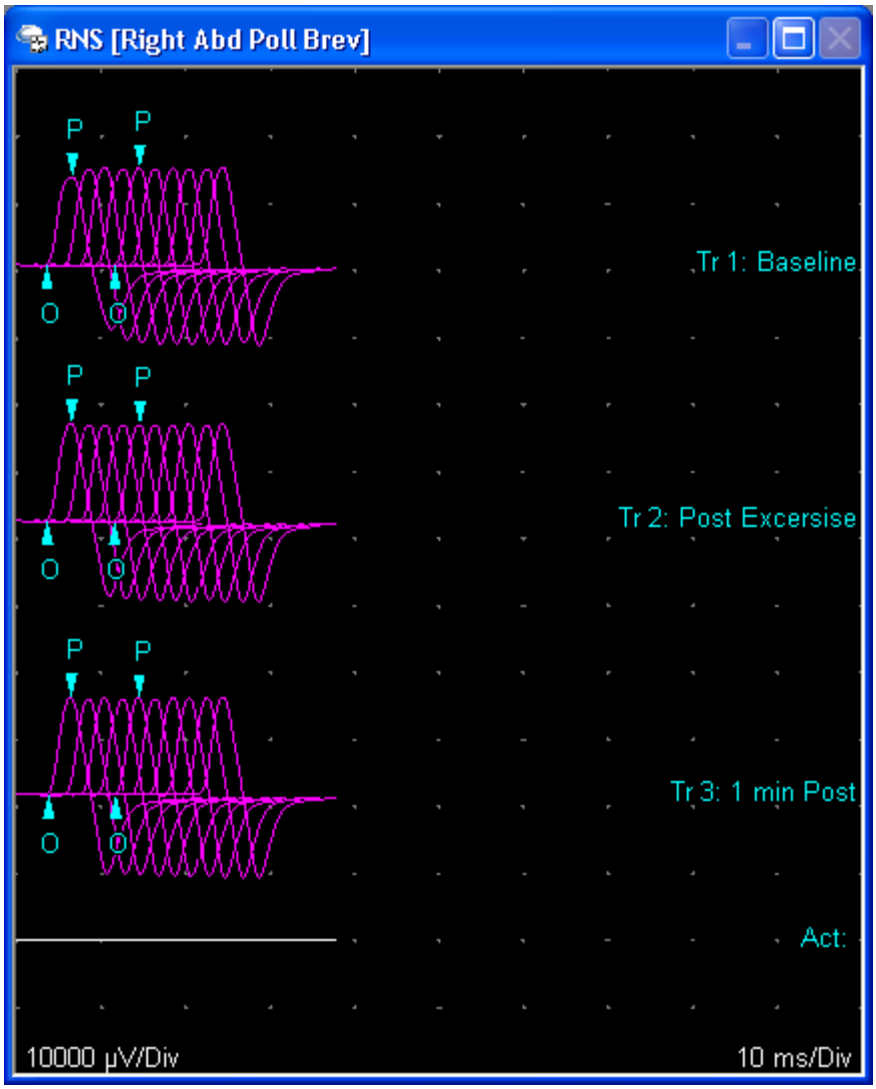
 20 milliseconds is acquired after each stimulus. This allows for a maximum repetition rate of 50 Hz during train stimulation.

After a train is automatically stored, a timer is started. The timer is displayed just below the side field in the RNS Controls window or at the top of the screen in the Controls Toolbar.

Use the timer to measure the time elapsed while the patient exercises the muscle or the time elapsed between successive stimulus trains. Typically, the patient will exercise the muscle for 30 seconds after the first train is delivered then another train will be delivered immediately after completion of exercise. Additional trains are then typically delivered at 1 minute intervals after this.

Press the **Run/Stop** key again to deliver the second stimulus train. Proceed in this fashion until all stimulus trains have been acquired.

 The timer automatically resets to zero after each train is stored. You can also manually reset the timer to zero by pressing the **F2 (Reset Timer)** function key on the Sierra Wave base unit.



Example RNS Traces

Automatic Stimulus Train Delivery:

Change the **Auto Seq.** control from **Off** to **On**. The first row in the RNS Table will be automatically highlighted.

Press the **Stim button** on the electrical stimulator handle. A train of stimuli will be delivered to the patient and a trace will be displayed for each stimulus within the train. The traces are stacked in a horizontal fashion (see Spread setting above).

After the Train is completed the program will automatically store the train and it will be displayed in a "purple" color. At this point the timer is started. The timer is displayed just below the side field in the RNS Controls window or at the top of the screen in the Controls Toolbar.

Once the timer reaches the preprogrammed pause time for the stimulus train, the program will automatically deliver the next stimulus train in the RNS Table.

Stimulation will continue in this manner until the last stimulus train is delivered.

You can stop the automatic sequencer at any time by changing the **Auto Seq.** control from **On** to **Off**.

9. Adjust Cursors (optional)

Onset (O) and **Peak (P)** cursors are automatically placed on the selected responses (see Response 1 and Response 2 settings above) as each train is acquired. The amplitude (onset to peak) and area (negative peak) of each response is calculated and displayed in the RNS table window.

The positions of these cursors can be adjusted by performing one of the following actions;

- By pressing the **F5 (Cursor mode)** function key and then using **Knob #1 (Sel Cursor / Move Cursor)** on the Sierra Wave base unit.
- By clicking on them with the **left mouse button** and dragging them to their new position.

The difference for both amplitude and area, between the two marked responses, is also automatically calculated and is displayed as a percentage (%). The equation used for this calculation is as follows;

$D = (V_{R2} - V_{R1}) / V_{R1} \times 100\%$

Where D = decrement or increment

V = value (amplitude or area)

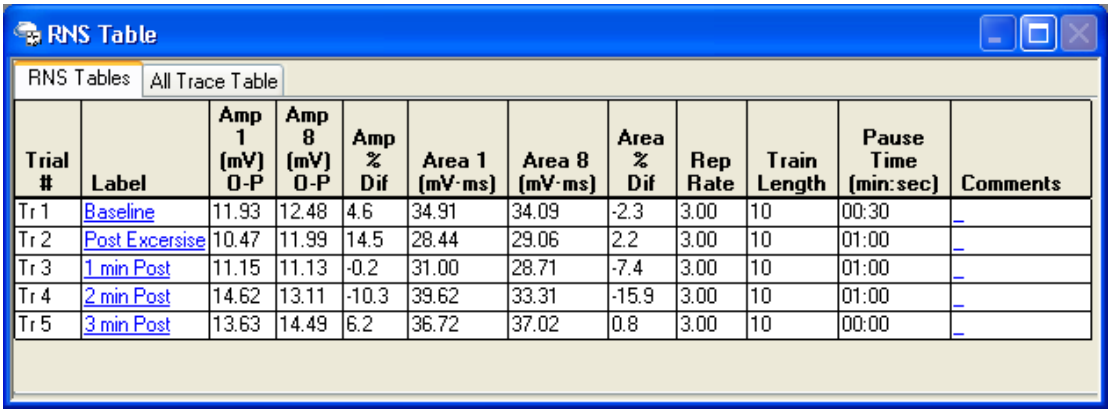
R1 = response 1

R2 = response 2

A decrement is displayed as a negative number, typically more than a **-10%** decrement is considered abnormal. An increment is displayed as a positive number.

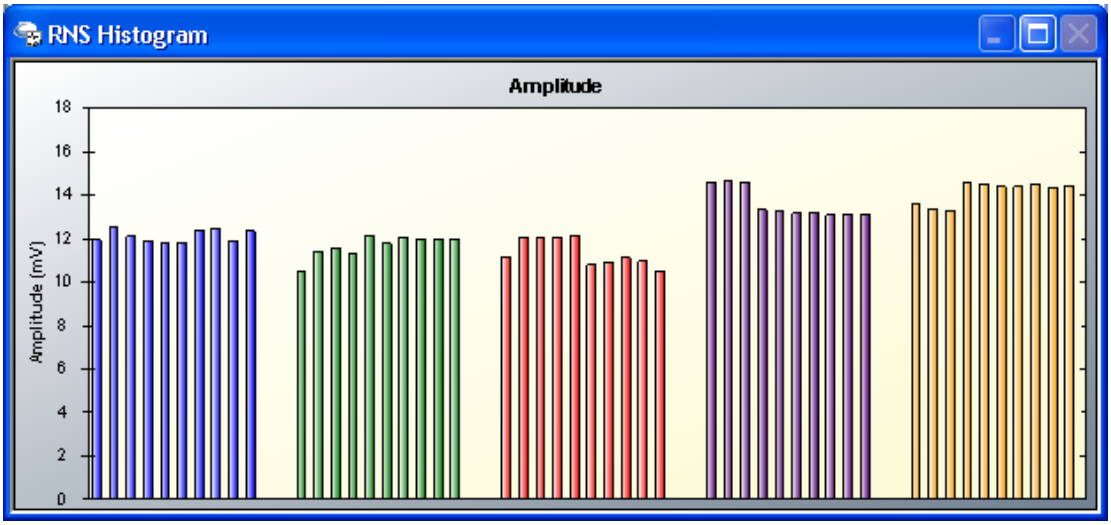
Peak-to-Trough amplitude measurements can also be selected in the RNS protocol's test setup window. In this case, **Peak (P)** and **Trough (T)** cursors will be automatically placed on the responses.

Use the **Comment** field in the RNS table to enter a notation for the train.



Trial #	Label	Amp 1 (mV) O-P	Amp 8 (mV) O-P	Amp % Dif	Area 1 (mV-ms)	Area 8 (mV-ms)	Area % Dif	Rep Rate	Train Length	Pause Time (min:sec)	Comments
Tr 1	Baseline	11.93	12.48	4.6	34.91	34.09	-2.3	3.00	10	00:30	_
Tr 2	Post Excersise	10.47	11.99	14.5	28.44	29.06	2.2	3.00	10	01:00	_
Tr 3	1 min Post	11.15	11.13	-0.2	31.00	28.71	-7.4	3.00	10	01:00	_
Tr 4	2 min Post	14.62	13.11	-10.3	39.62	33.31	-15.9	3.00	10	01:00	_
Tr 5	3 min Post	13.63	14.49	6.2	36.72	37.02	0.8	3.00	10	00:00	_

RNS Cursor Table



RNS Histogram Window

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Muscle or Test

To advance to the Next Muscle:

- Use **Knob #1 (Study Item / Site)** to highlight another RNS muscle in the **Study** window.
- **Click** on another RNS muscle in the **Study** window using the **mouse**.
- **Press** the **F3 (Muscle List)** function key on the **Sierra Wave base unit** and select another muscle from the muscle list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (RNS)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press this knob to switch to the **Pulse Width** mode and turn to change the value of the electrical stimulus pulse width, the current pulse width value (in microseconds) will be displayed on the knob icon.

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the Trace window. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the Trace window.

F Keys

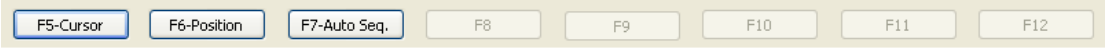
Train / Single - in **Train** mode, when the Stim button on the handheld stimulator or the Run/Stop button is pressed a train of stimuli will be delivered. In **Single** mode, when the Stim button on the hand held stimulator or the Single button is pressed a single stimulus will be delivered. This mode is useful for determining supramaximal stimulation prior to delivering a train of stimuli.

Reset Timer - manually resets the timer to zero.

Muscle List - opens the RNS Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

PC Function Keys (F5-F12)



F5-Cursor - enables Cursor mode (see below).

F6-Position - enables Position mode (see below).

F7-Auto Seq. - toggles the Auto Sequencer On and Off.

Cursor mode (F5)

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on any trace within the Trace window. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trial - turn this knob to select an RNS train. When selected, the train will be displayed in yellow.

Gain - turn this knob to change the gain of the selected RNS train. The current gain setting for the train is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) train.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) train.

All On / All Off - defaults to All On mode. Press to hide all cursors on all trains.

Position mode (F6)

Knobs

Sel. Trial / Move - defaults to **Select Trial** mode, turn this knob to select a stored RNS train. When selected, the train will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected train up or down within the Trace window.

Move Active - turn this knob to move the active (white colored) train up or down within the Trace window.

Sel. Trial / Delete - turn this knob to select a stored RNS train. When selected, the train will be displayed in yellow color. Press the knob to permanently delete the selected train.

Gain - turn this knob to change the Gain of the selected RNS train. The current gain setting for the train is displayed on the knob icon.

F Keys

- there are no functions assigned to the F Keys is position mode.

RNS Test Setup

RNS test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Single / Train Mode

Mode: Select the default stimulus mode for the test. Choices are **Train** or **Single**.

- **Train** - When the Stim button on the handheld stimulator or the Run/Stop button is pressed a train of stimuli will be delivered.
- **Single** - When the Stim button on the hand held stimulator or the Single button is pressed a single stimulus will be delivered. This mode is useful for determining supramaximal stimulation prior to delivering a train of stimuli.

Using the Automatic Sequencer

After checking the recording setup, press the **F1 (Train/Single)** function key to select **Train** mode. Follow the instructions below for Automatic Stimulus Train delivery.

Automatic Stimulus Train Delivery:

Change the **Auto Seq.** control from **Off** to **On**. The first row in the RNS Table will be automatically highlighted.

Press the **Stim button** on the electrical stimulator handle. A train of stimuli will be delivered to the patient and a trace will be displayed for each stimulus within the train. The traces are stacked in a horizontal fashion (see Spread setting above).

After the Train is completed the program will automatically store the train and it will be displayed in a "purple" color. At this point the timer is started. The timer is displayed just below the side field in the RNS Controls window or at the top of the screen in the Controls Toolbar.

Once the timer reaches the preprogrammed pause time for the stimulus train, the program will automatically deliver the next stimulus train in the RNS Table.

Stimulation will continue in this manner until the last stimulus train is delivered.

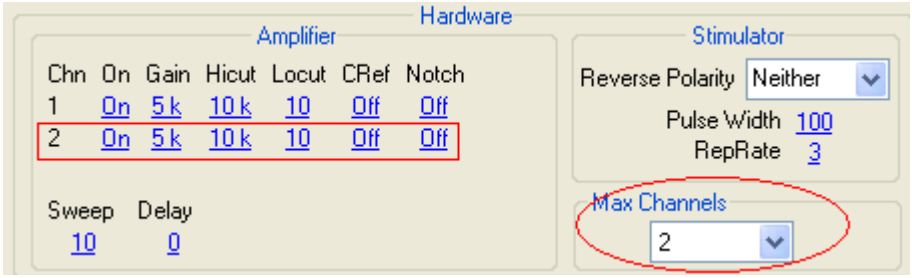
You can stop the automatic sequencer at any time by changing the **Auto Seq.** control from **On** to **Off**.

2 Channel Recording in RNS

The RNS test protocol is capable of simultaneous recording from 2 channels.

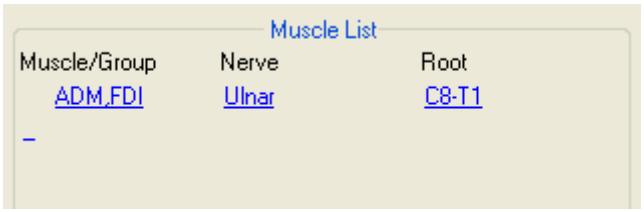
To Enable 2 Channel Mode:

In the **RNS Test Setup** window, change the **Max Channel parameter from 1 to 2**. Then, change the status of channel 2 in the Amplifier Settings from **Off to On** and set the appropriate gain and filter values for the channel.



Labeling the Channels:

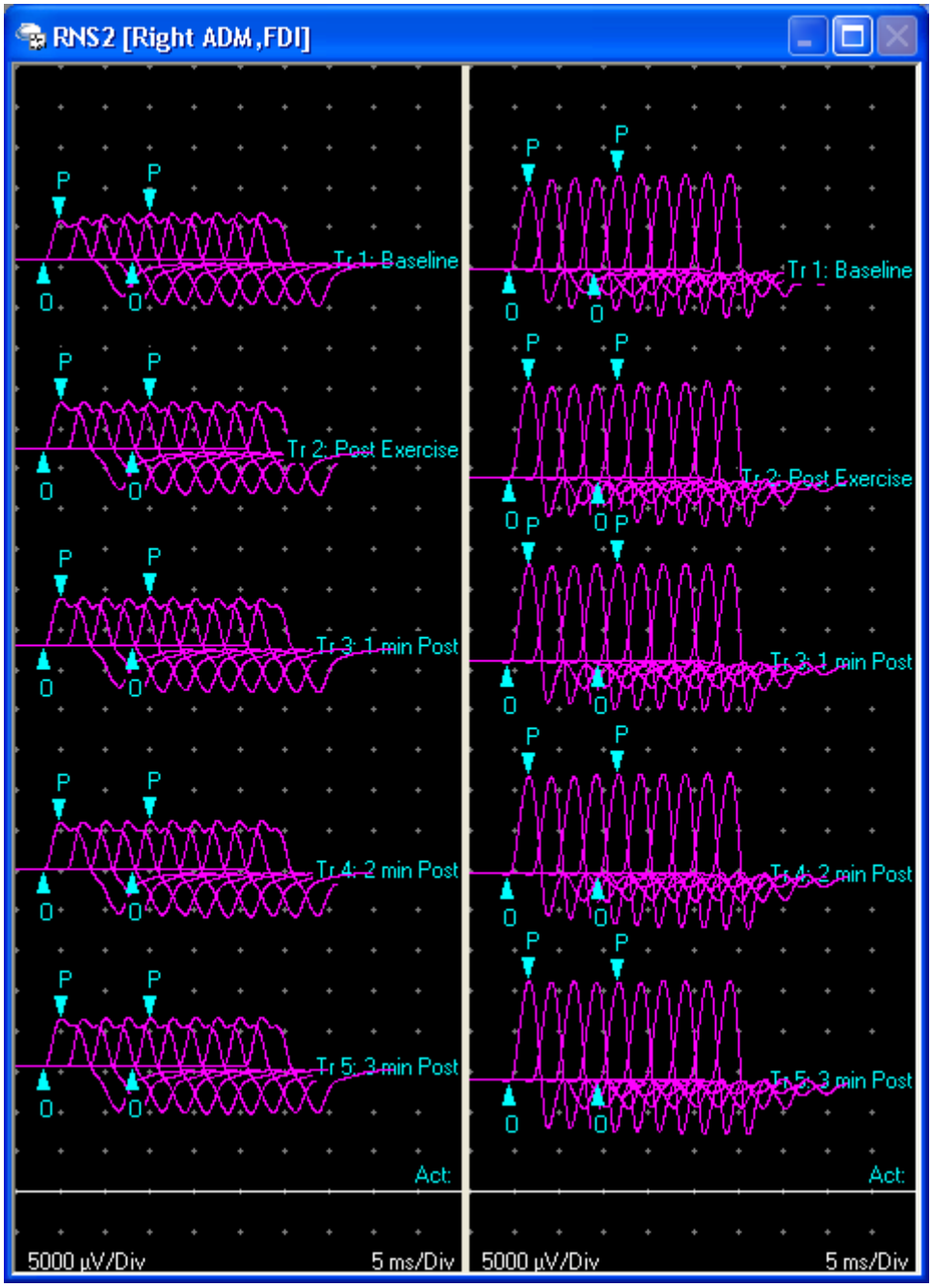
You can label each channel with the name of the muscle it will be recording from. To do this, add a compound muscle name to the muscle list, this is actually two muscles names on the same line separated with a comma.



Channel 1 will use the name to the left of the comma, while channel 2 will use the name to the right of the comma.

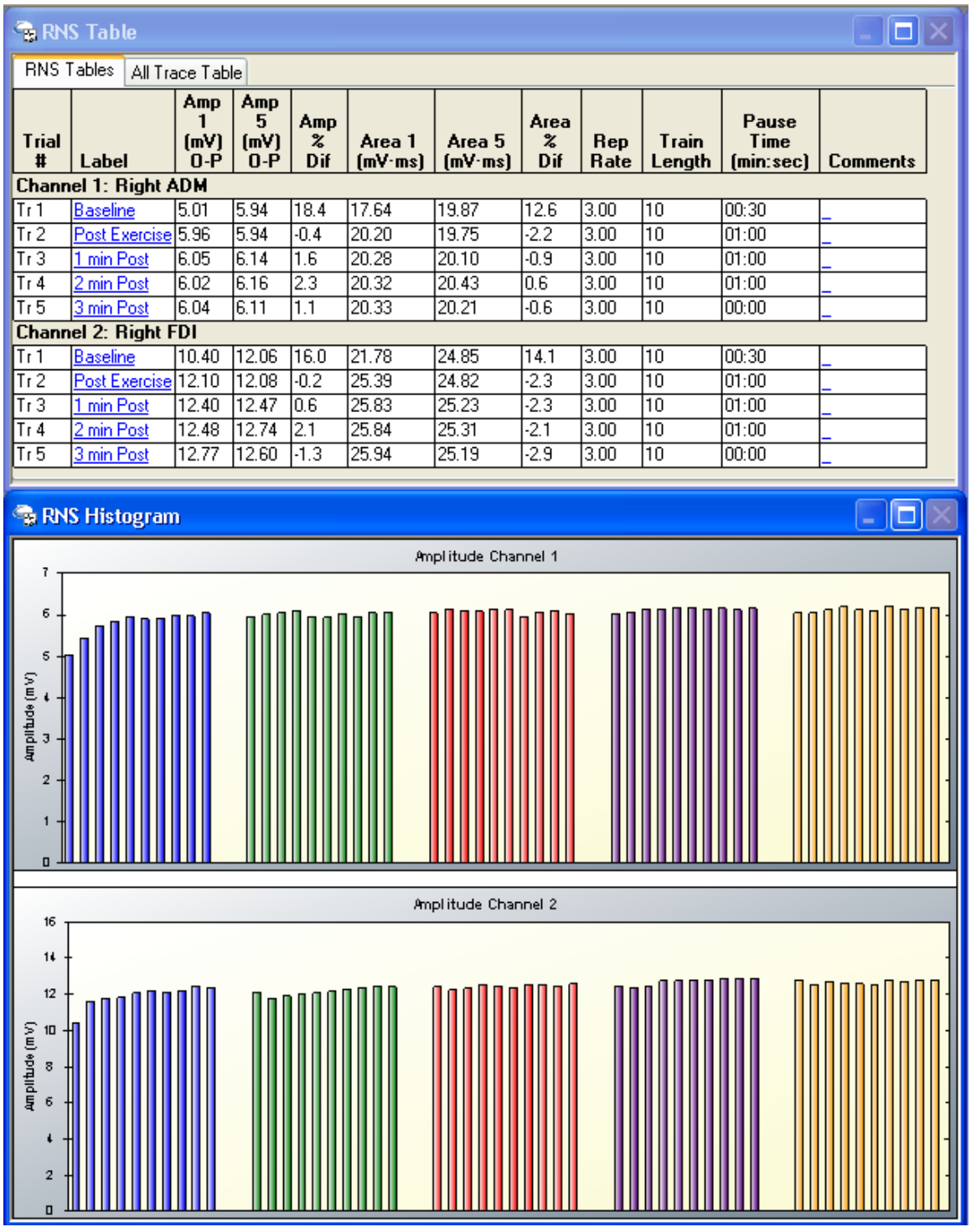
Data Acquisition:

In 2 Channel recording mode the Sierra Wave program will automatically split the trace window. Responses from channel 1 will be displayed in the left half of the window, while responses to channel 2 will be displayed in the right half of the window.



2 channel RNS Trace window.

The program will also create a complete table for each channel in the RNS Table window. The RNS Histogram will be split in half with channel 1 represented in the top half of the window and channel two in the bottom half.



Trial #	Label	Amp 1 (mV) O-P	Amp 5 (mV) O-P	Amp % Dif	Area 1 (mV·ms)	Area 5 (mV·ms)	Area % Dif	Rep Rate	Train Length	Pause Time (min:sec)	Comments
Channel 1: Right ADM											
Tr 1	Baseline	5.01	5.94	18.4	17.64	19.87	12.6	3.00	10	00:30	
Tr 2	Post Exercise	5.96	5.94	-0.4	20.20	19.75	-2.2	3.00	10	01:00	
Tr 3	1 min Post	6.05	6.14	1.6	20.28	20.10	-0.9	3.00	10	01:00	
Tr 4	2 min Post	6.02	6.16	2.3	20.32	20.43	0.6	3.00	10	01:00	
Tr 5	3 min Post	6.04	6.11	1.1	20.33	20.21	-0.6	3.00	10	00:00	
Channel 2: Right FDI											
Tr 1	Baseline	10.40	12.06	16.0	21.78	24.85	14.1	3.00	10	00:30	
Tr 2	Post Exercise	12.10	12.08	-0.2	25.39	24.82	-2.3	3.00	10	01:00	
Tr 3	1 min Post	12.40	12.47	0.6	25.83	25.23	-2.3	3.00	10	01:00	
Tr 4	2 min Post	12.48	12.74	2.1	25.84	25.31	-2.1	3.00	10	01:00	
Tr 5	3 min Post	12.77	12.60	-1.3	25.94	25.19	-2.9	3.00	10	00:00	

2 channel RNS Table & Histogram.

Stimulator Polarity

Press the **Reverse Polarity (+/-) button** on the electrical stimulator handle to select the Cathode (i.e., the negative stimulus probe). A green LED indicates the probe that is the Cathode. **For routine nerve conduction, RNS, and Blink Studies the Cathode (-) should be oriented closest to the recording electrodes.**

Clicking on the **Polarity field** in the **Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., Normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

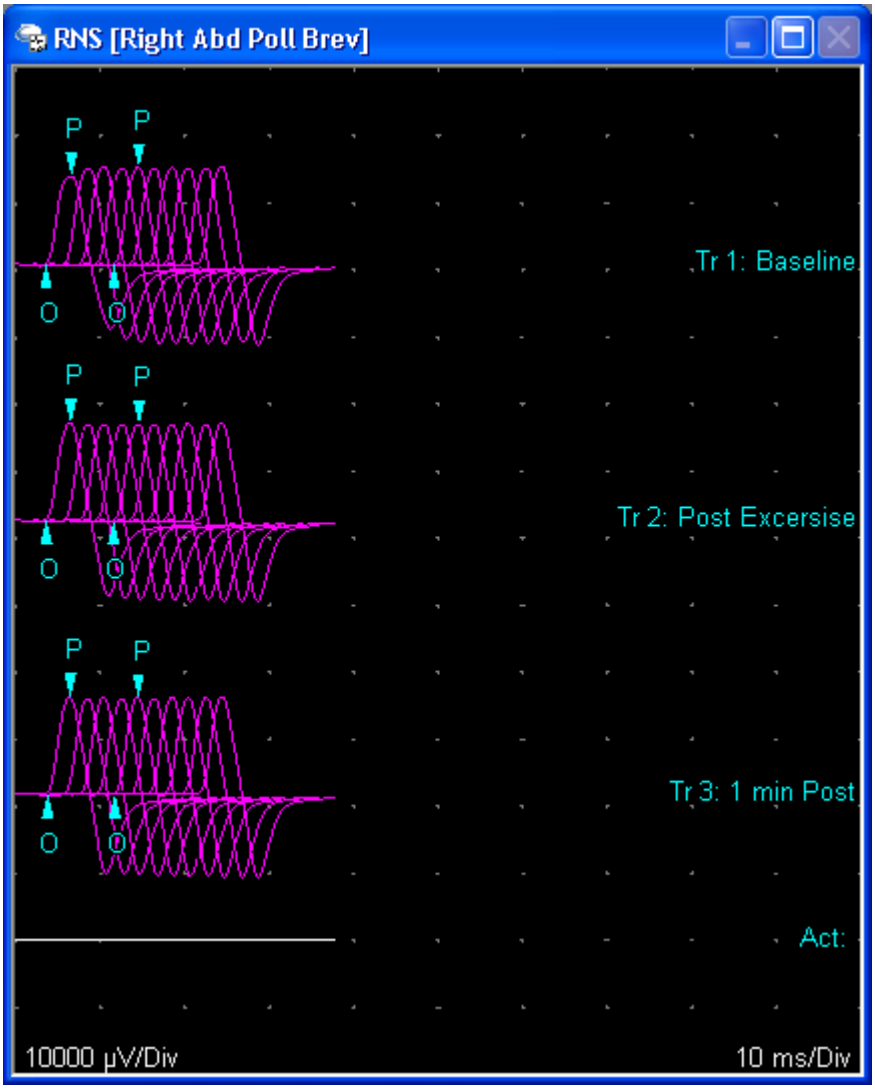
In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

Cursors (RNS)

In the RNS Test Protocol, if the response is of sufficient amplitude, cursors are automatically placed on the trace. Depending on how your test protocol is configured - two or three cursors are placed on Response 1 and 2. If the test is configured for **O-P** amplitude measurements then an **Onset (O)**, and **Peak (P)** cursor are displayed. If the test is configured for **P-T** amplitude measurements then an **Onset (O), Peak (P),** and **Trough (T)** cursor are displayed.



RNS single trace and two trains with cursors positioned.

Adjusting Cursor Positions

The positions of the cursors on a trace with a train can be easily adjusted by following one of the methods below.

- **Using the mouse** - simply left click on the appropriate cursors blue triangle and drag the cursor along the trace to its new location. While the cursor is being moved the blue triangle is replaced with a yellow triangle.
- **Using the F5-Cursor mode** - press the F5 key on the PC's keyboard to change the base unit's knob and functions keys to cursor mode. See the Knob & Fkey Controls topic for further information.

Change Gain of a Train

To change the gain of a selected RNS train, perform the following.

1. **Select the Train** you want to change.
   - **Using the Mouse** - simply left click the mouse over any of the traces within the train, when selected the train will be displayed in yellow rather than purple.
   - **Using the Knobs** - enter **Position mode** by pressing the **F6** function key on the PC's keyboard. Turn **Knob #1 (Sel Trial / Move)** until the desired train is selected.
2. Now, **turn Knob #4 (Gain)**, the selected train will be changed and it's current gain value will be displayed on the knob's icon.

To change the gain of **all the RNS trains** at one time, simply turn **Knob #4 (Gain / Sweep)**.

RNS Timer

After an RNS train is automatically stored, a timer is started. The Timer is displayed just below the side field in the **RNS Controls window** and to the left of the stimulus controls in the **Controls Toolbar**.

Use the timer to measure the time elapsed while the patient exercises the muscle or the time elapsed between successive stimulus trains.

The timer automatically resets to zero after each train is stored. You can also manually reset the timer to zero by pressing the **F2 (Reset Timer)** function key on the Sierra Wave base unit.

Train Comments

A comment can be entered for each train in the RNS Table window.

Simply select the comment field by left clicking the mouse within the comment box, then type your comment and press the Enter key when you have finished.

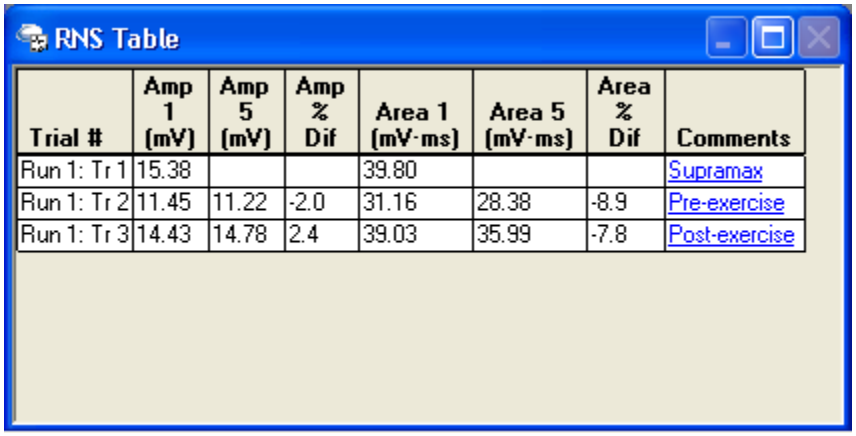
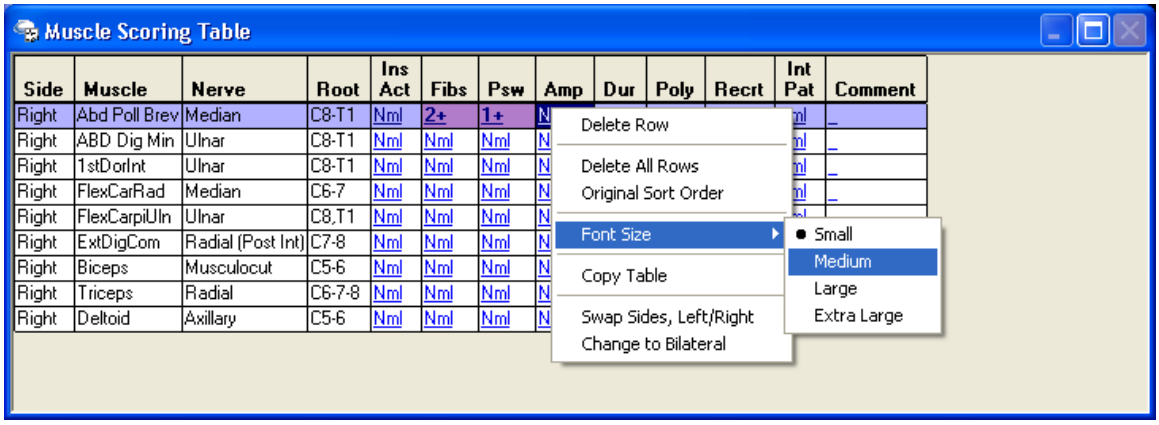
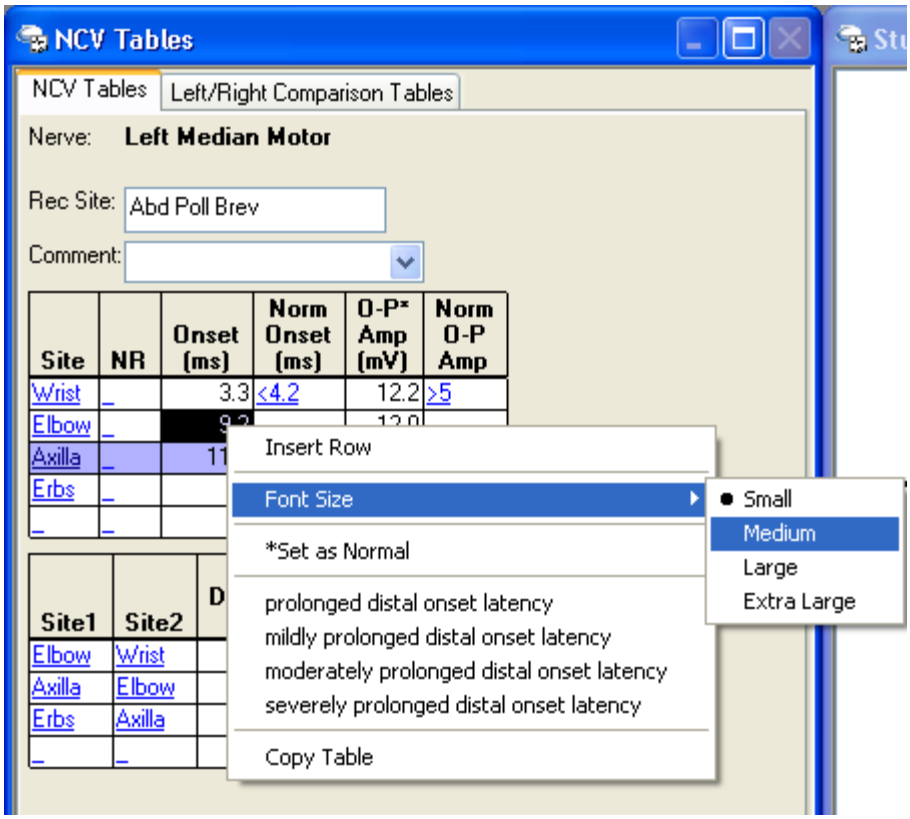


Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



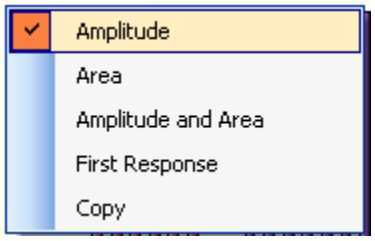
Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

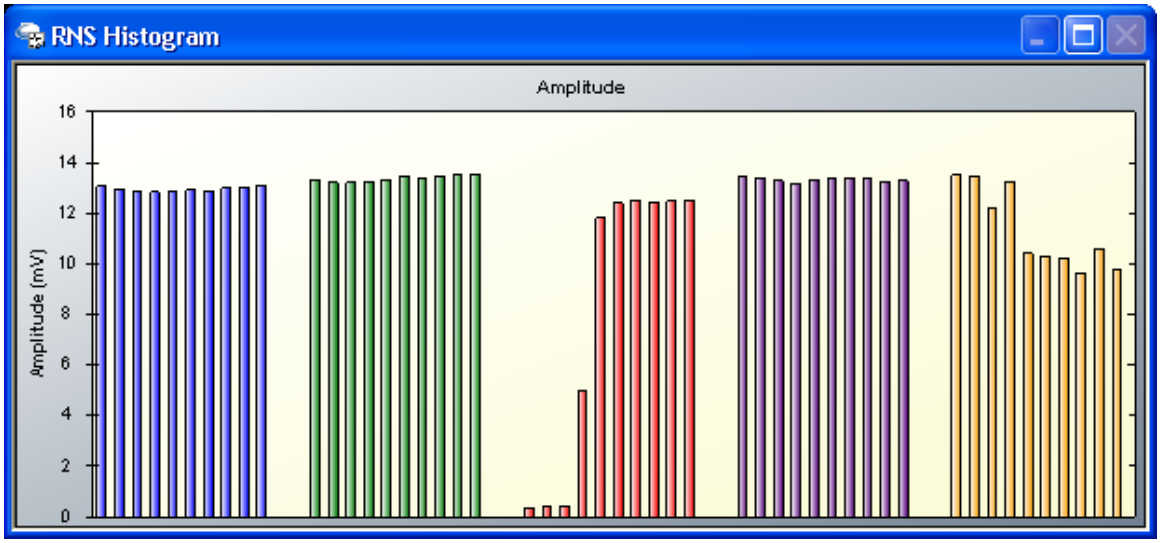
Histogram window

The Histogram window can display the Amplitude, Area, or both for each response in every train. **Right-click** over this window to select the histogram you would like to view.



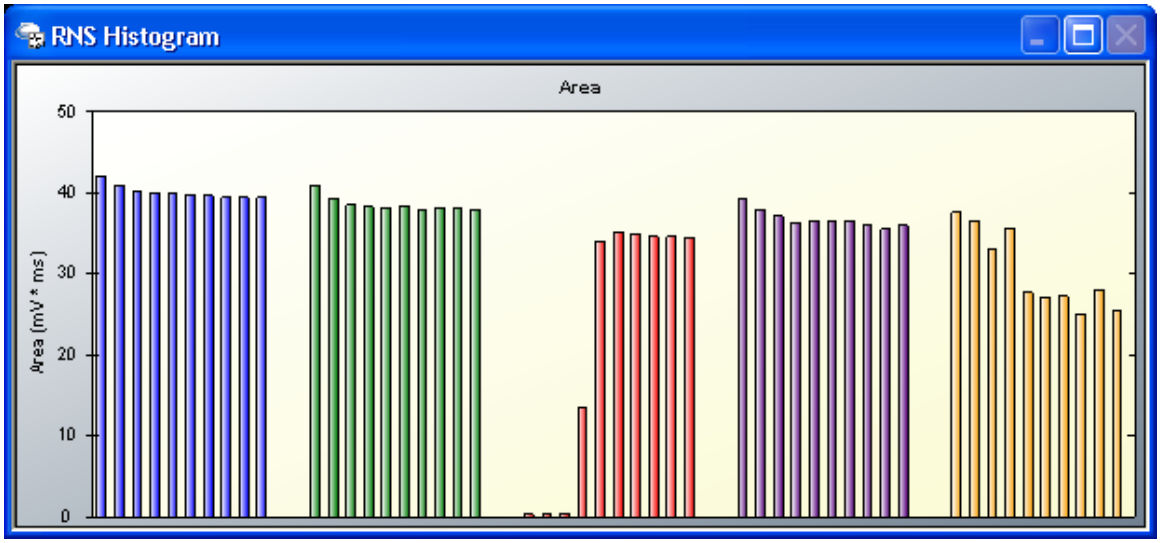
Amplitude

This histogram displays the amplitude (mV) for each response in every train. Different colors are used to represent the different trains.



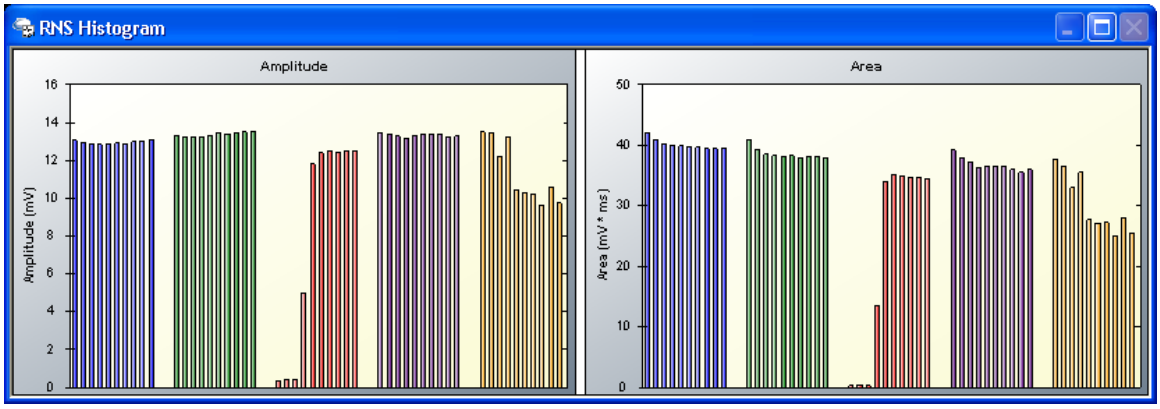
Area

This histogram displays the area (mV/ms) for each response in every train. Different colors are used to represent the different trains.



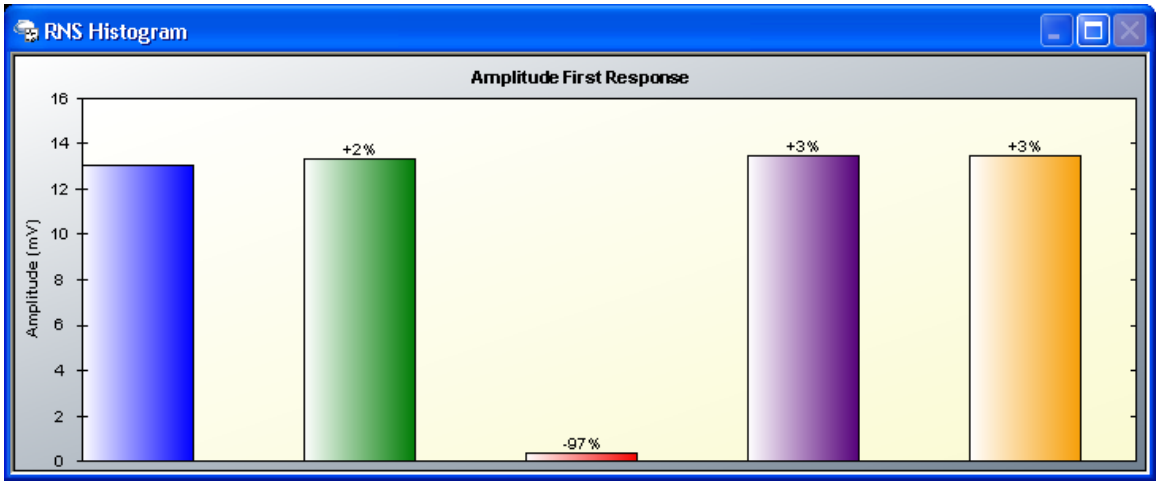
Amplitude and Area

This histogram displays both the amplitude (mV) and area (mV/ms) for each response in every train. Different colors are used to represent the different trains.



First Response

Select this in combination with Amplitude or Area to show the percentage change between the first response in train #1 and the first response in all other trains.

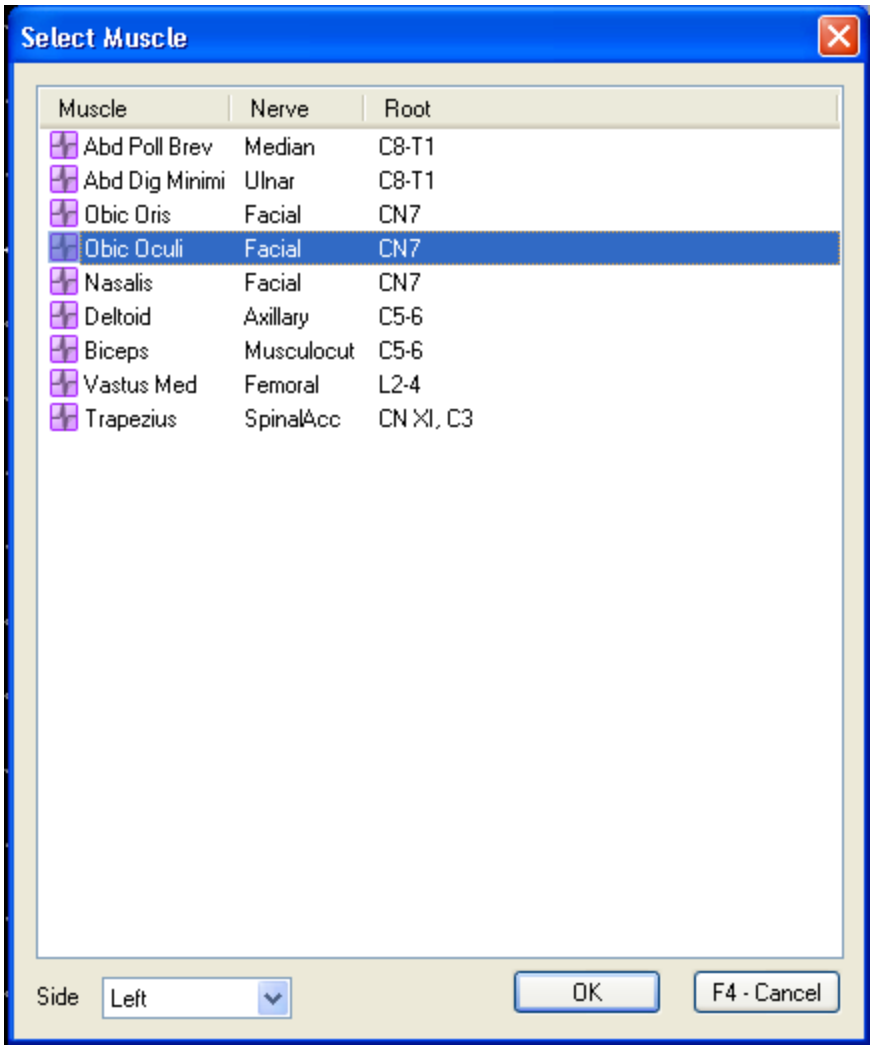


Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the RNS Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the RNS Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight**

the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

 Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

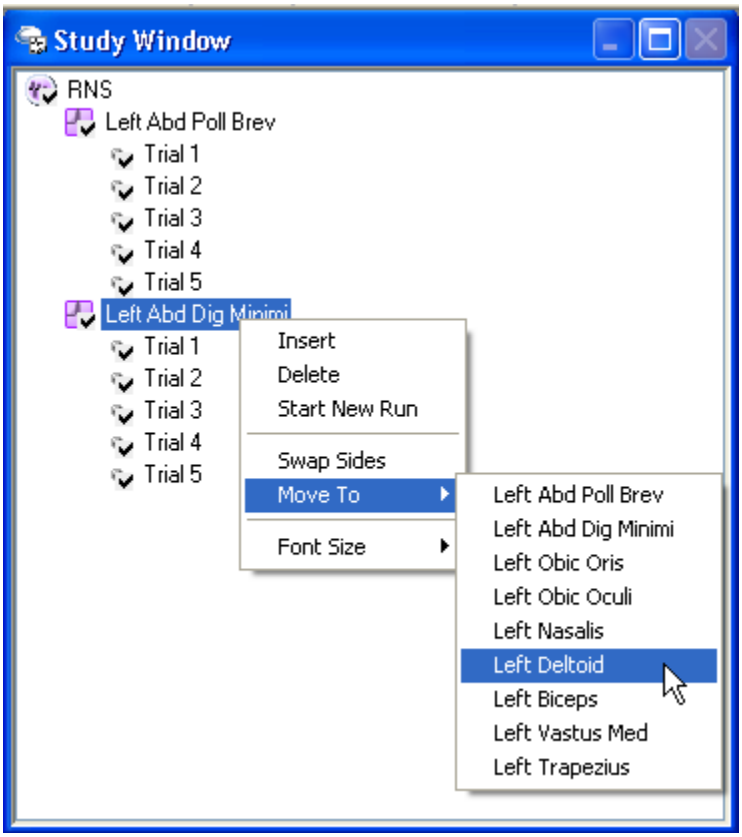
 Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

Move To

This feature allows the RNS trains to be moved to a different muscle. For example, the ADM traces can be moved to any other muscle in your RNS nerve list.

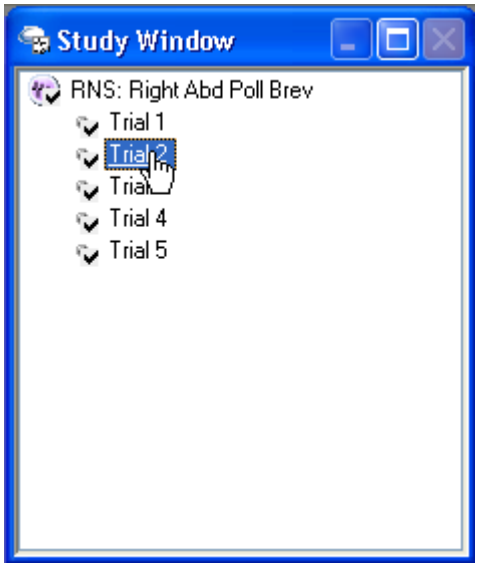
To Move the traces to another muscle:

- **Right click** the mouse over the muscle in the Study window.
- Select **Move To** from the pop-up menu.
- Select a muscle from the displayed list.



Review a single Train

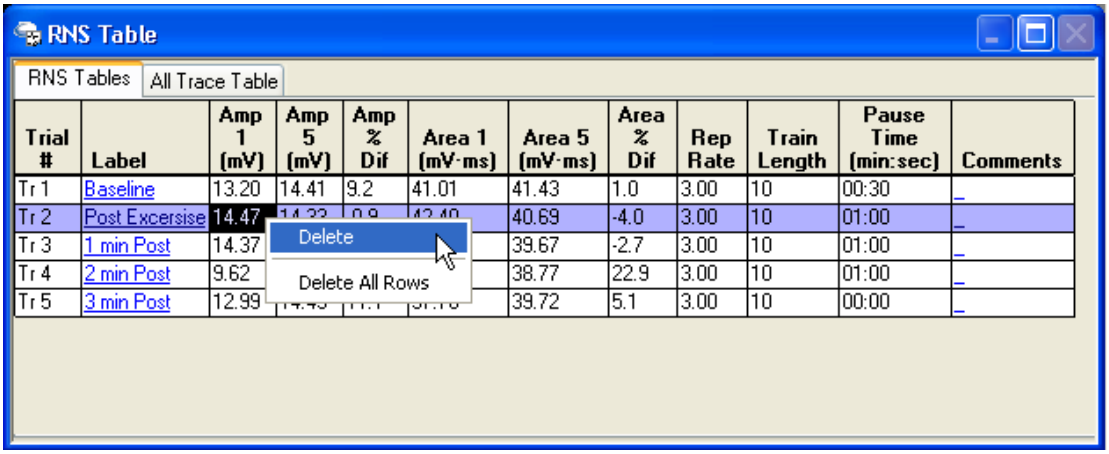
To view the responses for only a single Train, simply click on the corresponding Trial # in the Study window.



Deleting a Train

To Delete a selected RNS train, perform one of the following.

- **Using the Mouse** - **select the train** you want to delete **by clicking** on it with the **left mouse** button. When selected, the entire train color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Train** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected train will be deleted.
- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #3 (Sel Trial / Delete)** until the train you want to delete is selected, a selected train is displayed in yellow. **Press the knob to delete** the selected train. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.
- **Using the RNS Table** - **right click** the mouse **over the row in the RNS Table** that corresponds to the train you want to delete. From the pop-up menu, select **Delete Row**.



RNS Table - right click over row and select delete.

Start New Run

If you decide to repeat a muscle you have a choice of clearing the previously acquired data for the muscle or of keeping the previously acquired data.

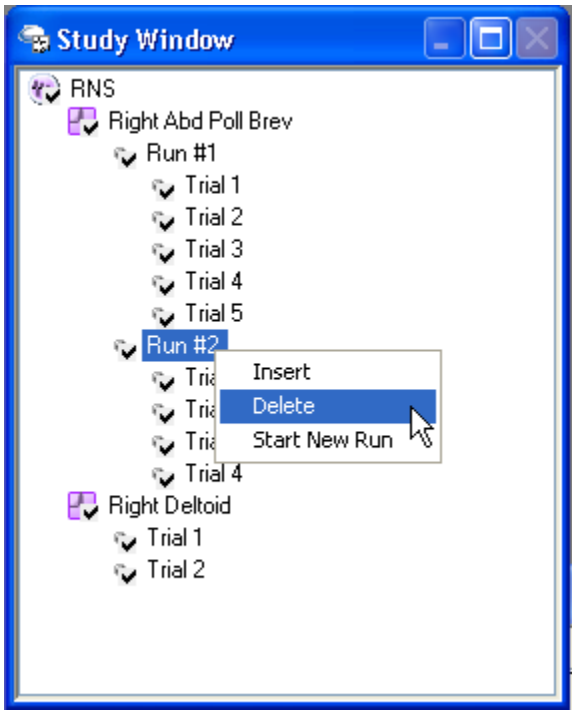
To Clear the Previous Data & Repeat:

1. **Right click** the mouse **in the RNS Trace window** over the previously acquired trains. From the pop-up menu select **Delete All Stored Trains**.

2. A confirmation message will be displayed. Click **OK** and all previous data for the muscle is cleared.
3. **Acquire new data** for the muscle in the normal fashion.

To Keep the Previous Data & Repeat:

1. **Right click** the mouse over the **muscle's name** in the **Study window**. From the pop-up menu select **Start New Run**.
2. A second run node will be displayed under the muscle's name.
3. Acquire new data for the muscle in the normal fashion.
4. To view the first run done on the muscle select **Run #1** from the Study window. To view the second run done on the muscle select **Run #2**.



Two separate runs have been acquired for the Right Abd Poll Brev muscle.

5. If you want **to delete one of the runs** for the muscle, simply **right click** over the run you want to delete and select **Delete** from the pop-up menu. A confirmation message will be displayed, click **OK** to delete the run.

Saving Changes to RNS Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the RNS test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

Blink

Blink Basics

This topic is a repeat of the basic Blink Reflex steps found in the **Getting Started** chapter.

Select the Blink Test:

- **If a Study has already been selected**, simply click on the Blink test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the Blink test protocol from the **Study/Test** menu.

Once the test has been selected. Follow these steps for performing Blink data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the test being performed.

   Typical Blink Settings

   Gain = 200 uV/Div

   Hicut = 5k Hz

   Locut = 10 Hz

   Sweep Speed = 10.0 ms/Div

2. **Electrode Placement**

   Attach the electrodes to the patient.

   Connect the electrode leads from the patient's **left** side to the **Channel 1 inputs** on the amplifier, and connect the electrode leads from the **right** side to the **Channel 2 inputs**. Electrodes must be connected to the amplifier in this configuration to ensure proper display of test data.

   Active 1 Input: Belly of the Left orbicularis oculi muscle below the eye.

   Reference 1 Input: Left side of nose.

   Active 2 Input: Belly of the Right orbicularis oculi muscle below the eye.

Reference 2 Input: Right side of nose.

Ground Electrode: Forehead or cheek.

3. Select Side of Stimulation

Select the side, **Left** or **Right**, that will be stimulated first.

Trials collected during left-side stimulation are displayed in the top half of the screen with the response recorded on the ipsilateral side (e.g., Ch1 : L) positioned above the response recorded on the contralateral side (Ch2 : L).

Responses collected during right side stimulation display in the bottom half of the screen. Eliminating the need to change electrodes at the amplifier, the Sierra automatically inverts the order in which trials collected during right side stimulation are displayed so that the ipsilateral response (Ch2 : R) appears above the contralateral response (Ch1 : R).

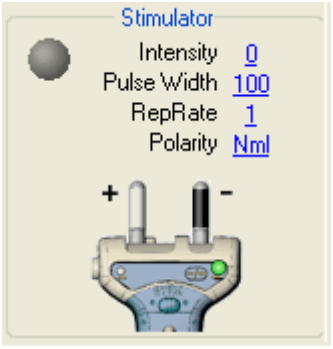
4. Check Stimulator Polarity

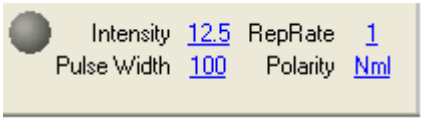
For Blink Reflex Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **Blink Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.





Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

Reversed mode (left probe is Cathode).

5. Stimulate

Increase the stimulus intensity level by turning the **wheel** on the electrical stimulator handle. The **intensity level** (in milliamps) is displayed on the screen in a small pop-up window and also in the Stimulator section. Once you have reached an appropriate starting intensity apply the stimulator to the patient's supra-orbital nerve and deliver the stimulus by pressing the **Stim button** on the electrical stimulator handle. The stimulator light, located next to the intensity level on the Screen, will flash Green and the patient's response will be displayed.

The **Single key** on the Sierra Wave base unit can also be used to deliver a single stimulus. Intensity can also be adjusted using **Knob #3 (Intensity / Pulse Width)** on the base unit.

6. Store the Response

To store the response, perform one of the following actions;

- Press the **Store button** on the **electrical stimulator handle**.
- Press the **Store key** on the Sierra Wave **base unit**.
- Press the **Footswitch** pedal.
- Click the **Store button** in the **Blink Controls** window.

When the response is stored the color of the trace changes from **white to purple**

7. Repeat Stimulation & Store additional responses

Generally, two trials are acquired per side.

8. Move Latency Markers (R1, R2i, R2c)

Three latency markers are utilized in the Blink test protocol. R1 is positioned at the onset of the ipsilateral R1 response. R2i is positioned at the onset of the ipsilateral R2 response. R2c is positioned at the onset of the contralateral R2 response.

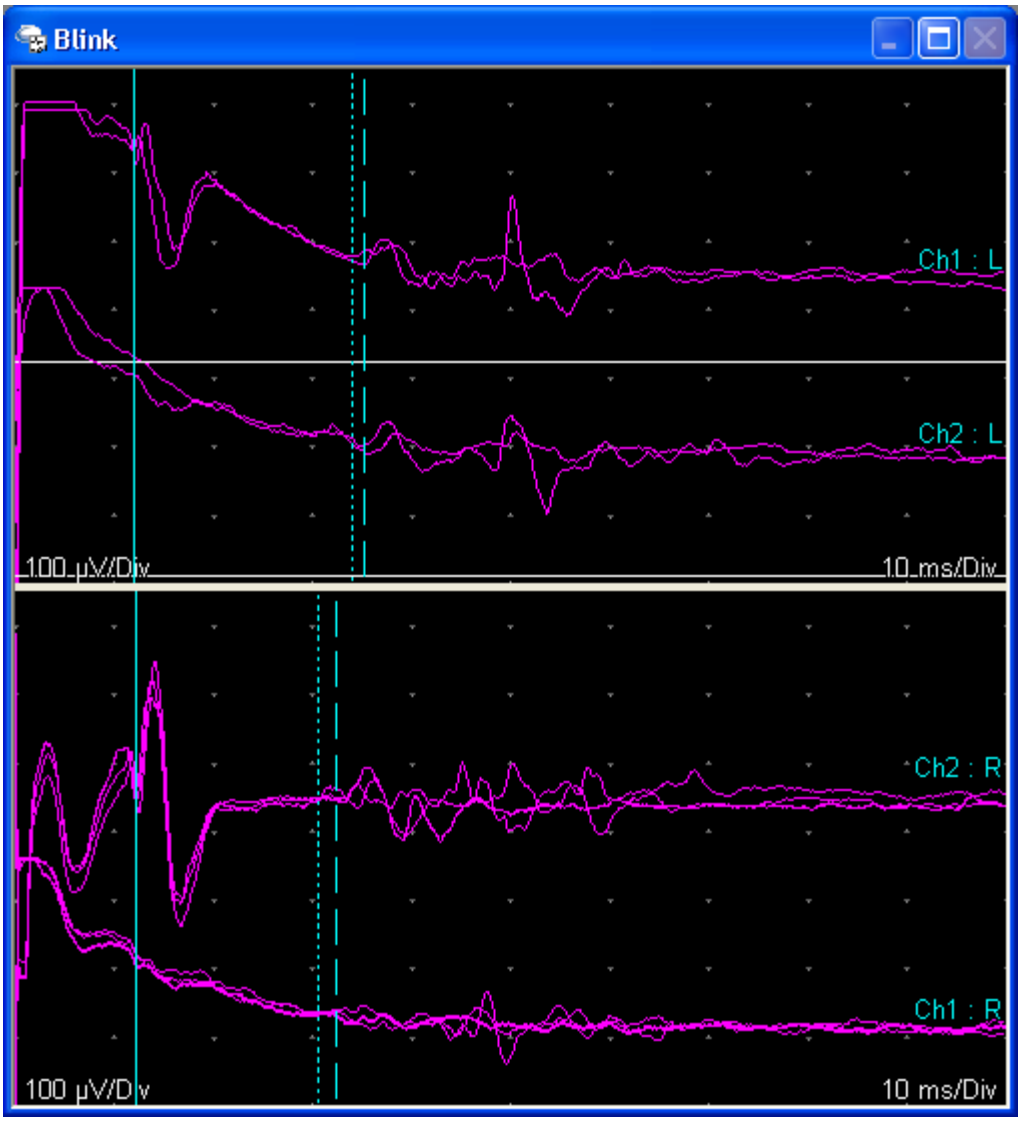
Each of the three markers has a different line pattern.

To move the latency markers:

- Use **Knob #2 (R1)** to move the **R1** marker, use **Knob #3 (R2i /R2c)** to move the **R2i** and **R2c** markers.
- Use the **mouse** to click and drag the appropriate marker to the desired location.

9. Change the Side and Repeat steps 4 - 8.

Selecting a different side automatically stores the currently active (white) traces.



Blink Example.

The program will automatically calculate the R2i-R2c difference for each side. It will also calculate the Left minus Right differences for R1, R2i, R2c, and R2i-R2c.

Blink Table

Side	R1	R2i	R2c	R2i-R2c
L	11.96	34.95	34.13	0.82
R	12.10	33.28	32.37	0.90
Diff(L-R)	0.14	1.68	1.76	0.08

Blink Cursor Table

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (Blink)

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to **Position** mode.

Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

R1 / Intensity - turn this knob to move the R1 latency marker. Press this knob and turn to increase or decrease the electrical stimulus intensity.

R2i / R2c - this knob defaults to the **R2i** mode, turn the knob to position the R2i (R2 ipsilateral) latency marker. Press the knob to activate the **R2c** mode and then turn to position the R2c (R2 contralateral) latency marker.

Gain / Sweep - this knob defaults to the **Gain** mode and can be used to increase or decrease the gain (uV/Div) of the Trace window. Press the knob to switch to **Sweep** mode and turn to adjust the sweep speed (ms/Div) of the Trace window.

F Keys

Left / Right - press to select the side of stimulation.

Trials collected during **left-side stimulation** are displayed in the top half of the screen with the response recorded on the ipsilateral side (Ch1 : L) positioned above the response recorded on the contralateral side (Ch2 : L).

Responses collected during **right side stimulation** display in the bottom half of the screen. Eliminating the need to change electrodes at the amplifier, the Sierra automatically inverts the order in which trials collected during right side stimulation are displayed so that the ipsilateral response (Ch2 : R) appears above the contralateral response (Ch1 : R).

TabData - opens the TabData Summary window.

Position mode

Knobs

Sel. Trial / Move - defaults to **Select Trial** mode, turn this knob to select a stored Blink trial. When selected, the trial will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trial up or down within the Trace window.

Move Active - turn this knob to move the active (white colored) trial up or down within the Trace window.

Sel. Trial / Delete - turn this knob to select a stored Blink trial. When selected, the trial will be displayed in yellow. Press the knob to permanently delete the selected trial.

Gain - turn this knob to change the Gain of the selected Blink trial. The current gain setting for the trial is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces from each channel are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces from each channel on top of one another.

Trace / Trial - defaults to **Trial** mode, in Trial mode the select knobs (Knobs #1 and #3) will function to select a complete trial. Press to activate **Trace** mode, in Trace mode the select knobs will function to select individual traces rather than complete trials.

Cursor mode

- this mode is not available in the Blink Reflex test protocol.

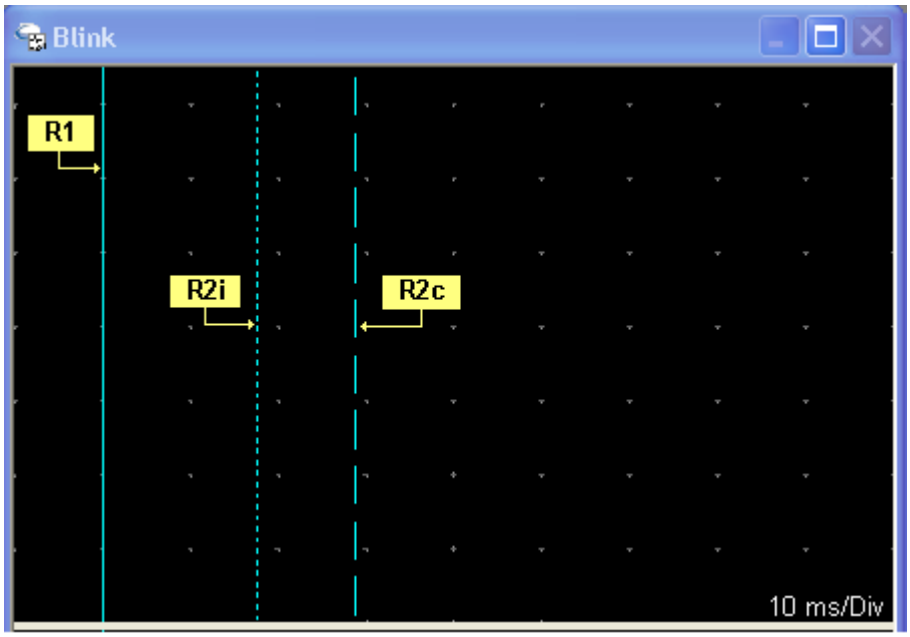
Blink Test Setup

Blink Reflex test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here, to go to this topic.

Markers

The Blink Reflex test protocol uses three latency markers, they are **R1**, **R2i**, and **R2c**. Each marker has its own distinct pattern.



R1 - this marker is shown as a straight line.

R2i - this marker is shown as a dotted line.

R2c - this marker is shown as a dashed line.

To position the latency markers use the corresponding knob on the Sierra Wave base unit or click on the marker using the mouse and drag it to its new location.

Raster / Overlay

Positioning the acquired traces in Overlay mode can be helpful when trying to identify the precise takeoff point of a response.

To enable Overlay mode:

- Enter **Position** mode by pressing the **F6** function key.

- Press the **F1 (Raster / Overlay)** function key to toggle it to **Overlay** mode.

To Overlay traces by adjusting the Trace Position Settings:

- **Right click** the mouse over the **Trace** window.
- From the pop-up menu, select **Trace Position Settings**.
- Change the **Trial Offset** value to **0.0** and press the Enter key.
- Click **OK**.

Stimulator Polarity

Press the **Reverse Polarity (+/-) button** on the electrical stimulator handle to select the Cathode (i.e., the negative stimulus probe). A green LED indicates the probe that is the Cathode. **For routine nerve conduction, RNS, and Blink Studies the Cathode (-) should be oriented closest to the recording electrodes.**

Clicking on the **Polarity field** in the **Blink Controls window** or **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., Normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode. The image of the stimulator on the screen updates to indicate the selected polarity as well.

In the **Normal mode**, the electrical stimulator image on the screen will show the **Right-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Nml**.

Controls Window. Controls Toolbar.

Normal mode (right probe is Cathode).

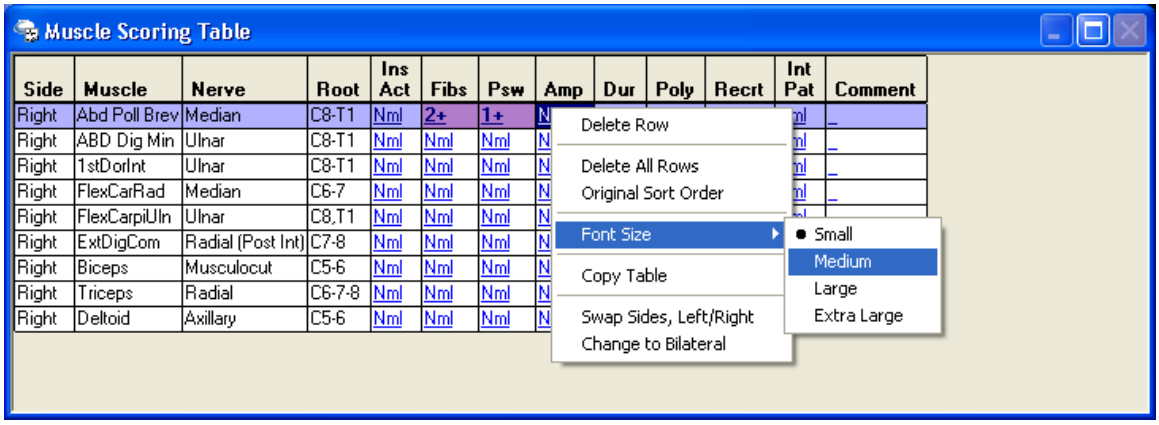
In the **Reversed mode**, the electrical stimulator image on the screen will show the **Left-side** probe as the **Cathode (-)**. The polarity field on the screen will indicate **Rev**.

Controls Window. Controls Toolbar.

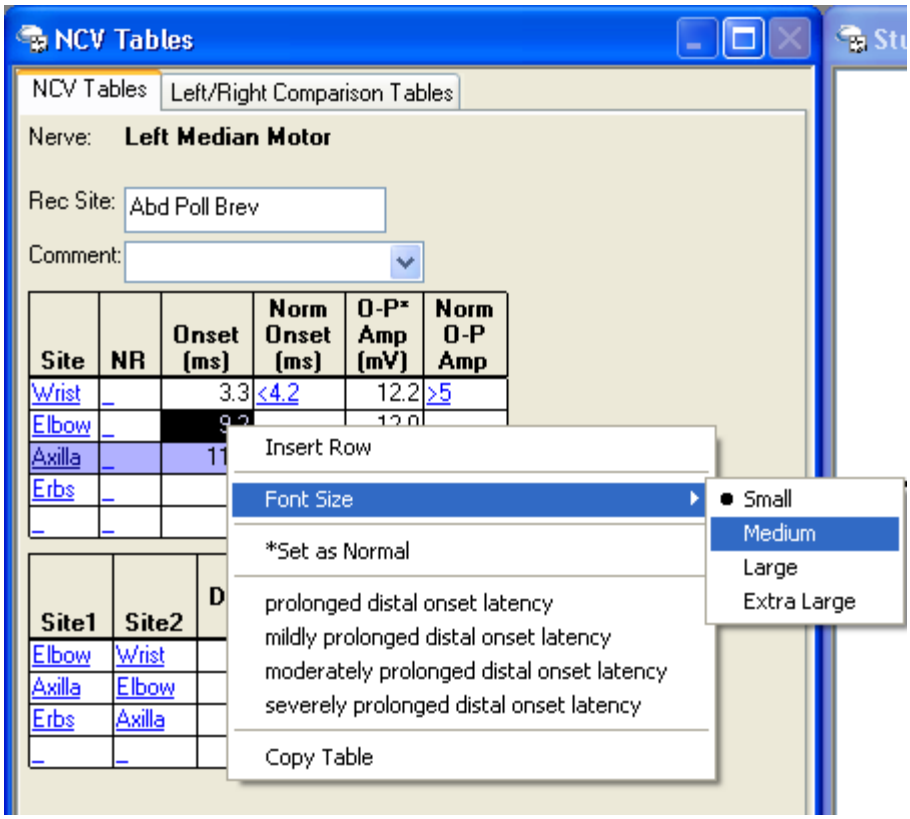
Reversed mode (left probe is Cathode).

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

Trace Positioning & Delete

Trace Positioning

There are several methods of changing the vertical positions of the Blink Reflex traces within the Trace window.

Using the Mouse:

Left click on the trial you want to move **and drag** the trial to it's new location.

To select and move an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

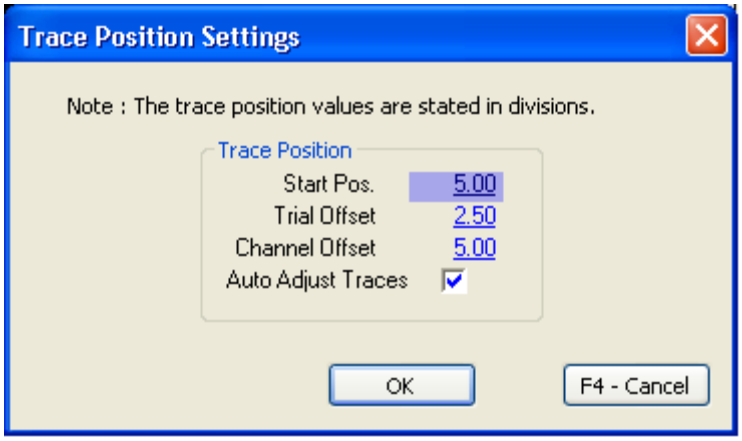
Using the Knobs:

1. Enter the **Position mode** by pressing the **F6** function key on the PC's keyboard.
2. Turn **Knob #1 (Sel Trial / Move)** until the trial you want to move is selected. A selected trial is displayed in yellow rather than purple.
3. **Press the knob** to activate the **Move** mode, now turn the knob to move the selected trial up or down.
4. Press the knob a second time to return to the **Sel Trial** mode.

To select and move an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

Using the Trace Position Settings:

1. **Right click** over the **Blink Reflex Trace** window.
2. From the pop-up menu, select **Trace Position Settings**. The Trace Position Settings window will be displayed.



Trace Position Settings window.

3. Change the listed parameters, then click **OK**.

   Start Position: This is the default trace position for the first trace in the window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

   Trial Offset: This setting determines how much space will separate each stored Blink Reflex trace acquired from each channel. In this example the setting is 2.5 divisions, therefore the second Blink Reflex trace will be displayed 2.5 divisions below the first trace. If a third Blink Reflex trace is acquired it will be

displayed 2.5 divisions below the second Blink Reflex trace and so on.

Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the two Live channels.

Trace Deletion

To delete Blink Reflex traces use one of the following methods.

- **Using the Mouse** - **select the trial** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trial color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trial will be deleted.

 To select an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #3 (Sel Trial / Delete)** until the trial you want to delete is selected, a selected trial is displayed in yellow. **Press the knob to delete** the selected trial. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

 To select and delete an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

Saving Changes to Blink Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the Blink Reflex test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

Single Fiber EMG

Performing SFEMG

Select the SFEMG Test:

- **If a Study has already been selected**, simply click on a SFEMG muscle name (i.e., Right Biceps) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual SFEMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that when a muscle is selected, it is displayed within the Study window.

Once the muscle has been selected. Follow these steps for performing routine SFEMG data acquisition and analysis:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate. Only Channel 1 can be used in the SFEMG test protocol.

   Typical Settings for SFEMG

   Gain = 100 uV/Div

   Hicut = 10k Hz

   Locut = 500 Hz

   Sweep Speed = 0.5 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Set the capture buffer Count value.**

   The Count value is the total number of traces that can be collected in the SFEMG trace buffer. When a SFEMG signal crosses the Trigger Line the trace is added to the trace buffer and the Capture number is incremented by one. The Count can be set to 10, 20, 30, 50, 70, 100, 150, or 200. This setting is located in the SFEMG Controls window and can be easily changed using the mouse.

4. **Insert the SFEMG Needle Electrode.**

5. **Adjust the Gain and Sweep Speed as necessary.**

   During SFEMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

   You can also use the mouse to change these settings in the **SFEMG Controls** window.

6. **Adjust the Volume**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume knob** on the left hand side of the base unit.

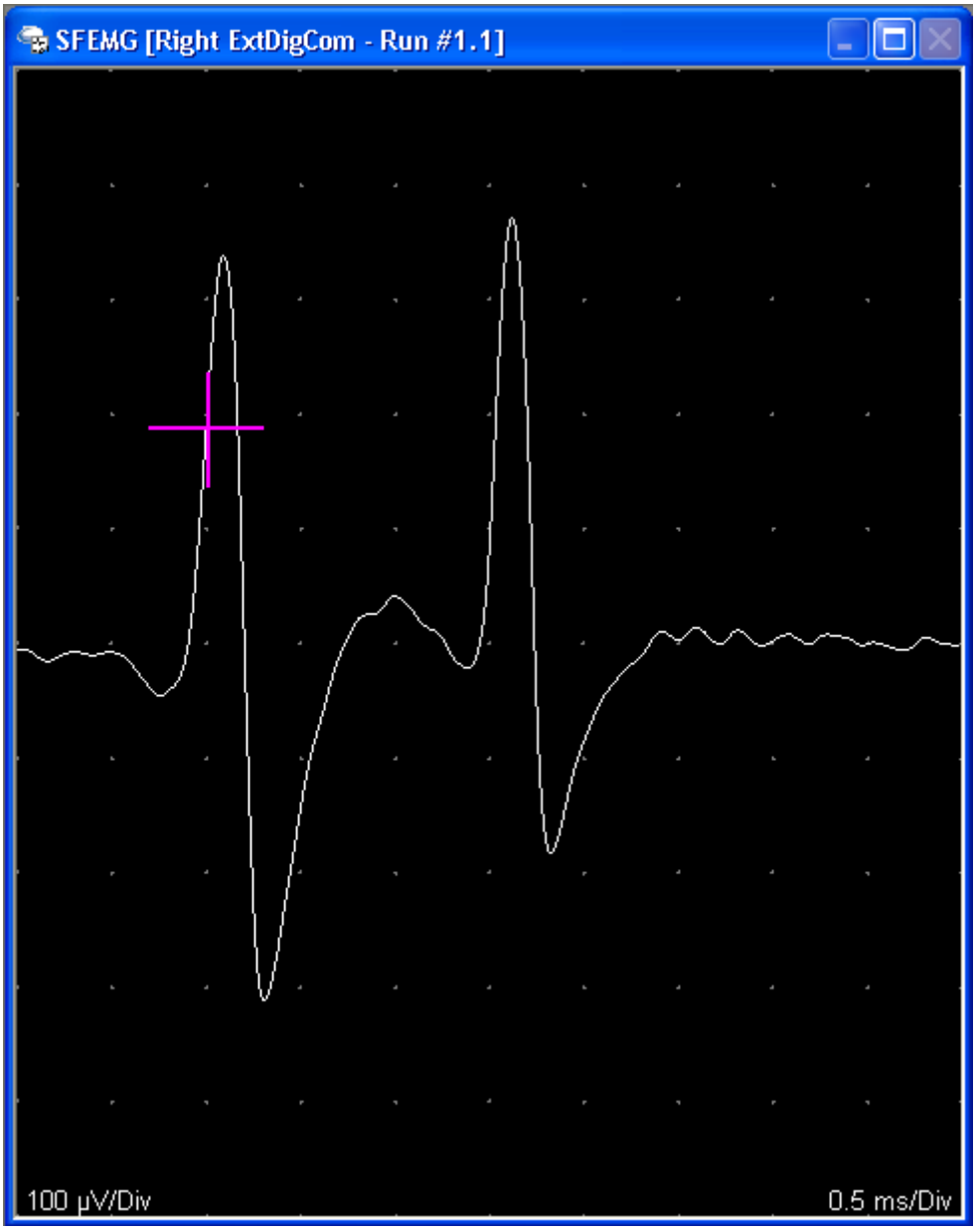
7. **Adjust Trigger Level & Delay**

   Knob #3 (Trig Lev /Trig Del) defaults to the **Trig Lev** mode, turn this knob to move the position of the trigger level (horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the sweep is added to the capture buffer. Press the knob to activate **Trig Del** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in one division increments. Changing the delay point allows you to see more or less data after the triggering potential.

   The **mouse** can also be used to move the Trigger Level/Delay indicator.

8. **Acquire SFEMG Potentials**

   Once the appropriate SFEMG signal is located and the Trigger and Delay positions have been adjusted appropriately, press the **Clear key** on the Sierra Wave base unit to reset the Capture buffer to zero. Now, acquire SFEMG potentials until the buffer Count is reached or until you are satisfied that enough SFEMG data has been captured for analysis.



Acquisition mode, the first potential is the triggering potential.

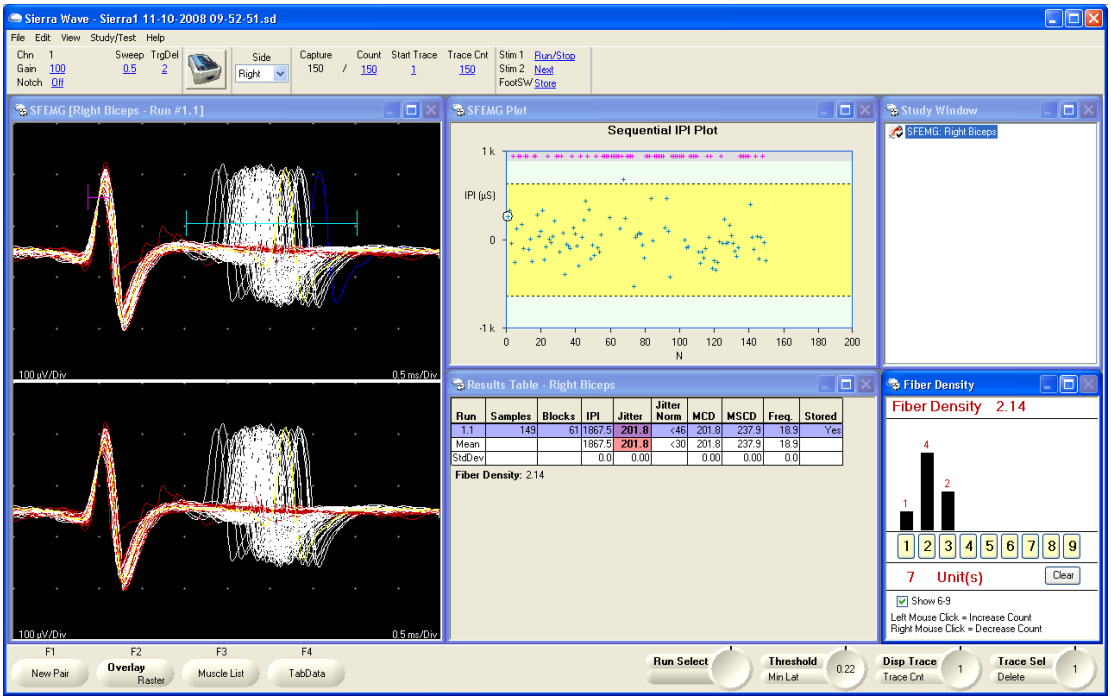
9. Stop Data Acquisition

Press the **Run/Stop key** on the Sierra Wave base unit to stop data acquisition. This will change the display to the **Analysis mode**.

The Analysis mode has two trace areas, the **Captured Trace** area and the **Filtered Trace** area. Typically a **Sequential IPI Plot** and **Results Table** are also displayed.

Captured Trace area - shows all the traces in the current capture buffer.

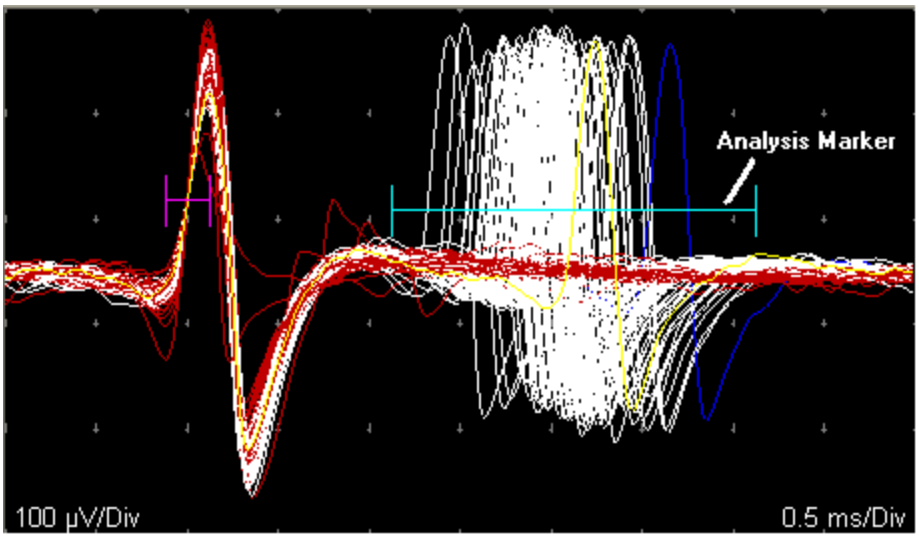
Filtered Trace area - shows only those traces that fall within the Sequential IPI Plots include area (yellow band). Blocking traces (red) are also shown in this area when the Jitter is abnormal. Jitter measurements are based on the traces in this area.



SFEMG Analysis Mode.

10. Verify the Position of the Analysis Marker

Check the position of analysis marker (shown in light-blue) in the **Captured Trace** area, the rising edge of the potentials to be analyzed should cross through the analysis marker. If a single fiber potential does not transition through the marker it will be considered as a block. The width of the analysis marker should be adjusted to encompass all the potentials that you want to analyze. Use the **mouse** or **Knob #2 (Threshold / Min Lat)** to make adjustments to the analysis marker position and width. The Filtered Trace area and the Sequential IPI Plot are automatically updated when the analysis marker is repositioned.



Analysis Marker correctly positioned in the Capture Trace area.

Colors Used in the Capture Trace Area

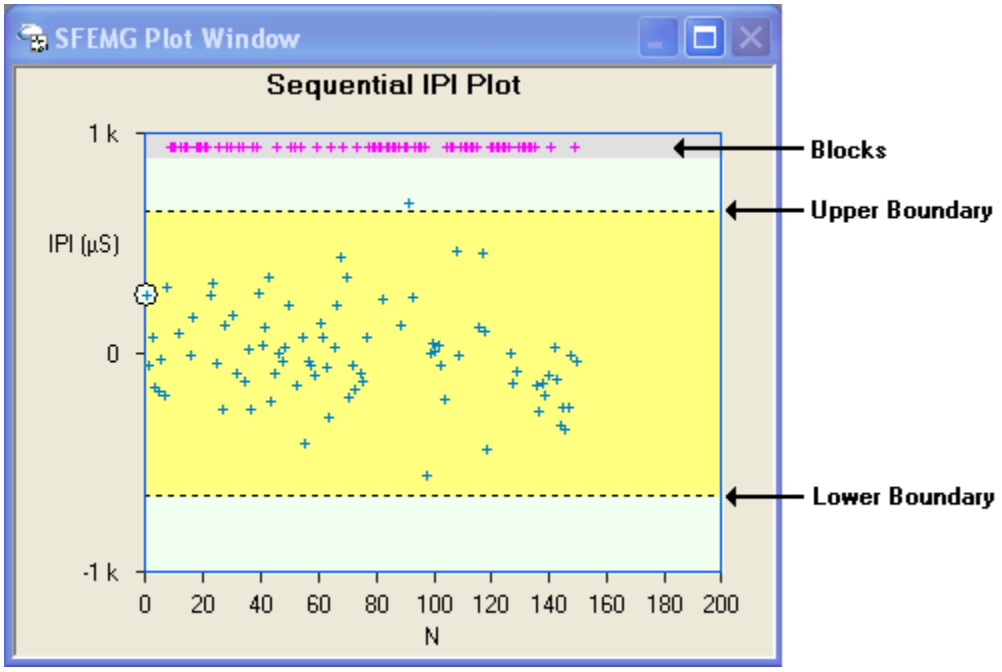
Trace Color	Description
White	These traces are within the Sequential IPI Plot include area (shown as yellow band on the plot) and are added to the Filtered Trace area where they are used for calculating the jitter.
Red	These traces did not cross through the analysis marker and are therefore considered blocks. They are added to the Filtered Trace area if the Jitter measurement is abnormal. If the Jitter is normal, these traces are most likely the result of artifacts or mis-triggers.
Dark Blue	These traces lie outside the Sequential IPI Plot include area and are not added to the Filtered Trace area.
Light Blue	These traces have been manually rejected from the data set and are removed from the Filtered Trace area.
Yellow	Indicates the trace has been selected (using the mouse or Knob #4), it can be manually rejected or deleted from the data set.

11. Make adjustments to the Sequential IPI Plot (Optional)

This is the default plot that is displayed in the Analysis Mode. The **Sequential IPI Plot** displays the distribution of the Inter-Potential Intervals by plotting the difference between each individual IPI (Inter-Potential Interval) and the mean IPI for the whole data set. The mean IPI is indicated as zero on the vertical axis. The horizontal axis represents each sweep in the data set, up to a maximum of 200.

Blocks are shown as red plus signs at the top of the plot and as red traces in the Captured and Filtered Trace areas. A **+/- 3 standard deviation** yellow band is drawn about the mean value and defines an acceptance limit of IPI for computing jitter. Potentials outside the yellow band are shown as dark blue color in the Captured Trace area and are not included in the Filtered Trace area. A circle is drawn around the currently selected trace (i.e., corresponds to the yellow trace).

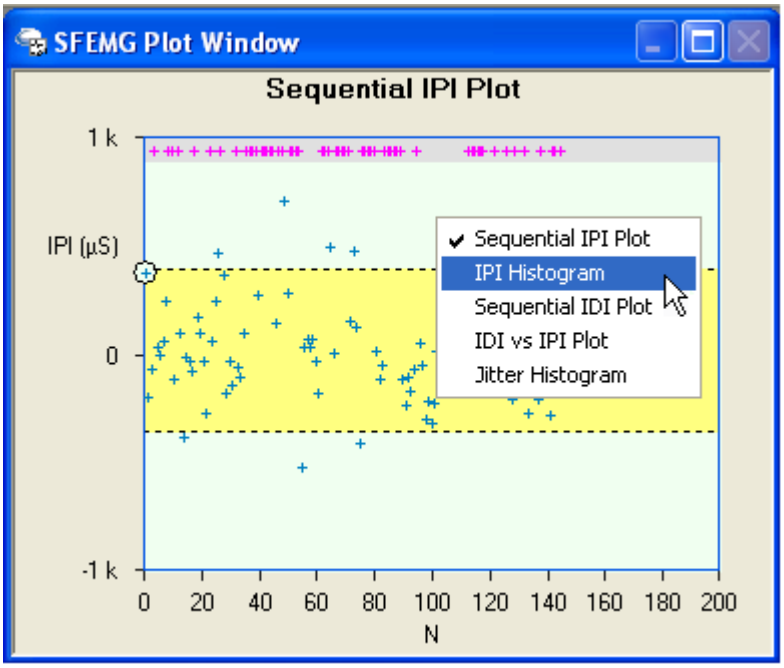
The upper & lower boundaries of the yellow band can be adjusted by clicking on the boundary with the mouse and then dragging it up or down. The Captured and Filtered trace areas and jitter measurements are updated automatically when the boundary is changed. This is a powerful and quick way to analyze multiple potentials in the data set and to exclude traces that represent technical problems.



Sequential IPI Plot

12. View other Data Plots (Optional)

The plot window can display up to three data plots at one time. To view other plots, simply **right-click** over this window and select the plots you would like to view from the pop-up menu.

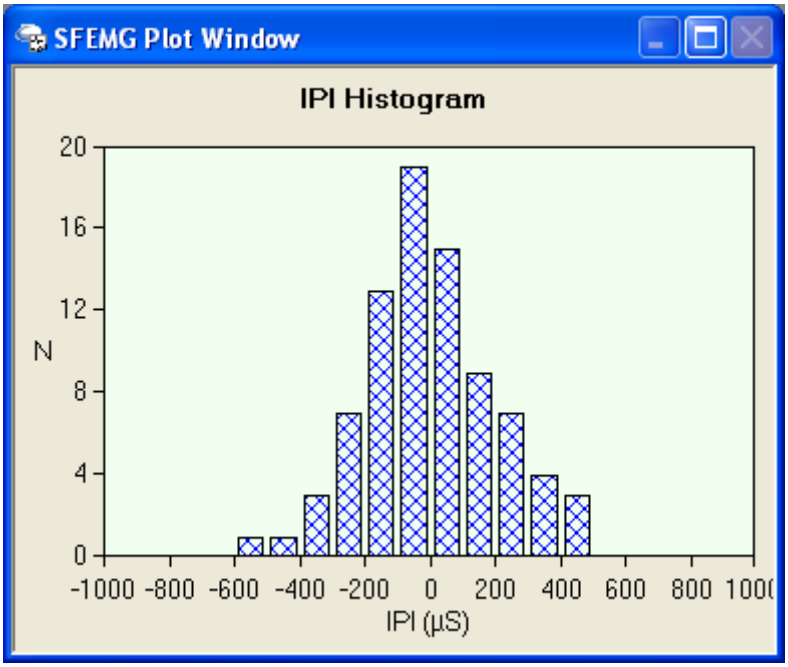


Sequential IPI Plot with right-click menu.

The available plots are:

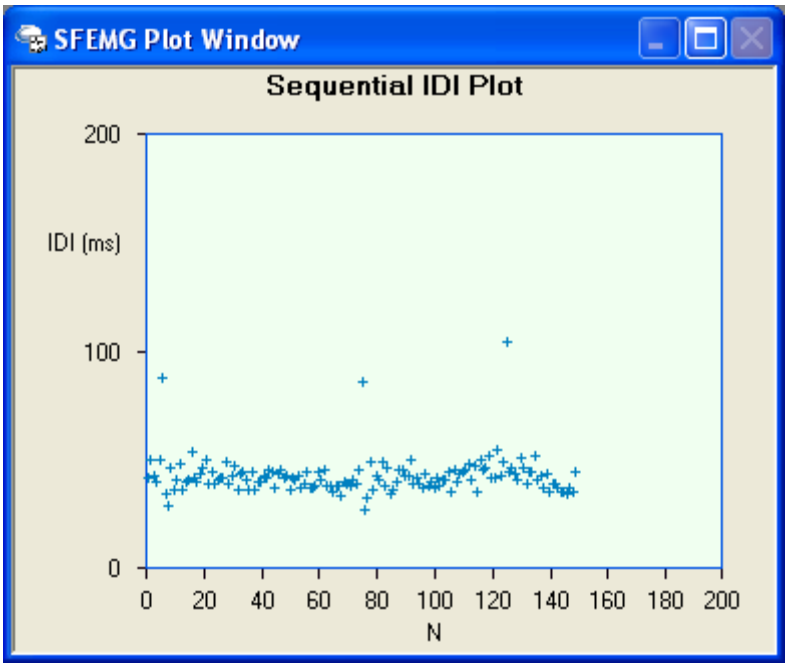
Sequential IPI: See step #11 above.

IPI Histogram: Displays the distribution of the IPI's in a bar graph format. The height of each bar indicates the counts (N) for each value of IPI. This graph should demonstrate a Gaussian distribution; any deviation would suggest that spurious data may have been acquired.



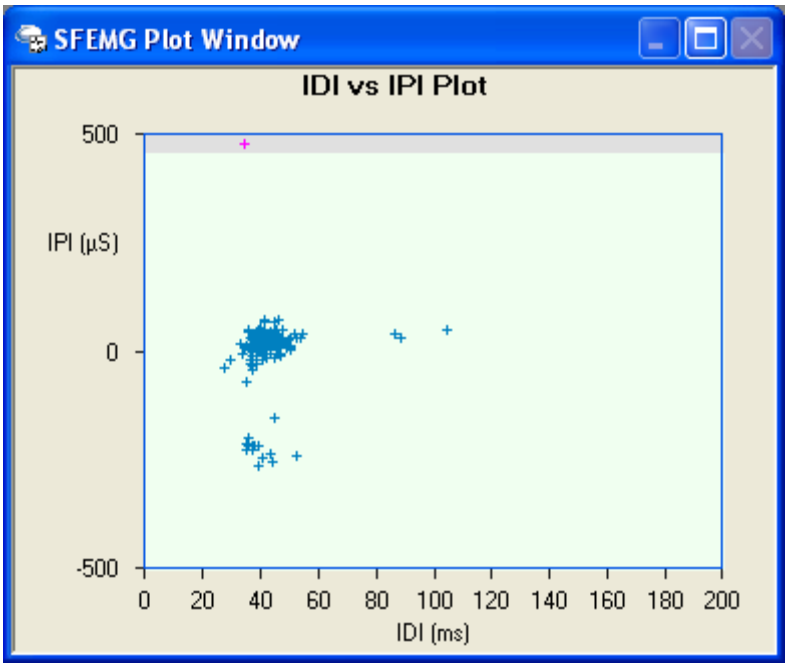
IPI Histogram

Sequential IDI Plot: Displays the distribution of the Inter-Discharge Intervals (IDI) for the data set.



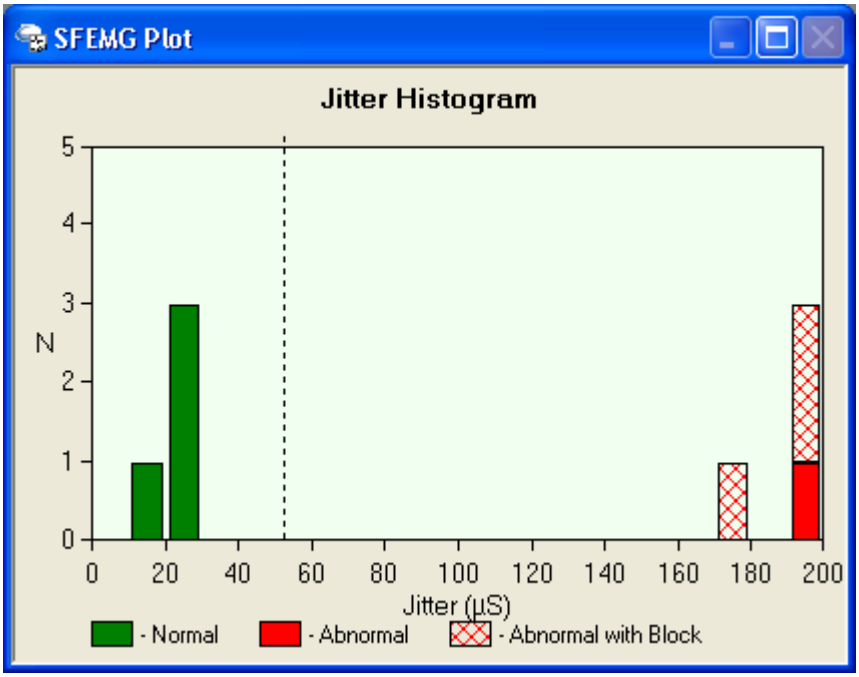
Sequential IDI Plot

IDI vs IPI Plot: Displays the distribution of the IPI versus the IDI, this plot is used to view the jitter dependence on the preceding interval.



IDV vs. IPI Plot

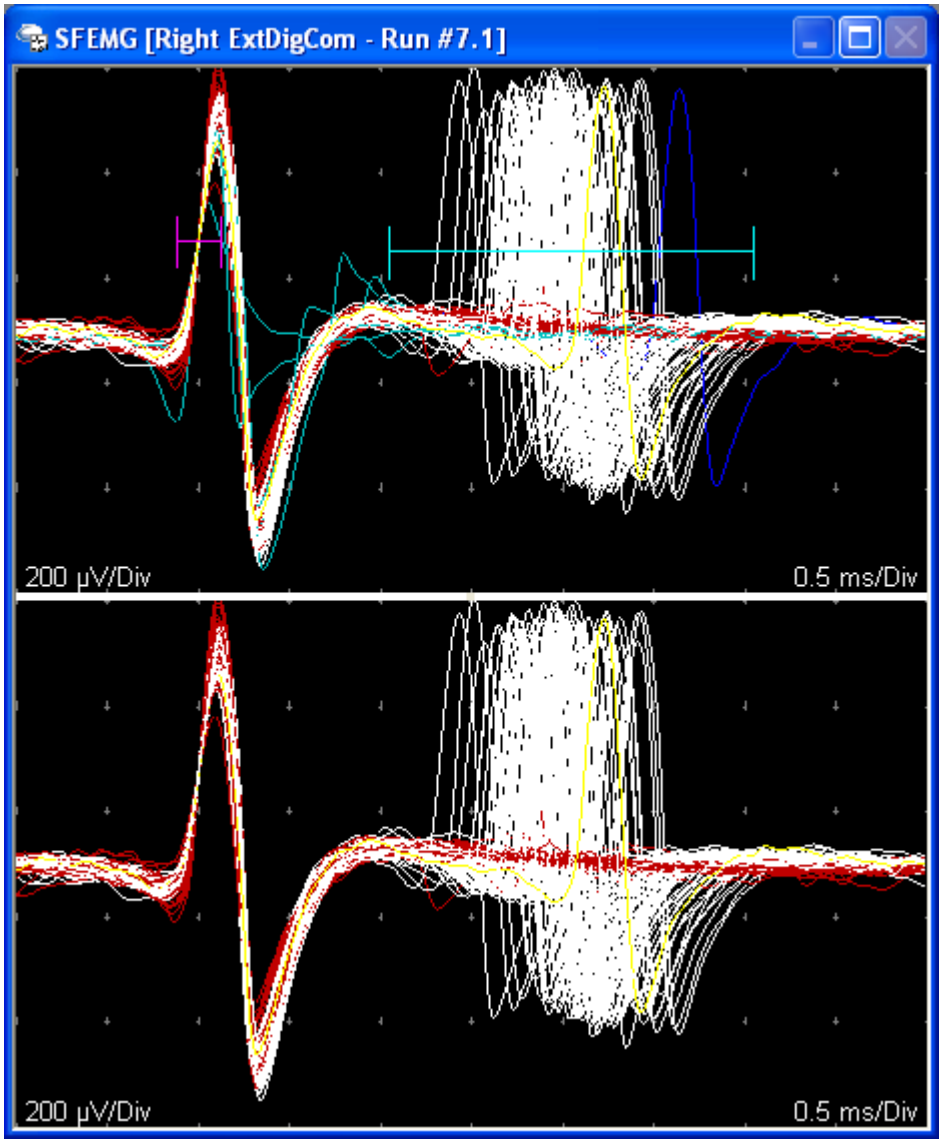
Jitter Histogram: This histogram provides a quick summary of the data collected for the muscle. The vertical axis marks the count, while the horizontal axis indicates jitter (in microseconds, us). The height of colored bar graphs indicates the number of runs containing that amount of jitter. Normal jitter is indicated by green bars, abnormal jitter as red bars, and abnormal jitter with blocking as red cross-hatched bars. A dashed line marks the jitter norm for individual potential pairs in the muscle. This is the default plot for the Acquisition Mode.



Jitter Histogram

13. Manually Reject Traces (Optional)

Traces can be manually excluded from the analysis by selecting them with the mouse (left-click). Once selected the trace is displayed in yellow color. Now, right-click and select **Reject Selected Traces** from the pop-up menu, this removes the trace from the analysis. Rejected traces are displayed in light blue color. You can re-accept a rejected trace by selecting it, then right-click to remove the check mark next to Reject Selected Traces.

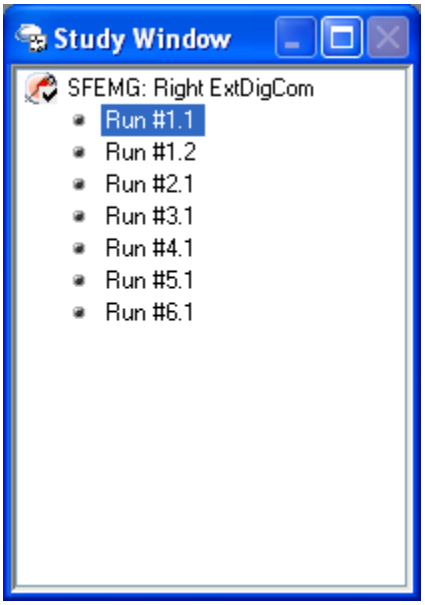


Example showing three manually rejected traces in the Captured Trace area that have been automatically removed from the Filtered Trace area.

14. Store the Run

Press the **Store key** on the Sierra Wave base unit to **keep the run**, by default all the traces for the run are stored as well. In the Results Table the "Stored" field will change from No to Yes.

As each SFEMG run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows six runs stored for the Right Ext Dig Com muscle.



If you decide not to keep the run, do not press the Store key, simply return to the Acquisition mode by pressing the **Run/Stop key** and the run will be discarded.

The **Results Table** records the analysis results for each run and calculates the mean and standard deviation values.

Right ExtDigCom

Run	Samples	Blocks	IPI	Jitter	Jitter Norm	MCD	MSCD	Freq.	Stored
1.1	133	0	784.6	20.9	<53	24.3	20.9	23.4	Yes
1.2	13	0	535.8	19.5		22.1	19.5	25.5	Yes
2.1	84	0	4226.6	28.7		28.7	33.5	14.2	Yes
3.1	28	0	3473.6	25.1		25.1	37.8	47.3	Yes
4.1	88	0	668.8	18.5		18.5	19.2	9.4	Yes
5.1	137	57	1831.7	**148.4**		148.4	189.5	18.5	Yes
6.1	53	0	1899.3	**191.4**		191.4	202.5	14.9	Yes
7.1	149	67	1871.0	**208.0**		208.0	255.9	17.6	Yes
Mean			1911.4	**82.5**	<36	82.5	97.4	21.3	
StdDev			1250.8	79.1		78.5	93.8	10.9	

Block Ratio: 25% **Fiber Density:** 2.14

SFEMG Results Table

Run – indicates the run #. If a run is analyzed more than once, it is indicated by **.**2, **.**3, and so on. This would occur if more than one potential was analyzed in the run using the **New Pair** function key.

Samples – indicates the total number of traces shown in the Filtered Trace area for that run.

Blocks – indicates the number of blocks shown in the Filtered Trace area for that run.

IPI – displays the mean Inter-Potential Interval for the traces shown in the Filtered Trace area.

Jitter – displays the lowest value of either the MCD or MSCD in microseconds (usec). The user can right-click on this value and select Swap Jitter Value, this will display the larger of the two values in this field.

Jitter Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

MCD – the jitter as calculated by using the Mean Consecutive Difference for the run.

MSCD – the jitter as calculated by using the Mean Sorted Consecutive Difference for the run.

Freq. – displays the mean firing frequency of the triggering potential in hertz (Hz).

Stored – indicates if the run has been stored to disk.

Block Ratio – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

15. Analyze a Second Potential Pair (Optional)

Sometimes the captured data can contain three or more time-locked action potentials. In this case, you can analyze the additional combinations by pressing the **F1 (New Pair)** function key. A new row will be added to the measurements table. **Repeat steps 10 to 14** to analyze the second potential pair.

16. Acquire additional SFEMG Runs.

Press the **Run/Stop key** to return to **Acquistion mode** and repeat **steps 7 through 15** to acquire additional SFEMG runs. Typically 20 runs should be collected for the muscle.

17. Select Next Muscle (optional)

From Acquisition mode, turn **Knob #1 (Study Item)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the next SFEMG muscle from the list.

Move the SFEMG Needle Electrode to the new muscle and repeat the above steps as necessary.

 It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

18. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

19. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (SFEMG)

The functions assigned to the Sierra Wave base unit's Knob and F Key controls will vary depending on whether the system is in **Acquisition** mode or **Analyze** mode.

Analyze mode is entered by pressing the **Run/Stop** key.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Trig Lev / Trig Delay - this knob defaults to the **Trig Lev** mode, turn the knob to change the vertical position of the trigger level indicator. Press the knob to activate the **Trig Delay** mode, then turn to change the trigger delay position from 1 to 9 divisions in 0.1 division increments.

Gain / Sweep - turn the knob to change the gain of the SFEMG trace. Press the knob, then turn to change the sweep speed of the SFEMG trace.

F Keys

Muscle List - opens the SFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Analyze mode

Knobs

Run Select - turn this knob to highlight and review stored runs in the Results table. When the run is highlighted the traces for that run will be displayed in the trace window.

Threshold / Min Lat - this knob defaults to the **Threshold** mode, turn the knob to move the Analysis Marker up or down within the Trace window. Press the knob to activate the **Min Lat** mode, then turn to move the Analysis Marker left or right within the Trace window.

Disp Trace / Trace Cnt - this knob effects how the traces in the SFEMG capture buffer are displayed. Turn the knob to change the starting display trace number. Press the knob, then turn to change the trace count number.

Here's an example of how to use the **Trace Cnt** and **Disp Trace** settings to view subsets of the capture buffer:

Assume there are 50 total traces in the SFEMG capture buffer. The Trace Cnt will default to 50 and the Disp Trace number will default to 1. Therefore all 50 traces (1 to 50) are displayed in the Trace window. Now, change the Trace Cnt to 20 and leave the Disp Trace number at 1. You will see traces 1-20 displayed in the Trace window. You can now change the Disp Trace number to 21, now you can view traces 21-40. Change the Disp Trace number again and it goes to 41, now you can view traces 41-50.

Trace Sel / Delete - defaults to the **Trace Sel** mode, turn this knob to select a SFEMG trace. When selected, the trace will be displayed in yellow color. Press the knob to **Delete** the selected trace from the capture buffer.

F Keys

New Pair - press to add an additional row to the results table and to analyze a second potential pair in the data.

Overlay / Raster - defaults **Overlay** mode, in this mode the traces are superimposed on top of one another. Press to activate **Raster** mode, in this mode the traces are evenly rastered down the trace window.

Muscle List - opens the SFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

SFEMG Test Setup

SFEMG test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

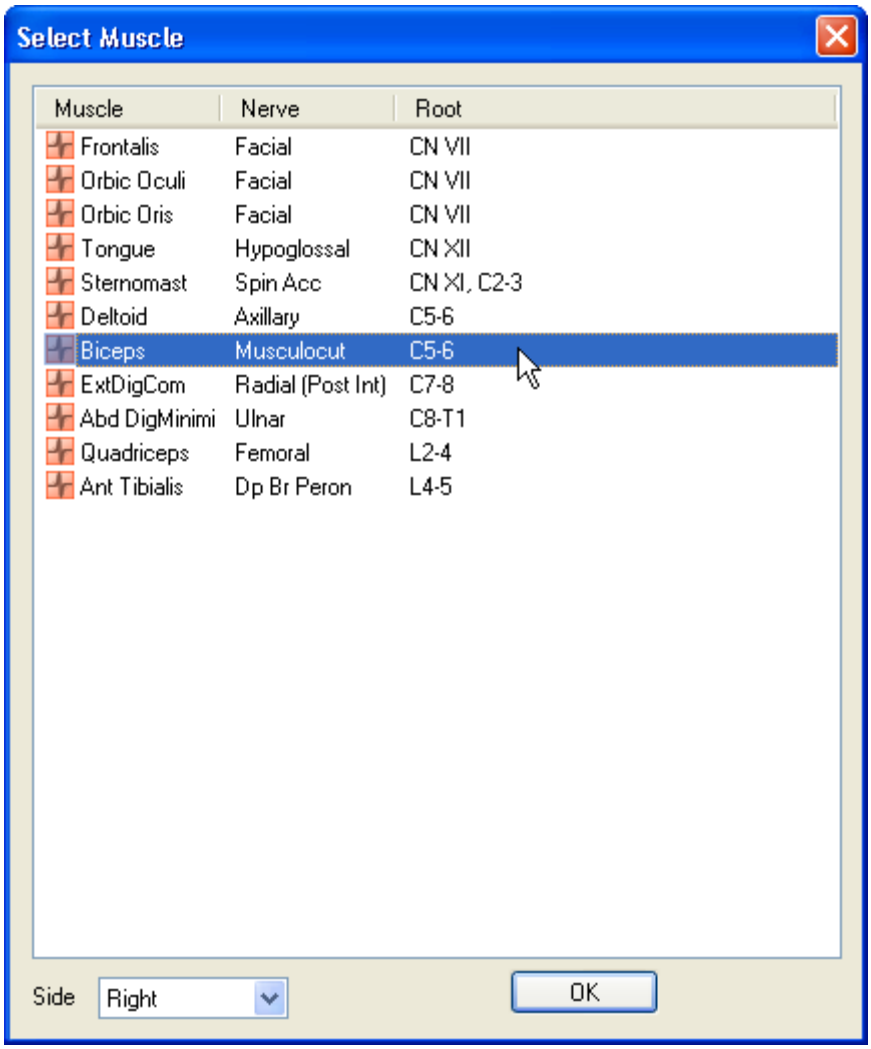
Click here, to go to this topic.

Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the SFEMG Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the SFEMG Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight**

the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

 Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

 Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

SFEMG Trace Area

The contents of the Trace Area will varying depending on whether the program is in the **Acquisition** or **Analysis** modes.

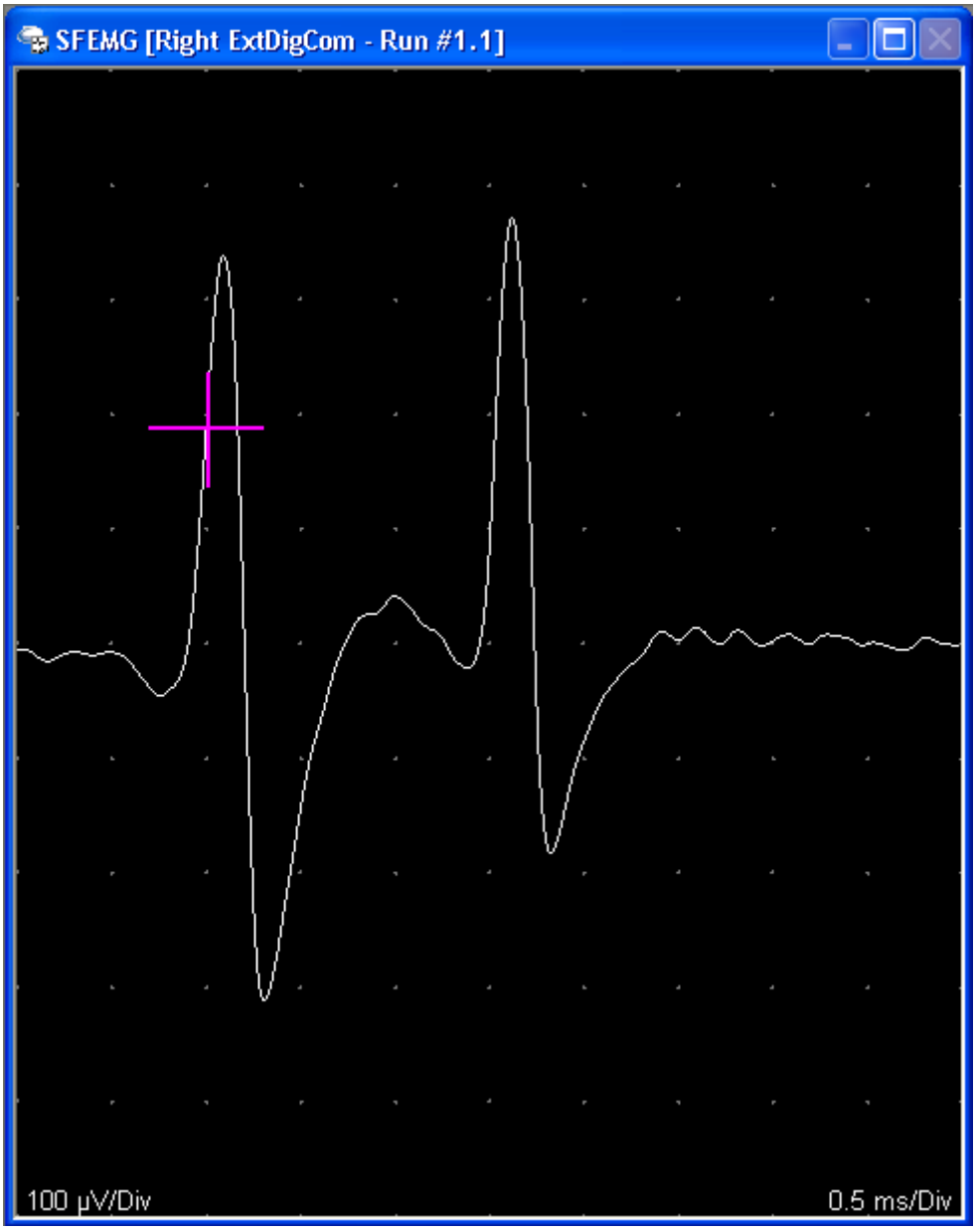
Acquisition Mode

Displays the volitional SFEMG activity. Adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

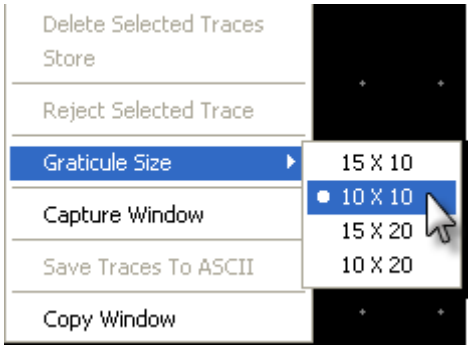
Adjust the **Trigger Level and Delay** by using **Knob #3 (Trig Lev /Trig Del).** Turn this knob to move the position of the trigger level (horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the sweep is added to the capture buffer. Press the knob to activate **Trig Del** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in one division increments. Changing the delay point allows you to see more or less data after the triggering potential.

 The **mouse** can also be used to move the Trigger Level/Delay indicator.

Right-clicking on the trace area displays a menu of functions that can be used.



Trace Area in SFEMG Acquisition mode.



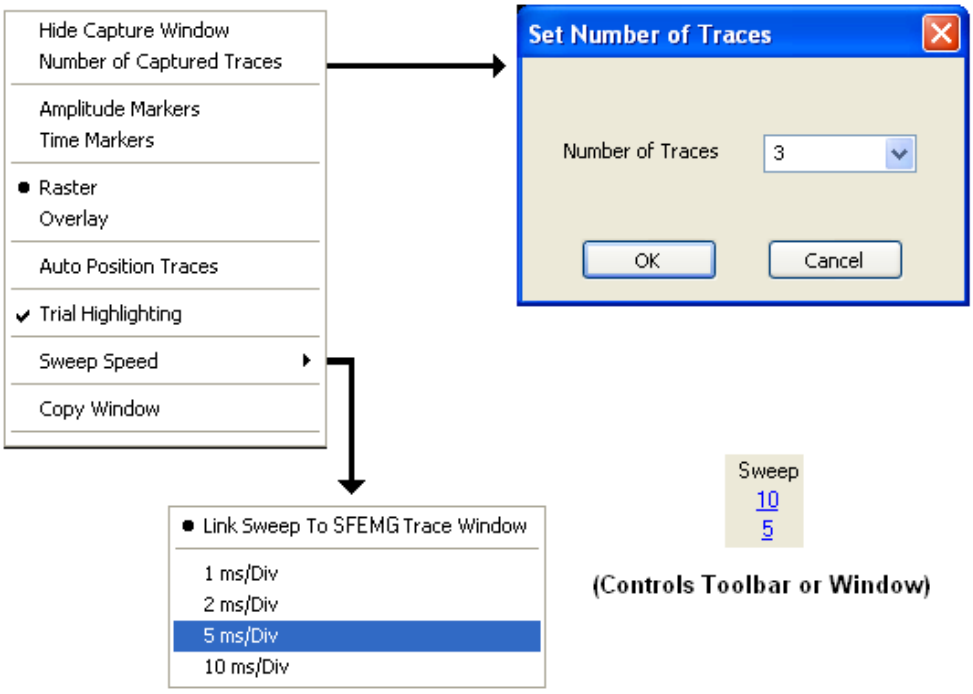
Right-click menu.

Graticule Size: The SFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Capture Window: When this feature is enabled the trace window is split into two sections; the top section shows the live SFEMG trace and the trigger level indicator line, the bottom section shows a rastered display of the most recently captured traces.

Capture Window Options.

When the Capture Window is enabled, right clicking within the capture window trace area will display a pop-up menu of display options.



- **Hide Capture Window** – turns off the capture window.
- **Number of Captured Traces** - changes the number of traces displayed in the captured window trace area. Select 3, 5, or 10 from the drop down list or type in any number between 2 and 100.
- **Amplitude Markers** – enables amplitude markers in the captured window area.

- **Time Markers** – enables time markers in the captured window area.
- **Raster / Overlay** – sets the position of the captured window traces as either rastered or overlayed (i.e., superimposed).
- **Auto Position Traces** - if captured window traces have been moved up/down using the mouse, this option will return the traces to their original positions.
- **Trial Highlighting** - enables the alternating white/gray coloring of the rastered traces.
- **Sweep Speed** – the sweep speed of the Live and Capture Window areas can be set independently.
    - **Link Sweep to SFEMG Trace Window** – automatically sets the captured window trace area to the same sweep speed as the Live trace.
    - **1, 2, 5, 10 ms/Div** – sets the captured window trace sweep speed to the selected value. Dual sweep values are displayed in the Controls Toolbar or Amplifier Controls window when the captured window sweep speed is set differently than the Live trace sweep speed.
- **Copy Window** - copies the contents of the SFEMG trace window to the clipboard.

Enabling the Capture Window Display as your default setting for SFEMG.

The status of the Capture Window display feature and the number of traces displayed within the window can be saved as part of the default settings for the SFEMG test protocol. With the feature enabled, simply select **Save Test Parameters** from the **Edit** menu.

Analysis Mode

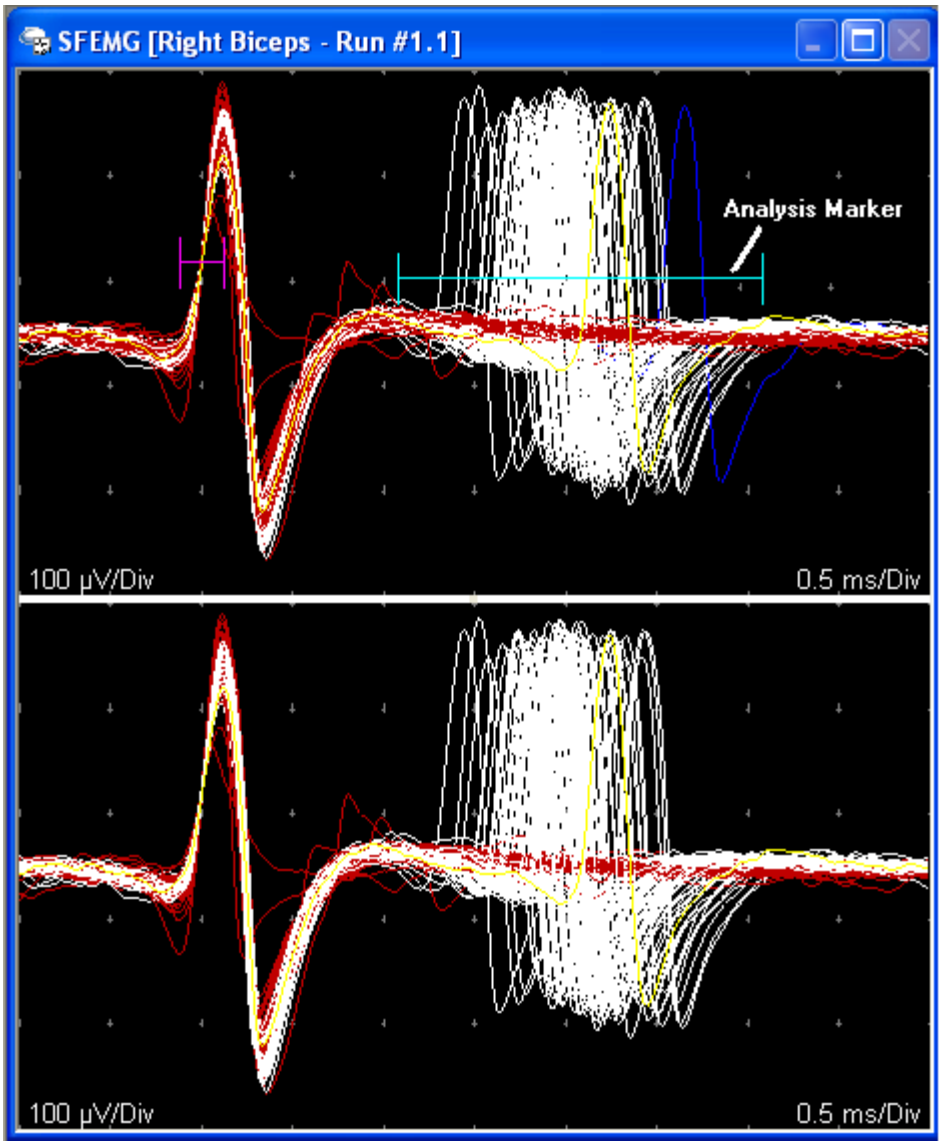
The Analysis mode has two trace areas, the **Captured Trace** area on the top, and the **Filtered Trace** area on the bottom. Right-clicking on the trace area displays a menu of functions that can be used.

Captured Trace area - shows all the traces in the current capture buffer and an adjustable Analysis Marker.

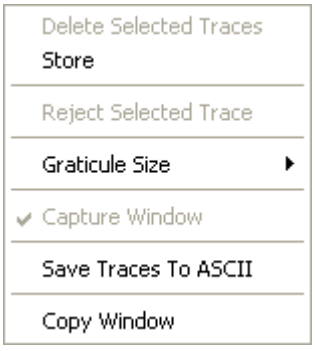
Colors Used in the Capture Trace Area

Trace Color	Description
White	These traces are within the Sequential IPI Plot include area (shown as yellow band on the plot) and are added to the Filtered Trace area where they are used for calculating the jitter.
Red	These traces did not cross through the analysis marker and are therefore considered blocks. They are added to the Filtered Trace area if the Jitter measurement is abnormal. If the Jitter is normal, these traces are most likely the result of artifacts or mis-triggers.
Dark Blue	These traces lie outside the Sequential IPI Plot include area and are not added to the Filtered Trace area.
Light Blue	These traces have been manually rejected from the data set and are removed from the Filtered Trace area.
Yellow	Indicates the trace has been selected (using the mouse or Knob #4), it can be manually rejected or deleted from the data set.

Filtered Trace area - shows only those traces that fall within the Sequential IPI Plots include area (yellow band). Blocking traces (red) are also shown in this area when the Jitter is abnormal. Jitter measurements are based on the traces in this area.



Trace Area in SFEMG Analysis mode.



Right-click menu.

Delete Selected Traces: Deletes the yellow (i.e, selected) traces from the capture buffer.

Store: Stores the run to disk. This is the same function as pressing the Store key on the base unit.

Reject Selected Traces: Marks the selected trace as "manually rejected" which colors it light-blue and removes it from the Filtered Trace area but does not delete it from the capture buffer.

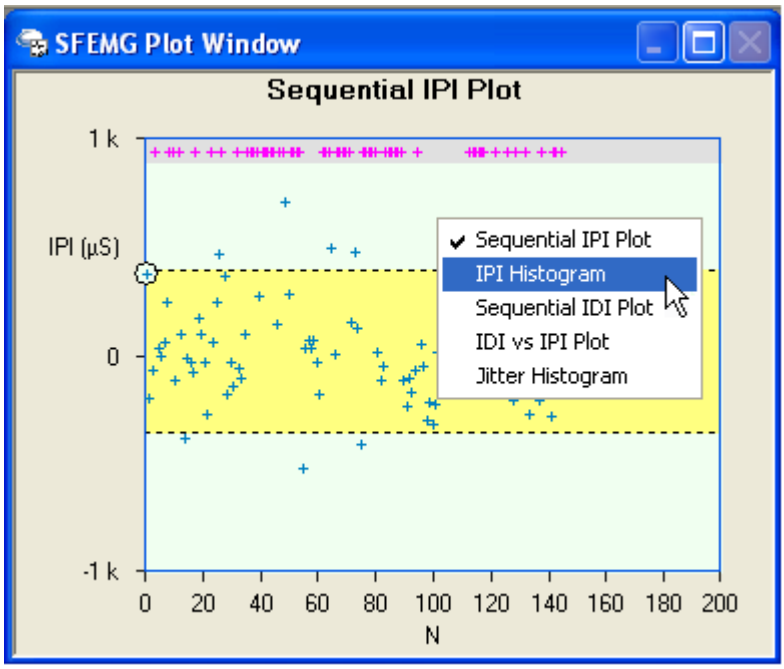
Graticule Size: The SFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Save Traces to ASCII: Allows all the traces in the Capture Trace area to be output to a comma separated values file (*csv). For more information on using the ASCII Output Utility click here.

Copy Window - copies the contents of the SFEMG trace window to the clipboard.

SFEMG Plot Descriptions

The plot window can display up to three data plots at one time. To view other plots, simply **right-click** over this window and select the plots you would like to view from the pop-up menu.



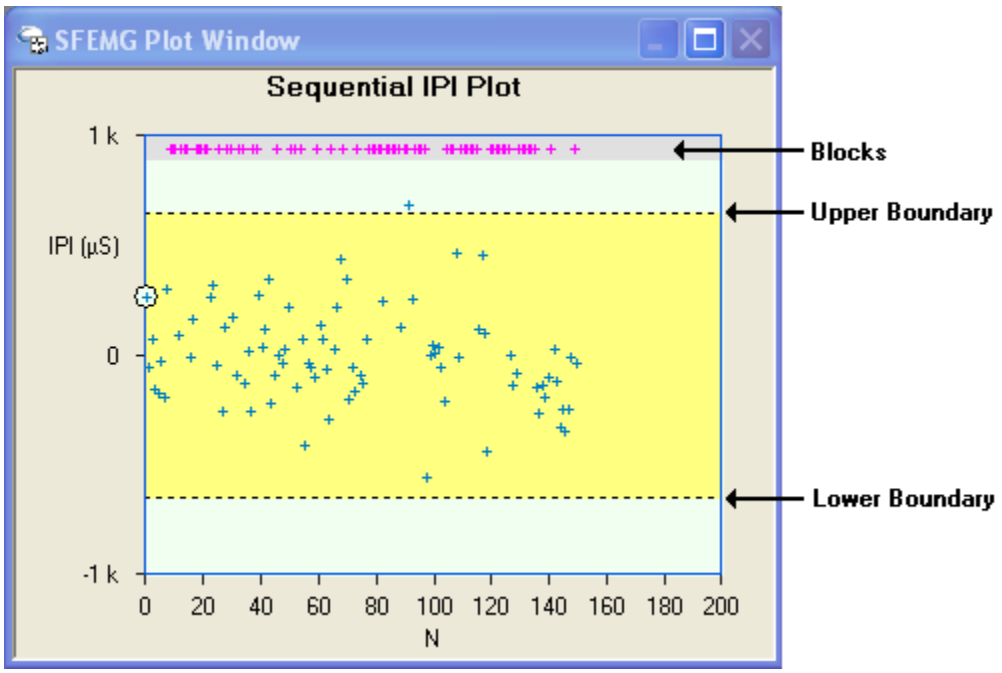
Sequential IPI Plot with right-click menu.

Sequential IPI Plot

This is the default plot that is displayed in the Analysis Mode. The **Sequential IPI Plot** displays the distribution of the Inter-Potential Intervals by plotting the difference between each individual IPI (Inter-Potential Interval) and the mean IPI for the whole data set. The mean IPI is indicated as zero on the vertical axis. The horizontal axis represents each sweep in the data set, up to a maximum of 200.

Blocks are shown as red plus signs at the top of the plot and as red traces in the Captured and Filtered Trace areas. A **+/- 3 standard deviation** yellow band is drawn about the mean value and defines an acceptance limit of IPI for computing jitter. Potentials outside the yellow band are shown as dark blue color in the Captured Trace area and are not included in the Filtered Trace area. A circle is drawn around the currently selected trace (i.e., corresponds to the yellow trace).

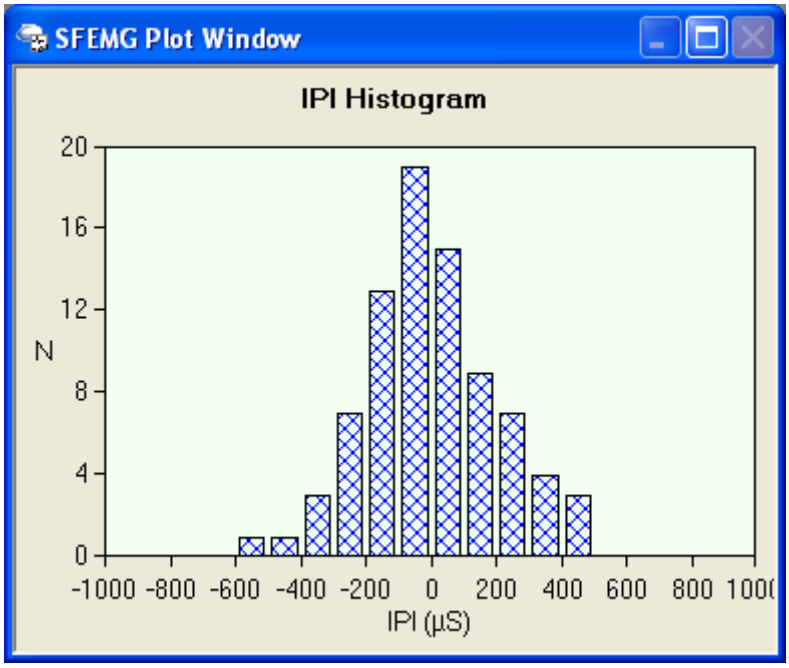
The upper & lower boundaries of the yellow band can be adjusted by clicking on the boundary with the mouse and then dragging it up or down. The Captured and Filtered trace areas and jitter measurements are updated automatically when the boundary is changed. This is a powerful and quick way to analyze multiple potentials in the data set and to exclude traces that represent technical problems.



Sequential IPI Plot

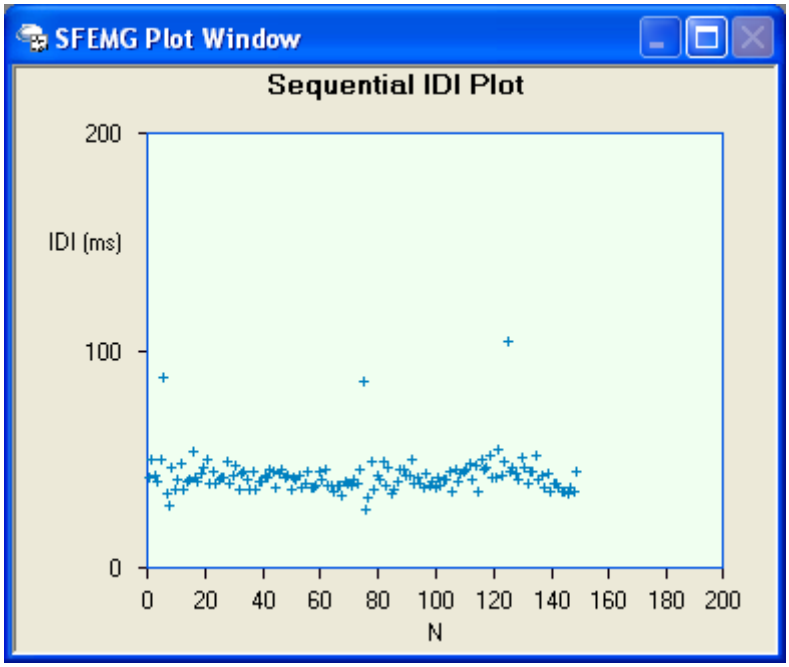
IPI Histogram: Displays the distribution of the IPI's in a bar graph format. The height of each bar indicates the counts (N) for each value of IPI. This graph

should demonstrate a Gaussian distribution; any deviation would suggest that spurious data may have been acquired.



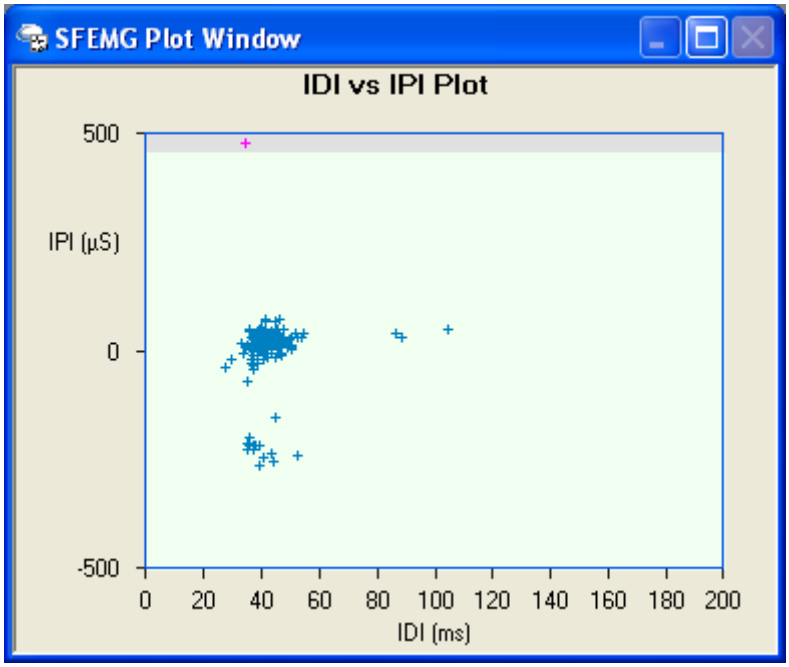
IPI Histogram

Sequential IDI Plot: Displays the distribution of the Inter-Discharge Intervals (IDI) for the data set.



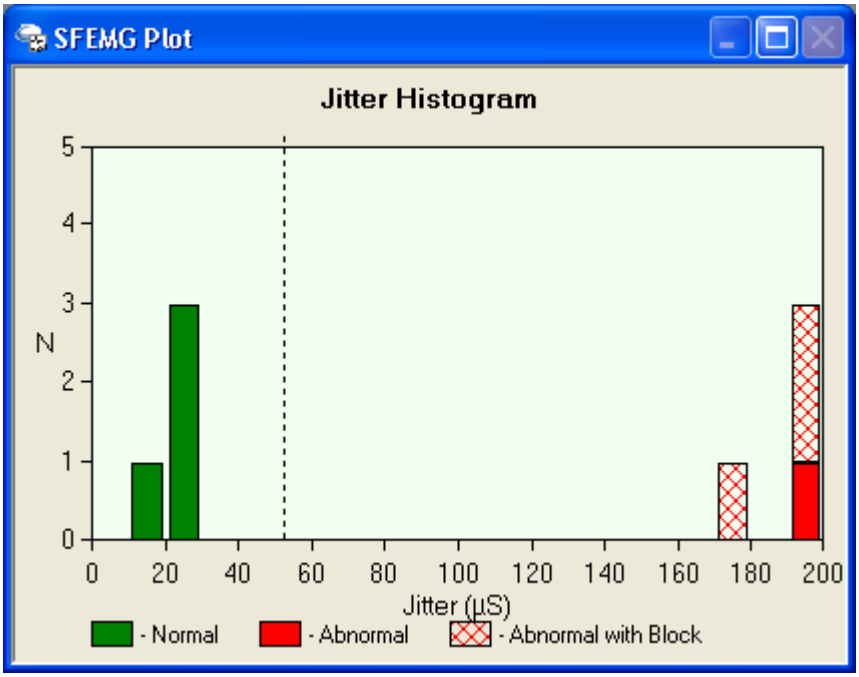
Sequential IDI Plot

IDI vs IPI Plot: Displays the distribution of the IPI versus the IDI, this plot is used to view the jitter dependence on the preceding interval.



IDV vs. IPI Plot

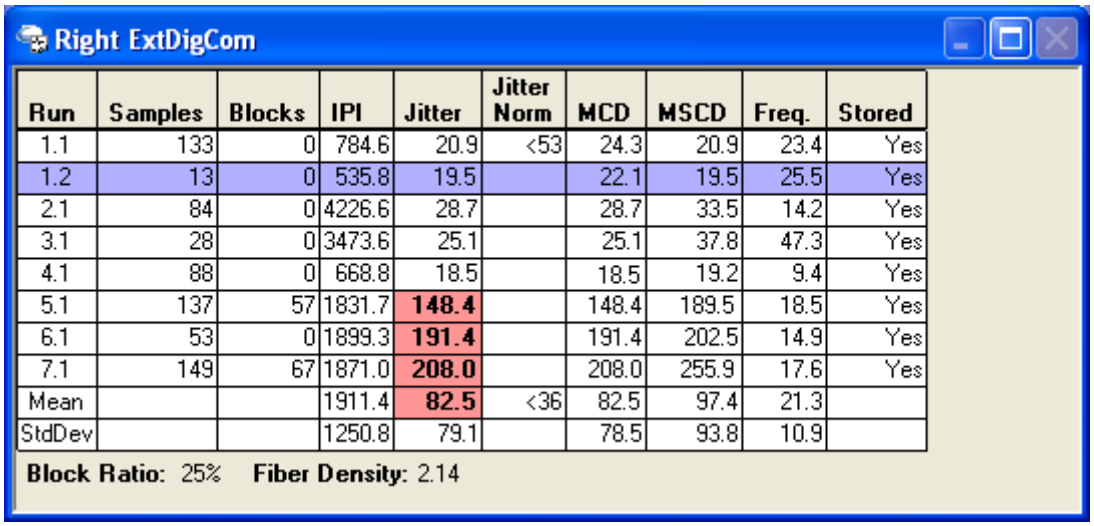
Jitter Histogram: This histogram provides a quick summary of the data collected for the muscle. The vertical axis marks the count, while the horizontal axis indicates jitter (in microseconds, us). The height of colored bar graphs indicates the number of runs containing that amount of jitter. Normal jitter is indicated by green bars, abnormal jitter as red bars, and abnormal jitter with blocking as red cross-hatched bars. A dashed line marks the jitter norm for individual potential pairs in the muscle. This is the default plot for the Acquisition Mode.



Jitter Histogram

Table Options

Clicking on a row in the Results Table highlights that row and allows that run's trace data to be reviewed. Right-clicking within the table will display a menu of options.



Right ExtDigCom

Run	Samples	Blocks	IPI	Jitter	Jitter Norm	MCD	MSCD	Freq.	Stored
1.1	133	0	784.6	20.9	<53	24.3	20.9	23.4	Yes
1.2	13	0	535.8	19.5		22.1	19.5	25.5	Yes
2.1	84	0	4226.6	28.7		28.7	33.5	14.2	Yes
3.1	28	0	3473.6	25.1		25.1	37.8	47.3	Yes
4.1	88	0	668.8	18.5		18.5	19.2	9.4	Yes
5.1	137	57	1831.7	**148.4**		148.4	189.5	18.5	Yes
6.1	53	0	1899.3	**191.4**		191.4	202.5	14.9	Yes
7.1	149	67	1871.0	**208.0**		208.0	255.9	17.6	Yes
Mean			1911.4	**82.5**	<36	82.5	97.4	21.3	
StdDev			1250.8	79.1		78.5	93.8	10.9	

Block Ratio: 25% **Fiber Density:** 2.14

SFEMG Results Table

Right-click menu.

Font Size: The font size of the table can be increased or decreased. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

Copy Table: Copies the contents of the SFEMG table to the Windows clipboard.

Delete Run: This will delete the highlighted row from the table and all the data for that run.

Swap Jitter Value: Selecting this option will cause the larger value between MCD and MSCD to be displayed in the Jitter field. By default, the lower value of the two is displayed in the Jitter field.

Column Definitions:

Run – indicates the run #. If a run is analyzed more than once, it is indicated by **.**2, **.**3, and so on. This would occur if more than one potential was analyzed in the run using the **New Pair** function key.

Samples – indicates the total number of traces shown in the Filtered Trace area for that run.

Blocks – indicates the number of blocks shown in the Filtered Trace area for that run.

IPI – displays the mean Inter-Potential Interval for the traces shown in the Filtered Trace area.

Jitter – displays the lowest value of either the MCD or MSCD in microseconds (usec).

Jitter Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

MCD – the jitter as calculated by using the Mean Consecutive Difference for the run.

MSCD – the jitter as calculated by using the Mean Sorted Consecutive Difference for the run.

Freq. – displays the mean firing frequency of the triggering potential in hertz (Hz).

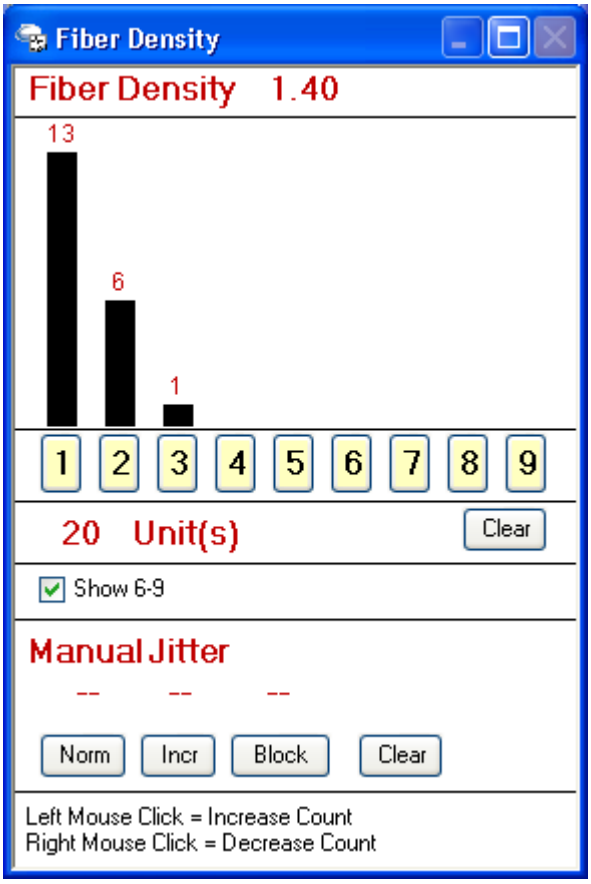
Stored – indicates if the run has been stored to disk.

Block Ratio – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

Fiber Density

The top portion of the **Fiber Density** window is used to record the results of fiber density studies. Count the number of time-locked potentials in the trace and then record that value by clicking on the corresponding button in the Fiber Density window. The program computes the fiber density by taking the total count and dividing it by the number of entries (units). The fiber density value is recorded in the results table and is included in reports.



Fiber Density window.

In the above example:

Fiber Density = (13 x 1) + (6 x 2) + (1 x 3) / (13 + 6 + 1)

= 13 +12 + 3 / 20

= 28 / 20

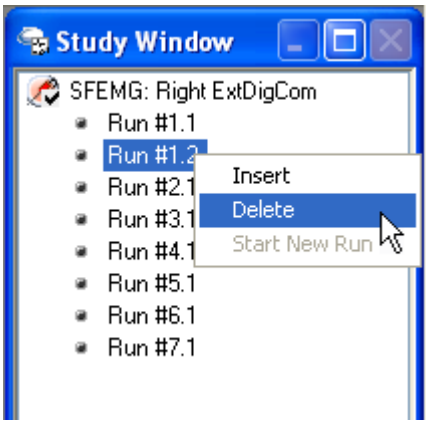
= 1.40

Deleting a Run

To **Delete** a stored SFEMG run, perform one of the following procedures.

Using the Study Window:

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted and the mean and standard deviation values in the Results table are automatically re-calculated.



Using the Results Table:

- **Right click** over the row in the table corresponding to the run you want to delete.
- From the pop-up menu, select **Delete Run**.

Re-analyzing a Run

To review and re-analyze a Run, follow these steps.

- **Select the Run #** you want to re-analyze by performing one of the following.
    - **Turn Knob #1 (Select Run)** until the desired **run #** is highlighted.
    - **Left click** the mouse over the desired **run #** in the **Study** window.
    - **Left click** the mouse over the desired **run #** within the **Results table**.
- Adjust the **Analysis Marker** as needed.
- Adjust the include area (i.e., yellow band) of the **Sequential IPI Plot** as needed.

Saving Changes to SFEMG Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the SFEMG test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

Stimulated Single Fiber EMG

Performing Stimulated SFEMG

Select the SSFEMG Test:

- **If a Study has already been selected**, simply click on a SSFEMG muscle name (i.e., Right Biceps) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual SSFEMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that when a muscle is selected, it is displayed within the Study window.

Once the muscle has been selected. Follow these steps for performing routine SSFEMG data acquisition and analysis:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate. Only Channel 1 can be used in the SSFEMG test protocol.

   Typical Settings for SSFEMG

   Gain = 100 uV/Div

   Hicut = 10k Hz

   Locut = 500 Hz

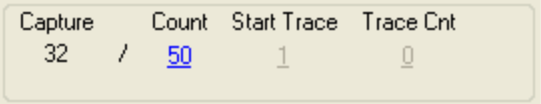
   Sweep Speed = 0.5 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Set the capture buffer Count value.**

   The Count value is the total number of traces that can be collected in the SSFEMG trace buffer. Each time the electrical stimulator fires the resulting time-locked trace is added to the trace buffer and the Capture number is incremented by one. The Count can be set to 10, 20, 30, 50, 70, 100, 150, or 200. This setting is located in the SSFEMG Controls window and can be easily changed using the mouse.



4. **Start Data Acquisition**

   Press the **F2 (Stim off / Stim on)** function key to initiate data acquisition. Leave the stimulus **intensity set to ZERO mA** until the recording and stimulating needles are inserted and positioned.

5. **Insert the recording SSFEMG Needle Electrode.**

6. **Position the Stimulating Electrode.**

   The stimulating electrode should be connected to the Cathode (-), indicated by the green LED on the electrical stimulator. A surface electrode should be connected to the Anode (+).

7. **Begin stimulus delivery.**

   Verify that the **F2 (Stim off / Stim on)** function key is set to the **Stim On** mode and increase the stimulation intensity. Adjust other stimulation settings as necessary.

   Intensity - adjust the stimulation intensity by turning the wheel on the hand held electrical stimulator or by clicking on the Intensity field in the SSFEMG Controls window and selecting a value from the pop-up list.

   Pulse Width - adjust the pulse width (in microseconds) by clicking on the Pulse Width field and selecting a value from the pop-up list.

   Rep Rate - adjust the stimulation frequency by clicking on the Rep Rate field and selecting a value from the pop-up list.

   Polarity - Typically set to the Normal mode, the Cathode (-) is indicated by the green LED.

8. **Adjust the Gain and Sweep Speed as necessary.**

   During SSFEMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

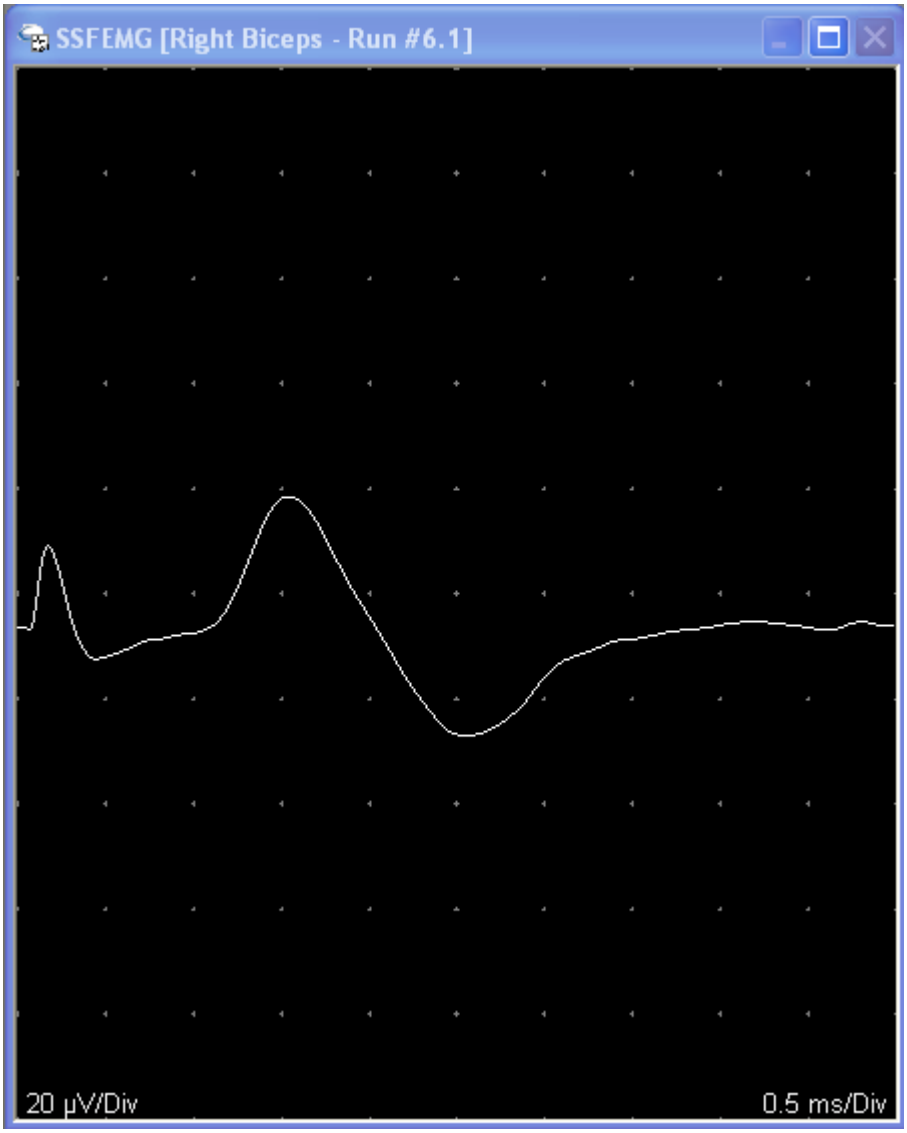
   You can also use the mouse to change these settings in the **SSFEMG Controls** window.

9. **Adjust the Volume (optional)**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume knob** on the left hand side of the base unit.

10. Acquire SSFEMG Potentials

Once the appropriate SSFEMG signal is located, press the **Clear key** on the Sierra Wave base unit to reset the Capture buffer to zero. Now, acquire SSFEMG potentials until the buffer Count is reached or until you are satisfied that enough SSFEMG data has been captured for analysis.



Acquisition mode.

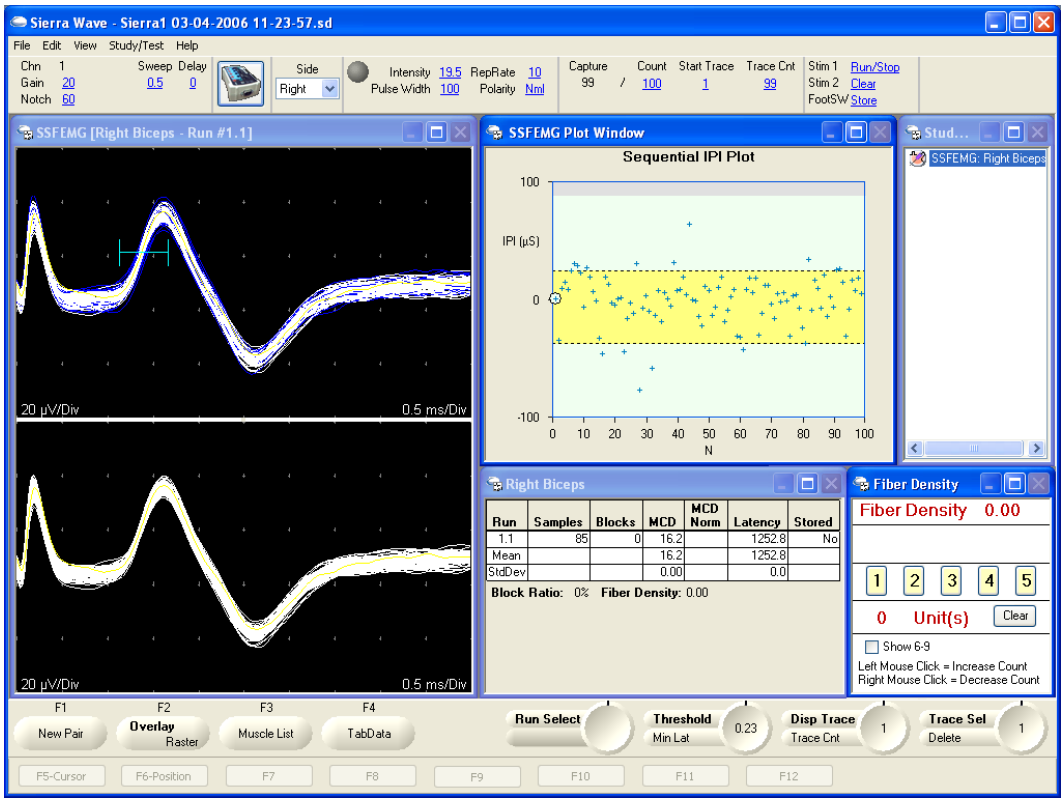
11. Stop Data Acquisition

Press the **Run/Stop key** on the Sierra Wave base unit to stop data acquisition. This will change the display to the **Analysis mode**. Electrical stimulus delivery is stopped while in the Analysis mode.

The Analysis mode has two trace areas, the **Captured Trace** area and the **Filtered Trace** area. Typically a **Sequential IPI Plot** and **Results Table** are also displayed.

Captured Trace area - shows all the traces in the current capture buffer.

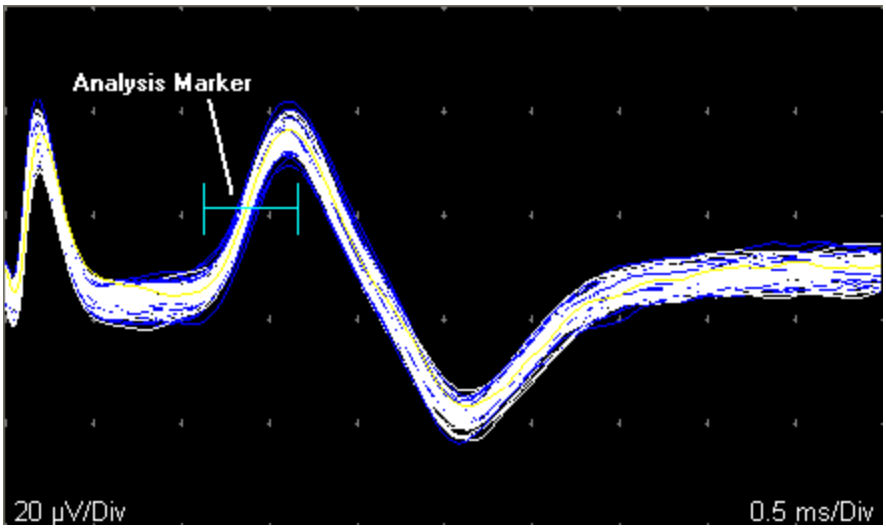
Filtered Trace area - shows only those traces that fall within the Sequential IPI Plots include area (yellow band). Blocking traces (red) are also shown in this area when the Jitter is abnormal. Jitter measurements are based on the traces in this area.



Stimulated SFEMG Analyze Mode

12. Verify the Position of the Analysis Marker

Check the position of analysis marker (shown in light-blue) in the **Captured Trace** area, the rising edge of the potentials to be analyzed should cross through the analysis marker. If a single fiber potential does not transition through the marker it will be considered as a block. The width of the analysis marker should be adjusted to encompass all the potentials that you want to analyze. Use the **mouse** or **Knob #2 (Threshold / Min Lat)** to make adjustments to the analysis marker position and width. The Filtered Trace area and the Sequential IPI Plot are automatically updated when the analysis marker is repositioned.



Analysis Marker correctly positioned in the Capture Trace area.

Colors Used in the Capture Trace Area

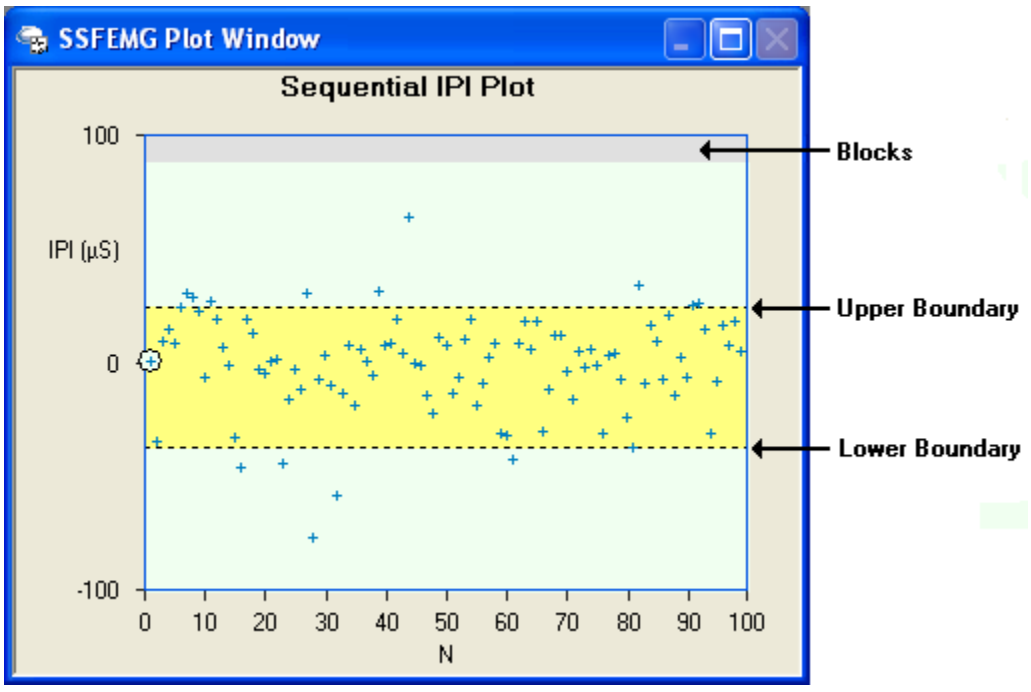
Trace Color	Description
White	These traces are within the Sequential IPI Plot include area (shown as yellow band on the plot) and are added to the Filtered Trace area where they are used for calculating the jitter.
Red	These traces did not cross through the analysis marker and are therefore considered blocks. They are added to the Filtered Trace area if the Jitter measurement is abnormal. If the Jitter is normal, these traces are most likely the result of artifacts or mis-triggers.
Dark Blue	These traces lie outside the Sequential IPI Plot include area and are not added to the Filtered Trace area.
Light Blue	These traces have been manually rejected from the data set and are removed from the Filtered Trace area.
Yellow	Indicates the trace has been selected (using the mouse or Knob #4), it can be manually rejected or deleted from the data set.

13. Make adjustments to the Sequential IPI Plot (Optional)

This is the default plot that is displayed in the Analysis Mode. The **Sequential IPI Plot** displays the distribution of the Inter-Potential Intervals by plotting the difference between each individual IPI (Inter-Potential Interval) and the mean IPI for the whole data set. The mean IPI is indicated as zero on the vertical axis. The horizontal axis represents each sweep in the data set, up to a maximum of 200.

Blocks are shown as red plus signs at the top of the plot and as red traces in the Captured and Filtered Trace areas. A **+/- 3 standard deviation** yellow band is drawn about the mean value and defines an acceptance limit of IPI for computing jitter. Potentials outside the yellow band are shown as dark blue color in the Captured Trace area and are not included in the Filtered Trace area. A circle is drawn around the currently selected trace (i.e., corresponds to the yellow trace).

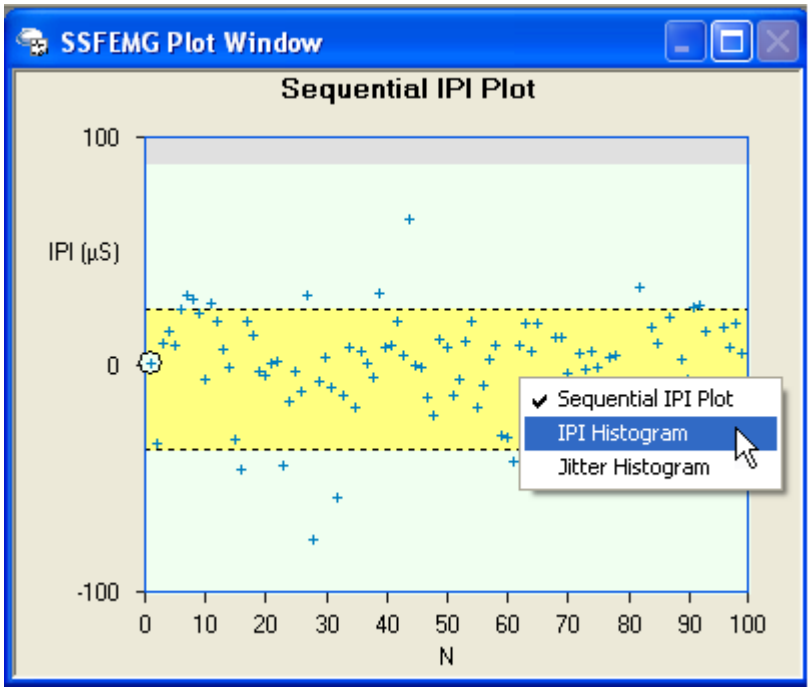
The upper & lower boundaries of the yellow band can be adjusted by clicking on the boundary with the mouse and then dragging it up or down. The Captured and Filtered trace areas and jitter measurements are updated automatically when the boundary is changed. This is a powerful and quick way to analyze multiple potentials in the data set and to exclude traces that represent technical problems.



Sequential IPI Plot

14. View other Data Plots (Optional)

The plot window can display up to three data plots at one time. To view other plots, simply **right-click** over this window and select the plots you would like to view from the pop-up menu.

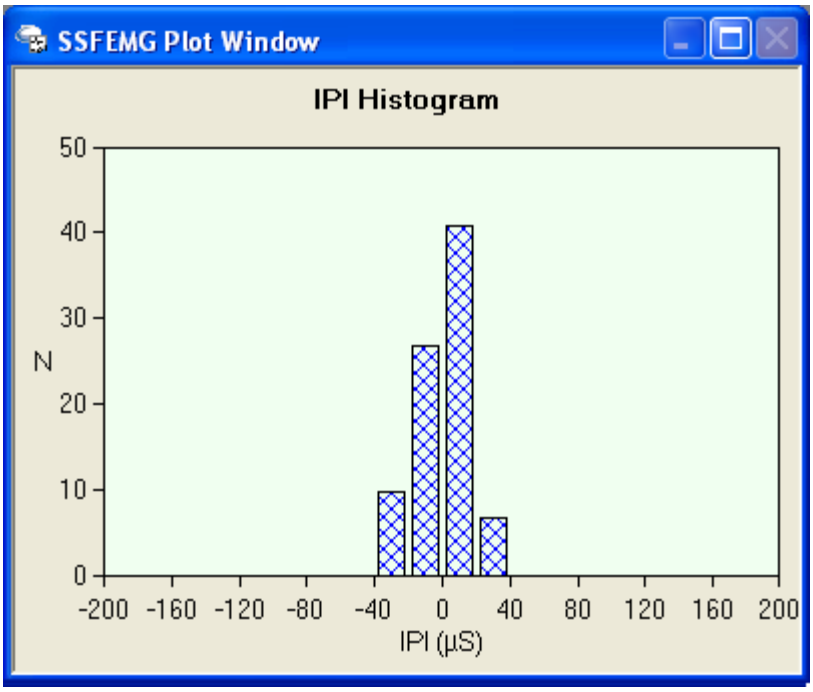


Sequential IPI Plot with right click menu.

The available plots are:

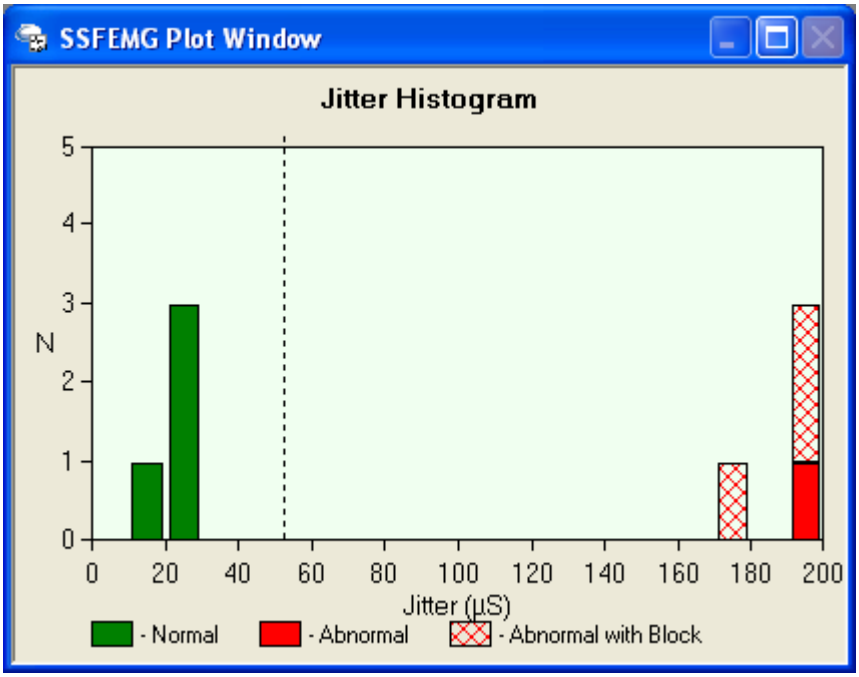
Sequential IPI: See step #13 above.

IPI Histogram: Displays the distribution of the IPI's in a bar graph format. The height of each bar indicates the counts (N) for each value of IPI. This graph should demonstrate a Gaussian distribution; any deviation would suggest that spurious data may have been acquired.



IPI Histogram

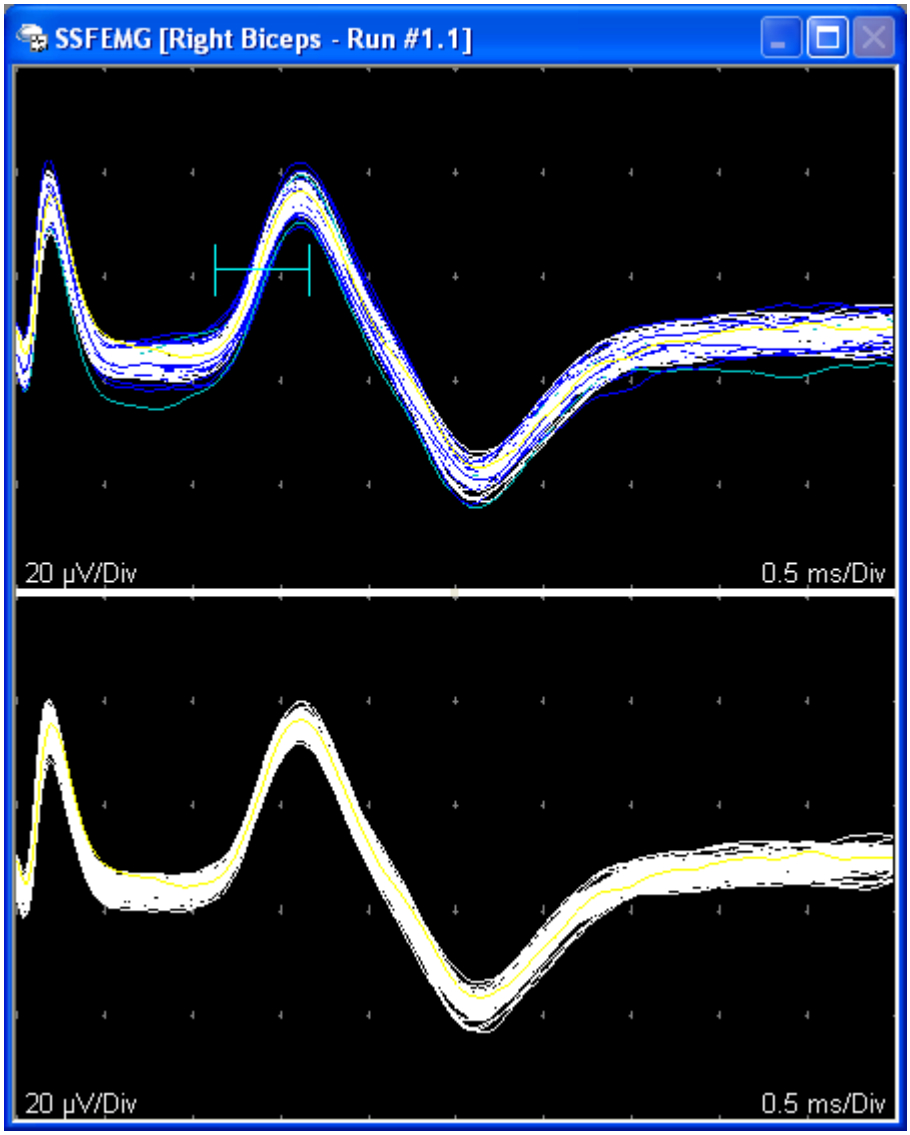
Jitter Histogram: This histogram provides a quick summary of the data collected for the muscle. The vertical axis marks the count, while the horizontal axis indicates jitter (in microseconds, us). The height of colored bar graphs indicates the number of runs containing that amount of jitter. Normal jitter is indicated by green bars, abnormal jitter as red bars, and abnormal jitter with blocking as red cross-hatched bars. A dashed line marks the jitter norm for individual potential pairs in the muscle. This is the default plot for the Acquisition Mode.



Jitter Histogram

15. Manually Reject Traces (Optional)

Traces can be manually excluded from the analysis by selecting them with the mouse (left-click). Once selected the trace is displayed in yellow color. Now, right-click and select **Reject Selected Traces** from the pop-up menu, this removes the trace from the analysis. Rejected traces are displayed in light blue color. You can re-accept a rejected trace by selecting it, then right-click to remove the check mark next to Reject Selected Traces.



Example showing two manually rejected traces in the Captured Trace area that have been automatically removed from the Filtered Trace area.

16. Store the Run

Press the **Store key** on the Sierra Wave base unit to **keep the run**, by default all the traces for the run are stored as well. In the Results Table the "Stored" field will change from No to Yes.

As each SSFEMG run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows five runs stored for the Right Biceps muscle.

Study Window

If you decide not to keep the run, do not press the Store key, simply return to the Acquisition mode by pressing the **Run/Stop key** and the run will be discarded.

The **Results Table** records the analysis results for each run and calculates the mean and standard deviation values.

Right Biceps

Run	Samples	Blocks	MCD	MCD Norm	Latency	Stored
1.1	83	0	15.8	<32	1252.9	Yes
2.1	31	0	28.4		1258.6	Yes
3.1	30	0	**46.4**		1145.6	Yes
4.1	80	0	**41.5**		1535.2	Yes
5.1	92	0	24.3		1383.4	Yes
Mean			**31.3**	<24	1315.1	
StdDev			11.2		133.4	

Block Ratio: 0% **Fiber Density:** 0.00

Results Table

Run – indicates the run #. If a run is analyzed more than once, it is indicated by **.**2, **.**3, and so on. This would occur if more than one potential was analyzed in the run using the **New Pair** function key.

Samples – indicates the total number of traces shown in the Filtered Trace area for that run.

Blocks – indicates the number of blocks shown in the Filtered Trace area for that run.

MCD – the Jitter (in microseconds) as calculated by using the Mean Consecutive Difference for the run.

MCD Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

Latency - the mean latency (in milliseconds) from the sweep onset to the single fiber potential.

Stored – indicates if the run has been stored to disk.

Block Ratio – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

17. Collect Additional SSFEMG Runs

Press the **Run/Stop key** to return to **Acquistion mode** and repeat **steps 7 - 16** to acquire additional SSFEMG runs.

18. Select Next Muscle (optional)

From Acquisition mode, turn **Knob #1 (Study Item)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the next SSFEMG muscle from the list.

Move the recording SSFEMG Needle Electrode and Stimulating Electrode to the new muscle and repeat the above steps as necessary.

 It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

19. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

20. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (SSFEMG)

The functions assigned to the Sierra Wave base unit's Knob and F Key controls will vary depending on whether the system is in **Acquisition** mode or **Analyze** mode.

Analyze mode is entered by pressing the **Run/Stop** key.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press this

knob to switch to the **Pulse Width** mode and then turn to increase or decrease the electrical stimulus pulse width, the current value (in microseconds) is displayed on the knob icon.

Gain / Sweep - turn the knob to change the gain of the SSFEMG trace. Press the knob, then turn to change the sweep speed of the SSFEMG trace.

F Keys

Stim off / Stim on - defaults to **Stim off** mode, press to activate **Stim on** mode and initiate data acquisition with stimulus delivery.

Muscle List - opens the SSFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Analyze mode

Knobs

Run Select - turn this knob to highlight and review stored runs in the Results table. When the run is highlighted the traces for that run will be displayed in the trace window.

Threshold / Min Lat - this knob defaults to the **Threshold** mode, turn the knob to move the Analysis Marker up or down within the Trace window. Press the knob to activate the **Min Lat** mode, then turn to move the Analysis Marker left or right within the Trace window.

Disp Trace / Trace Cnt - this knob effects how the traces in the SSFEMG capture buffer are displayed. Turn the knob to change the starting display trace number. Press the knob, then turn to change the trace count number.

Here's an example of how to use the **Trace Cnt** and **Disp Trace** settings to view subsets of the capture buffer:

Assume there are 50 total traces in the SSFEMG capture buffer. The Trace Cnt will default to 50 and the Disp Trace number will default to 1.

Therefore all 50 traces (1 to 50) are displayed in the Trace window. Now, change the Trace Cnt to 20 and leave the Disp Trace number at 1. You will see traces 1-20 displayed in the Trace window. You can now change the Disp Trace number to 21, now you can view traces 21-40. Change the Disp Trace number again and it goes to 41, now you can view traces 41-50.

Trace Sel / Delete - defaults to the **Trace Sel** mode, turn this knob to select a SSFEMG trace. When selected, the trace will be displayed in yellow color. Press the knob to **Delete** the selected trace from the capture buffer.

F Keys

New Pair - press to add an additional row to the results table and to analyze a second potential pair in the data.

Overlay / Raster - defaults **Overlay** mode, in this mode the traces are superimposed on top of one another. Press to activate **Raster** mode, in this mode the traces are evenly rastered down the trace window.

Muscle List - opens the SSFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Stimulated SFEMG Test Setup

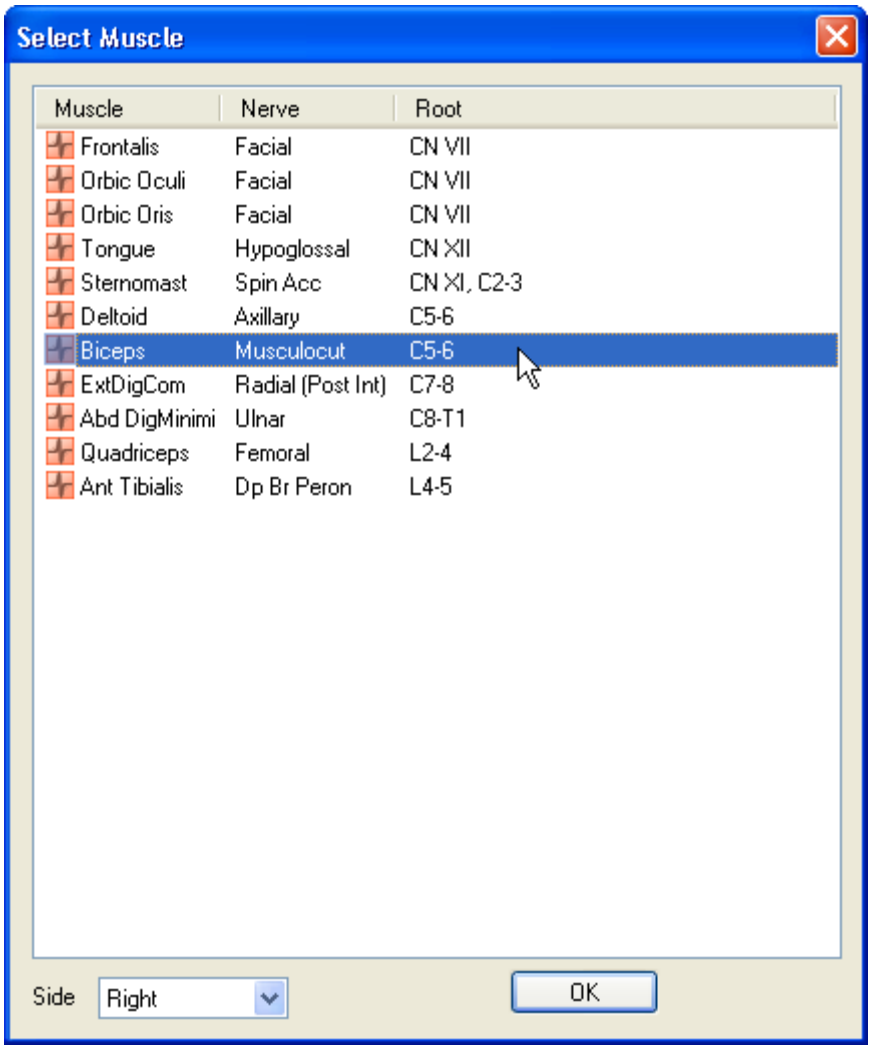
SSFEMG test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the SSFEMG Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the SSFEMG Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight**

the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

 Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

 Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

Stimulated SFEMG Trace Area

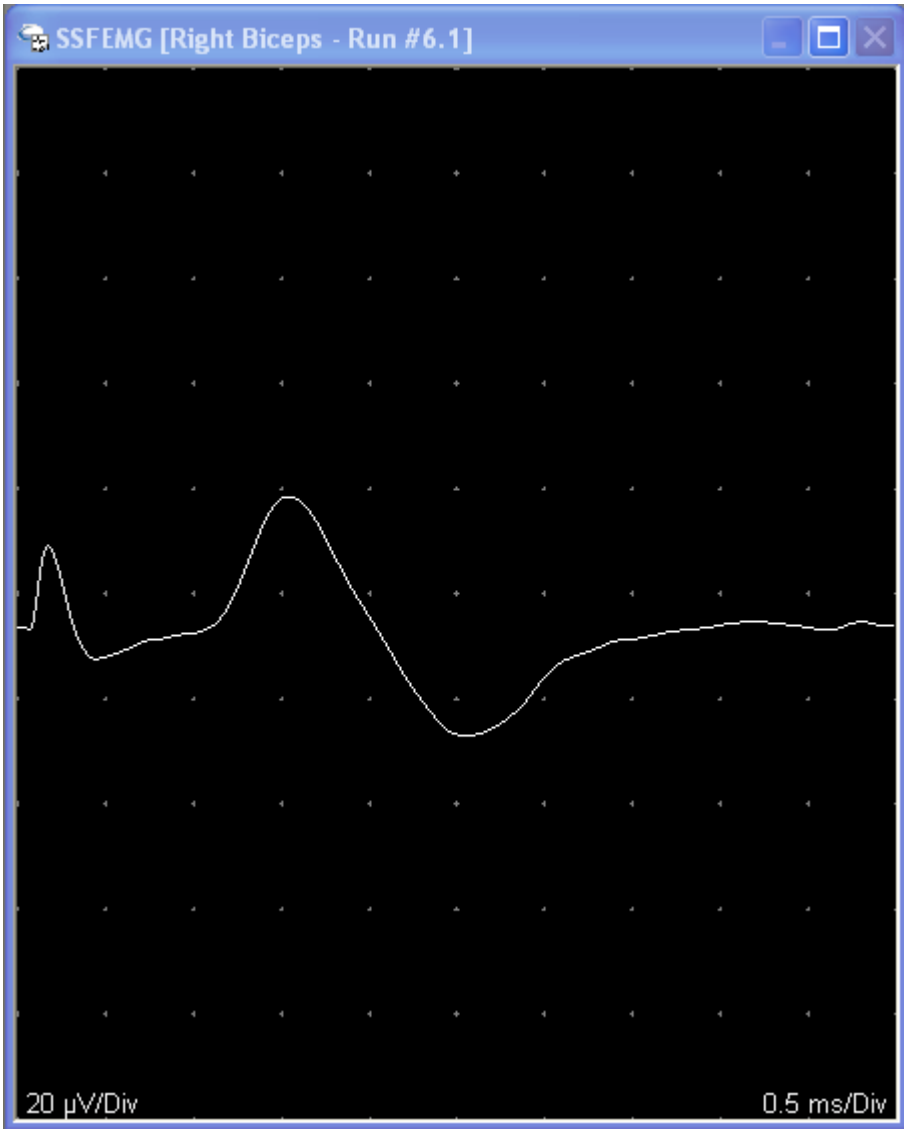
The contents of the Trace Area will varying depending on whether the program is in the **Acquisition** or **Analysis** modes.

Acquisition Mode

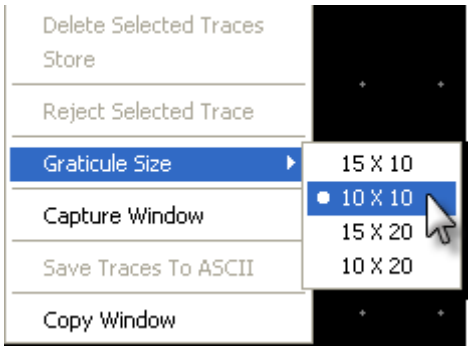
Displays the Stimulated SFEMG activity. Adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

To begin data acquisition press the **F2 (Stim off / Stim on)** function key is set to the **Stim On** mode and increase the stimulation intensity. Adjust other stimulation settings as necessary.

Right-clicking on the trace area displays a menu of functions that can be used.



Acquisition Trace Area



Right-click menu.

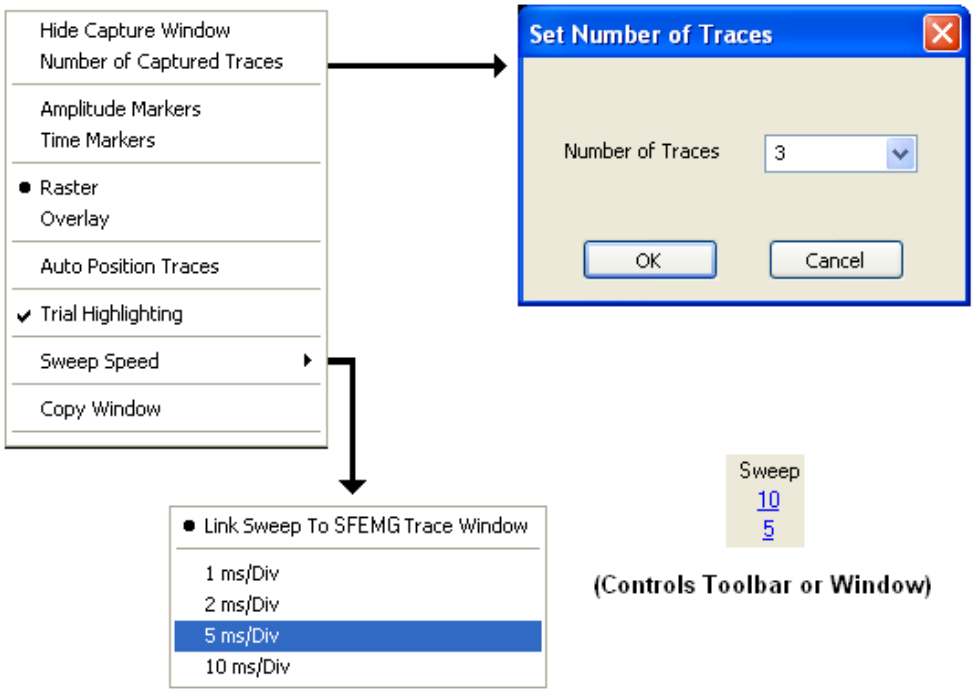
Graticule Size: The SSFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can

be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Capture Window: When this feature is enabled the trace window is split into two sections; the top section shows the live SSFEMG trace, the bottom section shows a rastered display of the most recently captured traces.

Capture Window Options.

When the Capture Window is enabled, right clicking within the capture window trace area will display a pop-up menu of display options.



- **Hide Capture Window** – turns off the capture window.
- **Number of Captured Traces** - changes the number of traces displayed in the captured window trace area. Select 3, 5, or 10 from the drop down list or type in any number between 2 and 100.
- **Amplitude Markers** – enables amplitude markers in the captured window area.
- **Time Markers** – enables time markers in the captured window area.

- **Raster / Overlay** – sets the position of the captured window traces as either rastered or overlayed (i.e., superimposed).
- **Auto Position Traces** - if captured window traces have been moved up/down using the mouse, this option will return the traces to their original positions.
- **Trial Highlighting** - enables the alternating white/gray coloring of the rastered traces.
- **Sweep Speed** – the sweep speed of the Live and Capture Window areas can be set independently.
    - **Link Sweep to SFEMG Trace Window** – automatically sets the captured window trace area to the same sweep speed as the Live trace.
    - **1, 2, 5, 10 ms/Div** – sets the captured window trace sweep speed to the selected value. Dual sweep values are displayed in the Controls Toolbar or Amplifier Controls window when the captured window sweep speed is set differently than the Live trace sweep speed.
- **Copy Window** - copies the contents of the SSFEMG trace window to the clipboard.

Enabling the Capture Window Display as your default setting for SSFEMG.

The status of the Capture Window display feature and the number of traces displayed within the window can be saved as part of the default settings for the SSFEMG test protocol. With the feature enabled, simply select **Save Test Parameters** from the **Edit** menu.

Analysis Mode

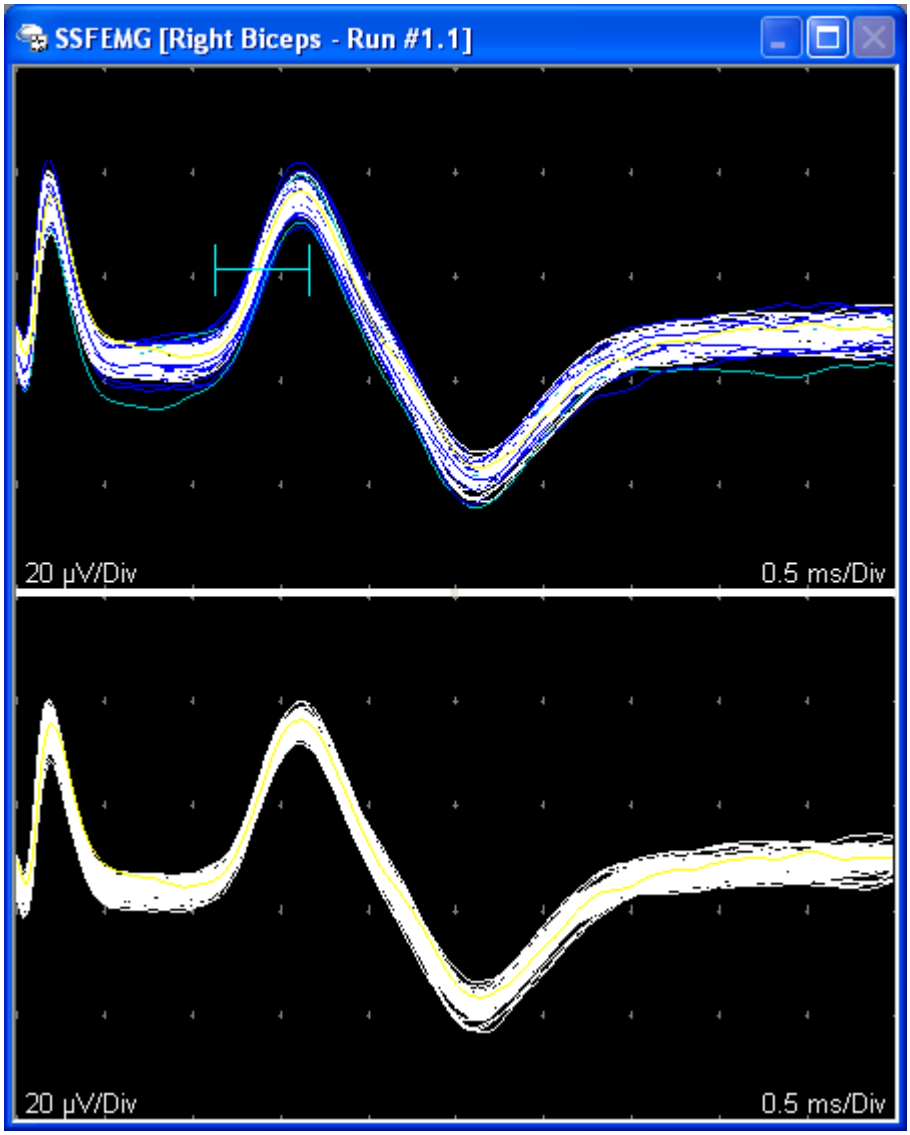
The Analysis mode has two trace areas, the **Captured Trace** area on the top, and the **Filtered Trace** area on the bottom. Right-clicking on the trace area displays a menu of functions that can be used.

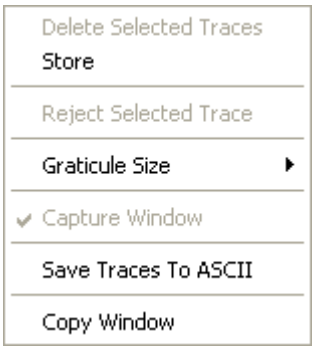
Captured Trace area - shows all the traces in the current capture buffer and an adjustable Analysis Marker.

Colors Used in the Capture Trace Area

Trace Color	Description
White	These traces are within the Sequential IPI Plot include area (shown as yellow band on the plot) and are added to the Filtered Trace area where they are used for calculating the jitter.
Red	These traces did not cross through the analysis marker and are therefore considered blocks. They are added to the Filtered Trace area if the Jitter measurement is abnormal. If the Jitter is normal, these traces are most likely the result of artifacts or mis-triggers.
Dark Blue	These traces lie outside the Sequential IPI Plot include area and are not added to the Filtered Trace area.
Light Blue	These traces have been manually rejected from the data set and are removed from the Filtered Trace area.
Yellow	Indicates the trace has been selected (using the mouse or Knob #4), it can be manually rejected or deleted from the data set.

Filtered Trace area - shows only those traces that fall within the Sequential IPI Plots include area (yellow band). Blocking traces (red) are also shown in this area when the Jitter is abnormal. Jitter measurements are based on the traces in this area.





Right-click menu.

Delete Selected Traces: Deletes the yellow (i.e, selected) traces from the capture buffer.

Store: Stores the run to disk. This is the same function as pressing the Store key on the base unit.

Reject Selected Traces: Marks the selected trace as "manually rejected" which colors it light-blue and removes it from the Filtered Trace area but does not delete it from the capture buffer.

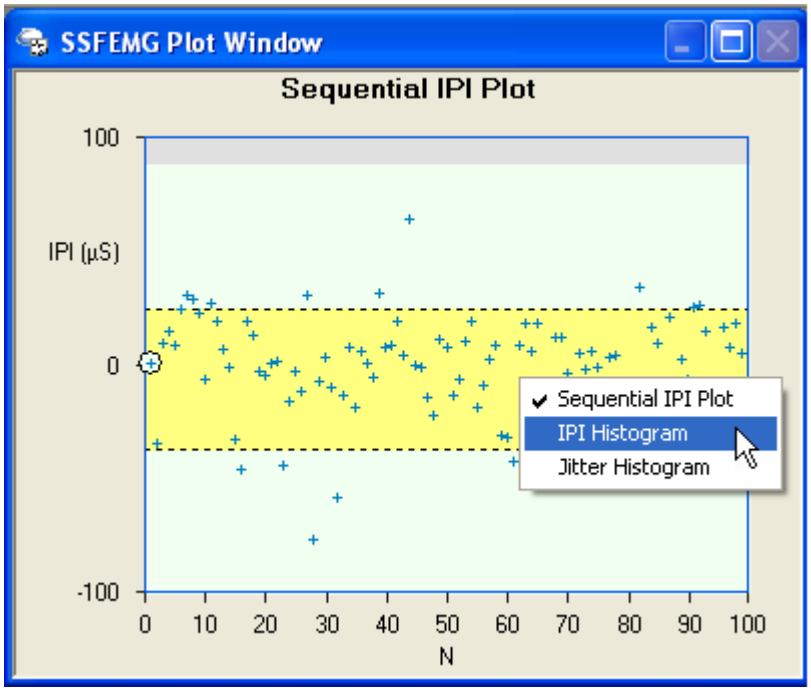
Graticule Size: The SSFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Save Traces to ASCII: Allows all the traces in the Capture Trace area to be output to a comma separated values file (*csv). For more information on using the ASCII Output Utility click here.

Copy Window - copies the contents of the SSFEMG trace window to the clipboard.

Stimulated SFEMG Plot Descriptions

The plot window can display up to three data plots at one time. To view other plots, simply **right-click** over this window and select the plots you would like to view from the pop-up menu.



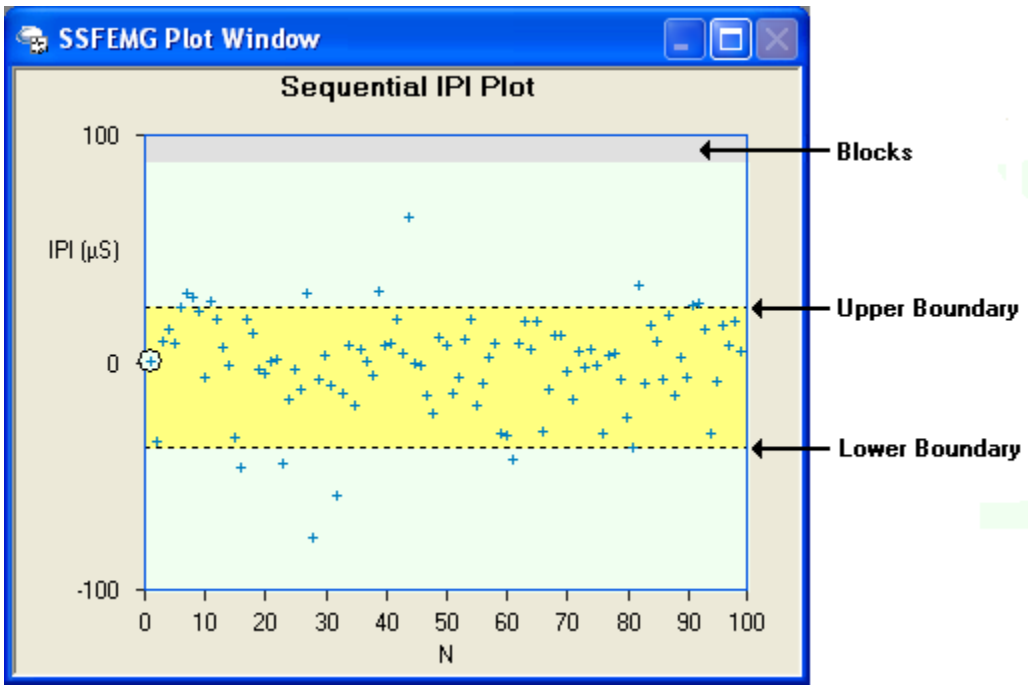
Sequential IPI Plot with right click menu.

Sequential IPI Plot

This is the default plot that is displayed in the Analysis Mode. The **Sequential IPI Plot** displays the distribution of the Inter-Potential Intervals by plotting the difference between each individual IPI (Inter-Potential Interval) and the mean IPI for the whole data set. The mean IPI is indicated as zero on the vertical axis. The horizontal axis represents each sweep in the data set, up to a maximum of 200.

Blocks are shown as red plus signs at the top of the plot and as red traces in the Captured and Filtered Trace areas. A **+/- 3 standard deviation** yellow band is drawn about the mean value and defines an acceptance limit of IPI for computing jitter. Potentials outside the yellow band are shown as dark blue color in the Captured Trace area and are not included in the Filtered Trace area. A circle is drawn around the currently selected trace (i.e., corresponds to the yellow trace).

The upper & lower boundaries of the yellow band can be adjusted by clicking on the boundary with the mouse and then dragging it up or down. The Captured and Filtered trace areas and jitter measurements are updated automatically when the boundary is changed. This is a powerful and quick way to analyze multiple potentials in the data set and to exclude traces that represent technical problems.

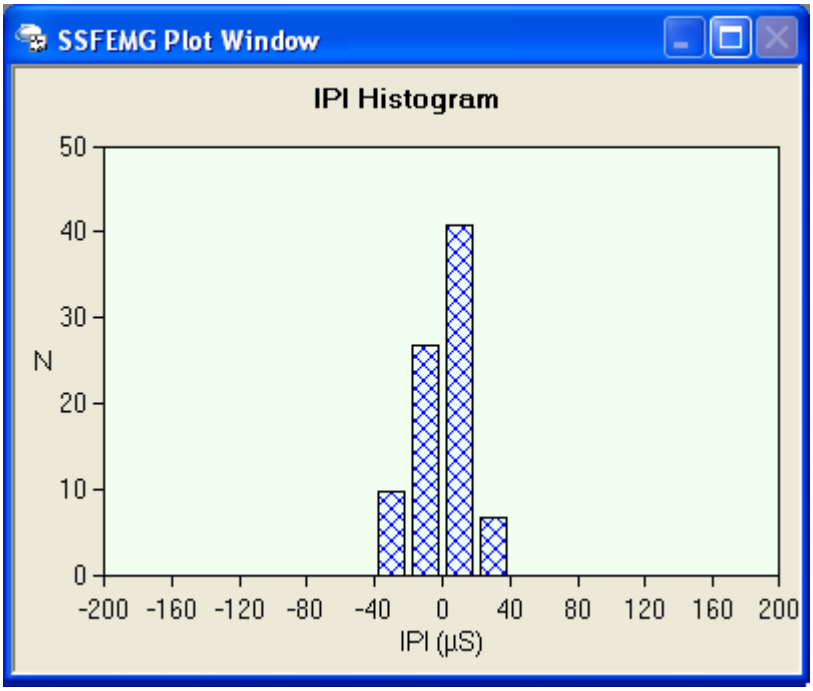


Sequential IPI Plot

IPI Histogram

Displays the distribution of the IPI's in a bar graph format. The height of each bar indicates the counts (N) for each value of IPI. This graph should

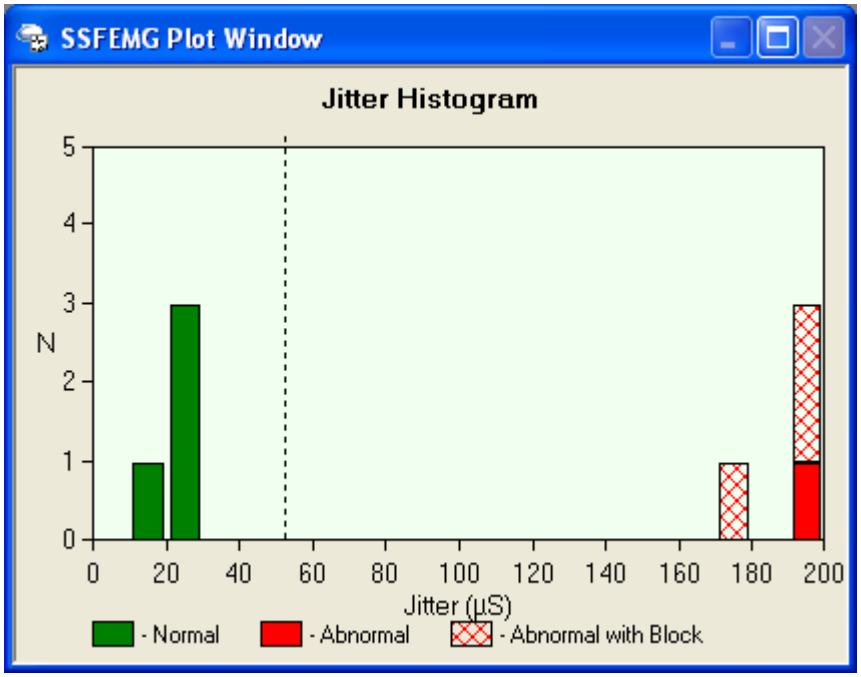
demonstrate a Gaussian distribution; any deviation would suggest that spurious data may have been acquired.



IPI Histogram

Jitter Histogram

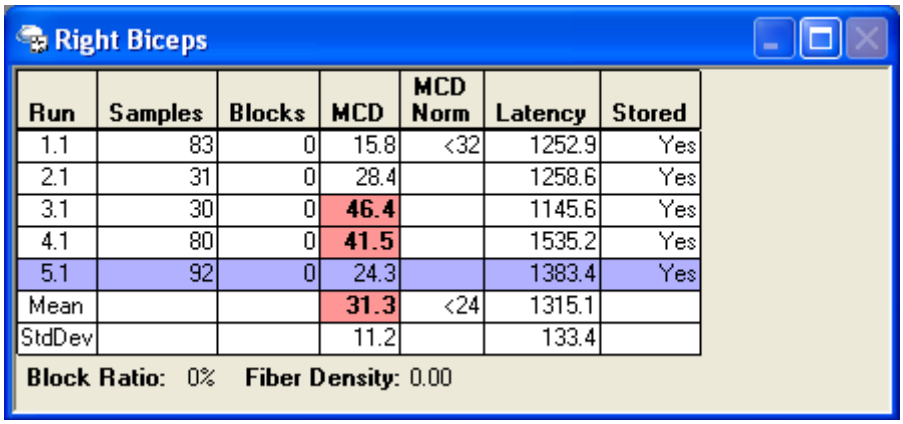
This histogram provides a quick summary of the data collected for the muscle. The vertical axis marks the count, while the horizontal axis indicates jitter (in microseconds, us). The height of colored bar graphs indicates the number of runs containing that amount of jitter. Normal jitter is indicated by green bars, abnormal jitter as red bars, and abnormal jitter with blocking as red cross-hatched bars. A dashed line marks the jitter norm for individual potential pairs in the muscle. This is the default plot for the Acquisition Mode.



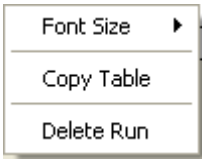
Jitter Histogram

Table Options

Clicking on a row in the Results Table highlights that row and allows that run's trace data to be reviewed. Right-clicking within the table will display a menu of options.



SSFEMG Results Table



Right-click menu.

Font Size: The font size of the table can be increased or decreased. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

Copy Table: Copies the contents of the SSFEMG table to the Windows clipboard.

Delete Run: This will delete the highlighted row from the table and all the data for that run.

Column Definitions:

Run – indicates the run #. If a run is analyzed more than once, it is indicated by **.**2, **.**3, and so on. This would occur if more than one potential was analyzed in the run using the **New Pair** function key.

Samples – indicates the total number of traces shown in the Filtered Trace area for that run.

Blocks – indicates the number of blocks shown in the Filtered Trace area for that run.

MCD – the Jitter (in microseconds) as calculated by using the Mean Consecutive Difference for the run.

MCD Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

Latency - the mean latency (in milliseconds) from the sweep onset to the single fiber potential.

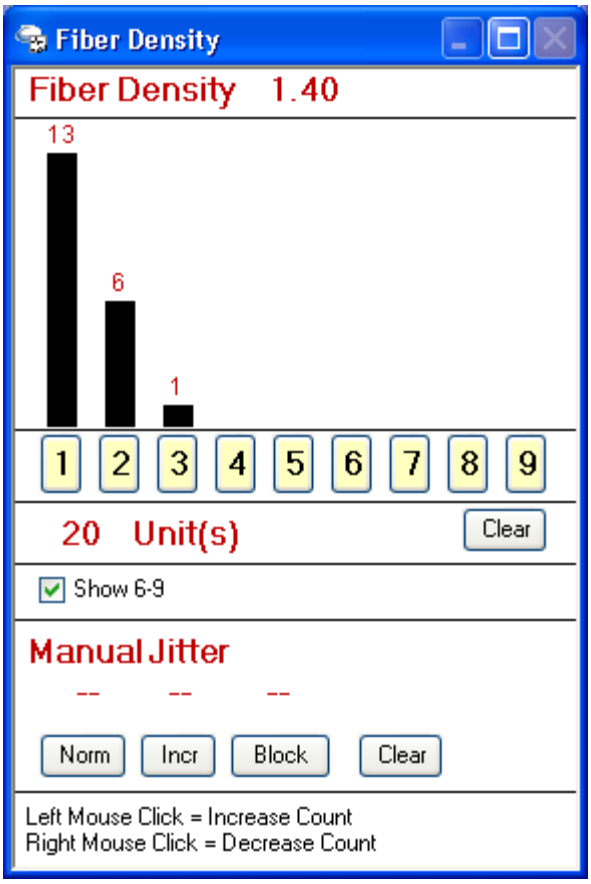
Stored – indicates if the run has been stored to disk.

Block Ratio – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

Fiber Density

The top portion of the **Fiber Density** window is used to record the results of fiber density studies. Count the number of time-locked potentials in the trace and then record that value by clicking on the corresponding button in the Fiber Density window. The program computes the fiber density by taking the total count and dividing it by the number of entries (units). The fiber density value is recorded in the results table and is included in reports.



Fiber Density window.

In the above example:

Fiber Density = (13 x 1) + (6 x 2) + (1 x 3) / (13 + 6 + 1)

= 13 +12 + 3 / 20

= 28 / 20

= 1.40

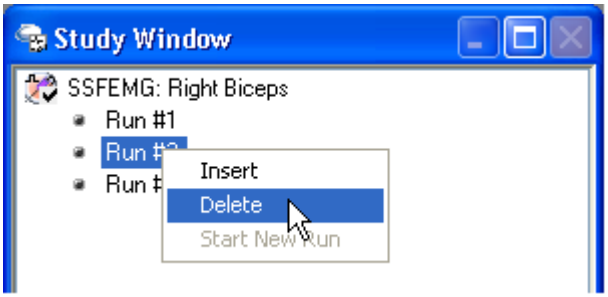
Stim OFF / Stim ON

To start data acquisition and initiate repetitive electrical stimulation in the Stimulated Single Fiber EMG test protocol, press the **F2 (Stim off / Stim on)** function key to activate the **Stim on** mode. When the test is first loaded the key defaults to the **Stim off** mode.

Deleting a Run

To **Delete** a stored SSFEMG run, follow these steps.

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted and the mean and standard deviation values in the Results table are automatically re-calculated.



Re-analyzing a Run

To review and re-analyze a Run, follow these steps.

- **Select the Run #** you want to re-analyze by performing one of the following.
  - **Turn Knob #1 (Select Run)** until the desired **run #** is highlighted.
  - **Left click** the mouse over the desired **run #** in the **Study** window.
  - **Left click** the mouse over the desired **run #** within the **Results table**.
- Adjust the **Analysis Marker** as needed.
- Adjust the include area (i.e., yellow band) of the **Sequential IPI Plot** as needed.

Saving Changes to Stimulated SFEMG Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the SSFEMG test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

Real Time SFEMG

Performing Real Time SFEMG

The **Real Time SFEMG** test protocol allows for the analysis of jitter during data acquisition. Analysis is based on the peak latency rather than on a rising or falling edge passing through an analysis marker. Up to 4 peaks (not including the triggering peak) can be analyzed simultaneously. Real Time SFEMG streamlines workflow and makes data acquisition and analysis significantly faster than the original SFEMG protocol.

Select the Real Time SFEMG Test:

- **If a Study has already been selected**, simply click on a Real Time SFEMG muscle name (i.e., Right Biceps) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual Real Time SFEMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that when a muscle is selected, it is displayed within the Study window.

If the Real Time SFEMG test protocol is not shown in your Study/Test menu, click here for instructions on how to insert this protocol into your menu.

Once the muscle has been selected. Follow these steps for performing routine Real Time SFEMG data acquisition and analysis:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate. Only Channel 1 can be used in the Real Time SFEMG test protocol.

   Typical Settings for Real Time SFEMG

   Gain = 100 uV/Div

   Hicut = 10k Hz

   Locut = 500 Hz (1 kHz for Concentric needle)

   Sweep Speed = 0.5 ms/Div

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Insert the SFEMG or Concentric Needle Electrode.**

4. **Adjust the Gain and Sweep Speed as necessary.**

   During Real Time SFEMG data acquisition you can easily adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

   You can also use the mouse to change these settings in the **Real Time SFEMG Controls** window.

5. **Adjust the Volume**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume knob** on the left hand side of the base unit.

6. **Adjust Trigger Level & Delay**

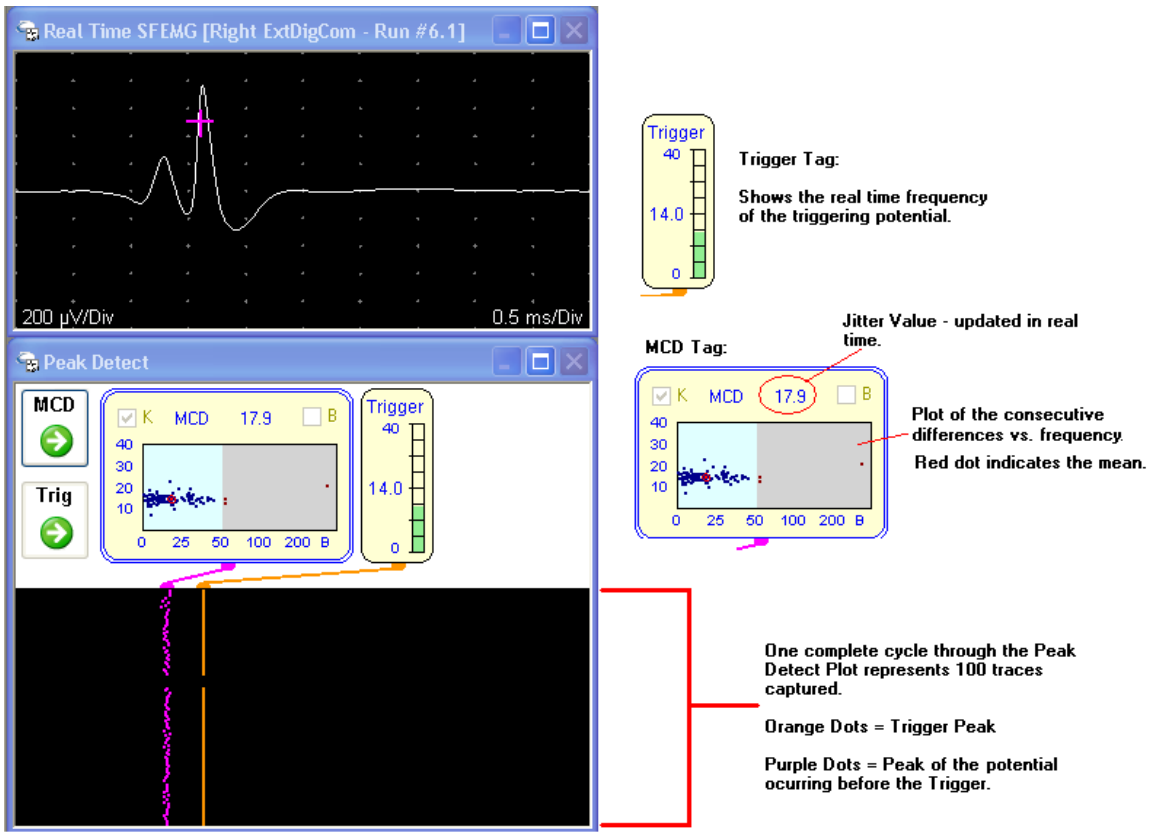
   Knob #3 (Trig Lev /Trig Del) defaults to the **Trig Lev** mode, turn this knob to move the position of the trigger level (horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the sweep is added to the capture buffer and the Peak Detect window is updated. Press the knob to activate **Trig Del** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in tenth of a division increments. Changing the delay point allows you to see more or less data after the triggering potential.

    The **mouse** can also be used to move the **Trigger Level/Delay** indicator.

    The Peak Detect window (& trace buffer) are automatically cleared whenever the trigger indicator is moved a significant amount. This feature can be disabled in the Real Time SFEMG Test Setup window.

7. **Acquire SFEMG Potentials**

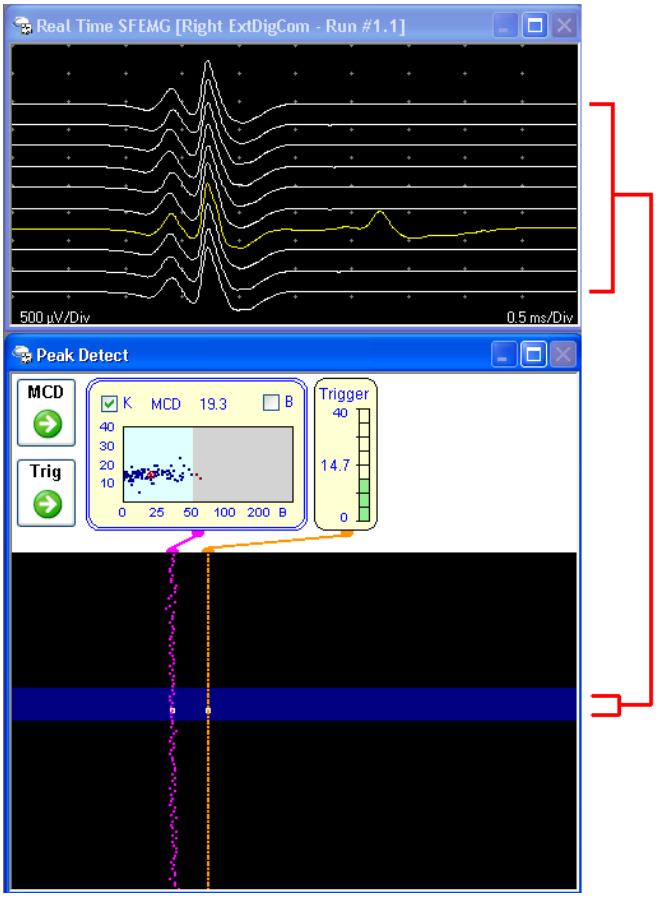
   Once the appropriate SFEMG signal is located and the Trigger and Delay positions have been adjusted, acquire SFEMG potentials until the Peak Detect window makes one complete cycle (one cycle represents 100 captured traces).



8. Stop Data Acquisition

Press the **Run/Stop key** on the Sierra Wave base unit to stop data acquisition. This will change the display to the **Analysis mode**.

In analysis mode, the **Trigger Tag** displays the mean frequency for the entire run and the trace area shows the captured sweeps in groups of ten.



9. Manually Reject Traces (Optional)

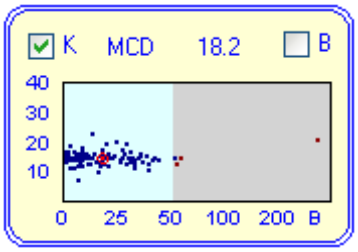
Traces can be manually excluded from the analysis by one of the following methods:

- **Rejecting traces using the mouse** - select a trace by left-clicking over it with the mouse. Once selected the trace is displayed in yellow color. Now, right-click and select **Reject Selected Trace** from the pop-up menu, this removes the trace from the analysis and the jitter value is updated. Rejected traces are displayed in light blue color. You can re-accept a rejected trace by selecting it, then right-click to remove the check mark next to Reject Selected Trace.
- **Use Knob #3 (Zoom Box) and Knob #4 (Trace Sel / Reject)** - turn **Knob #3 (Zoom Box)** to move through the captured trace buffer in groups of ten. Use **Knob #4 (Trace Sel / Reject)** to move the yellow highlight to the trace you want to reject, then press the knob to reject the trace. You can re-accept a rejected trace by first selecting it then pressing Knob #4 again.

10. Verify the Keep (K) and Block (B) check boxes in the MCD Tag.

By default, the **Keep (K)** box is checked for each detected peak. If you do not wish to keep the data for a particular peak then you should un-check this box. When the Store key is pressed, all peaks with a check mark in the **Keep (K)** box will be added to the results table.

If a check mark appears in the **Block (B)** box this indicates that the program has detected blocking for that peak. You can override the program by un-checking this box. When the Store key is pressed, all peaks with a check mark in the **Block (B)** box will have the notation of "Yes" entered in the Blocks column of the results table.



MCD Tag.

If the jitter value is normal for the individual potential pair, the **Block (B)** box will not be automatically checked by the program as this is probably due to artifact in the data. Blocking does not occur when the jitter is normal.

If there is more than one peak detected, use the **Next Tag button** 

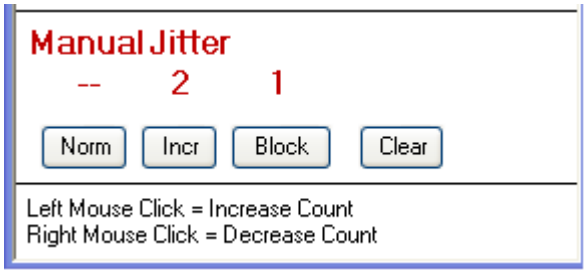
to expand the other MCD tags.

Use the **Change Trigger button** 

when you would like to select a different potential as the trigger peak. All jitter data is automatically recalculated when the trigger is changed.

11. (Optional) Manually record a Potential Pair

Use the **Norm**, **Incr**, or **Block** buttons within the **Fiber Density window** to manually record a potential pair that is not detected by the automatic peak detection algorithm.

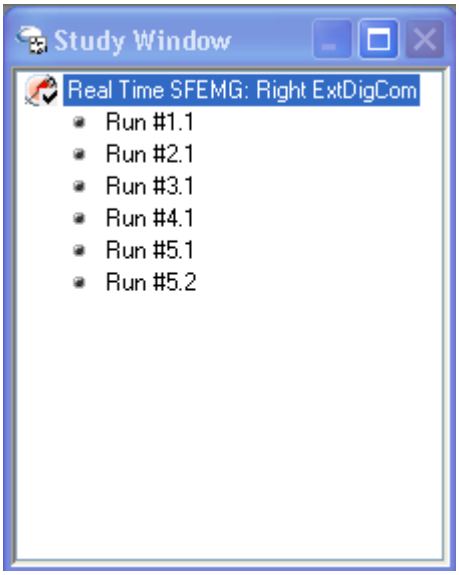


These values are automatically included in the % Normal Pairs, % Abnormal Pairs, and % Blocks summary calculations.

12. Store the Run

Press the **Store key** on the Sierra Wave base unit to **keep the run**, the jitter data for each peak is entered into the results table and the jitter histogram is updated.

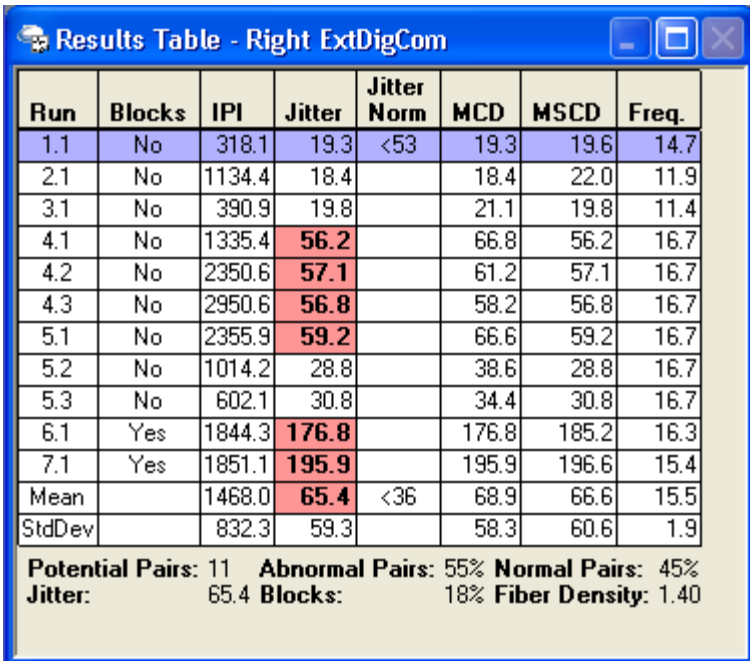
As each SFEMG run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows five runs stored for the Right Ext Dig Com muscle. Run #5 had two peaks analyzed (#5.1 and #5.2).



Study window.

If you decide not to keep any data for the run, do not press the Store key, simply return to the Acquisition mode by pressing the **Run/Stop key** and the run will be discarded.

The **Results Table** records the analysis results for each run and calculates the mean and standard deviation values.



Run	Blocks	IPI	Jitter	Jitter Norm	MCD	MSCD	Freq.
1.1	No	318.1	19.3	<53	19.3	19.6	14.7
2.1	No	1134.4	18.4		18.4	22.0	11.9
3.1	No	390.9	19.8		21.1	19.8	11.4
4.1	No	1335.4	**56.2**		66.8	56.2	16.7
4.2	No	2350.6	**57.1**		61.2	57.1	16.7
4.3	No	2950.6	**56.8**		58.2	56.8	16.7
5.1	No	2355.9	**59.2**		66.6	59.2	16.7
5.2	No	1014.2	28.8		38.6	28.8	16.7
5.3	No	602.1	30.8		34.4	30.8	16.7
6.1	Yes	1844.3	**176.8**		176.8	185.2	16.3
7.1	Yes	1851.1	**195.9**		195.9	196.6	15.4
Mean		1468.0	**65.4**	<36	68.9	66.6	15.5
StdDev		832.3	59.3		58.3	60.6	1.9

Potential Pairs: 11 **Abnormal Pairs:** 55% **Normal Pairs:** 45%
Jitter: 65.4 **Blocks:** 18% **Fiber Density:** 1.40

Results Table.

Table Columns:

Run – indicates the run #. If a run contains more than one analyzed potential pair, it is indicated by .2, .3, .4. If the run was acquired using stimulation, an 's' will be added to this value.

Blocks – a value of "Yes" indicates blocking occurred.

IPI – displays the mean Inter-Potential Interval in microseconds (usec).

Jitter – displays the lowest value of either the MCD or MSCD in microseconds (usec). The user can right-click on this value and select Swap Jitter Value, this will display the larger of the two values in this field.

Jitter Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

MCD – the jitter as calculated by using the Mean Consecutive Difference for the run.

MSCD – the jitter as calculated by using the Mean Sorted Consecutive Difference for the run.

Freq. – displays the mean firing frequency of the triggering potential in hertz (Hz).

Summary Data:

Potential Pairs - displays the total number of potential pairs (automatic & manual) that have been recorded.

Abnormal Pairs % - indicates the percentage of runs with increased jitter for individual potential pairs.

Normal Pairs % - indicates the percentage of runs with normal jitter for individual potential pairs.

Jitter - displays the mean jitter value for the muscle.

Blocks % – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

13. Acquire additional Runs.

Press the **Run/Stop key** to return to **Acquistion mode** and repeat **steps 6 through 11** to acquire additional runs. Typically 20 runs should be collected for the muscle.

14. Select Next Muscle (optional)

From Acquisition mode, turn **Knob #1 (Study Item)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the next muscle from the list.

Move the SFEMG or Concentric Needle Electrode to the new muscle and repeat the above steps as necessary.

 It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

15. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

16. Next Test

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (Real Time SFEMG)

The functions assigned to the Sierra Wave base unit's Knob and F Key controls will vary depending on whether the system is in **Acquisition** mode or **Analyze** mode.

Analyze mode is entered by pressing the **Run/Stop** key.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs (with Stimulation Off)

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Trig Lev / Trig Delay - this knob defaults to the **Trig Lev** mode, turn the knob to change the vertical position of the trigger level indicator. Press

the knob to activate the **Trig Delay** mode, then turn to change the trigger delay position from 1 to 9 divisions in 0.1 division increments.

Gain / Sweep - turn the knob to change the gain of the SFEMG trace. Press the knob, then turn to change the sweep speed of the SFEMG trace.

Knobs (with Stimulation On)

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press this knob to switch to the **Pulse Width** mode and then turn to increase or decrease the electrical stimulus pulse width, the current value (in microseconds) is displayed on the knob icon.

Gain / Sweep - turn the knob to change the gain of the SSFEMG trace. Press the knob, then turn to change the sweep speed of the SSFEMG trace.

F Keys

Stim off / Stim on - defaults to **Stim off** mode, press to activate **Stim on** mode and initiate data acquisition with stimulus delivery.

Muscle List - opens the Real Time SFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Analyze mode

Knobs

Run Select - turn this knob to highlight and review stored runs in the Results table. When the run is highlighted the first 10 traces for that run will be displayed in the trace window and the Peak Detect window will updated.

Zoom Box - turn this knob to move through the capture buffer in groups of ten traces at a time. The dark blue highlight in the Peak Detect window indicates the current position of the Zoom Box.

Trace Sel / Reject - defaults to the **Trace Sel** mode, turn this knob to select a SFEMG trace. When selected, the trace will be displayed in yellow color. Press the knob to **Reject** the selected trace and remove it from the analysis.

F Keys

Overlay / Raster - defaults to **Raster** mode, in this mode the traces are evenly separated within the trace window. Press to activate **Overlay** mode, in this mode the traces are superimposed on top of one another.

Muscle List - opens the Real Time SFEMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

Real Time SFEMG Test Setup

SFEMG test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

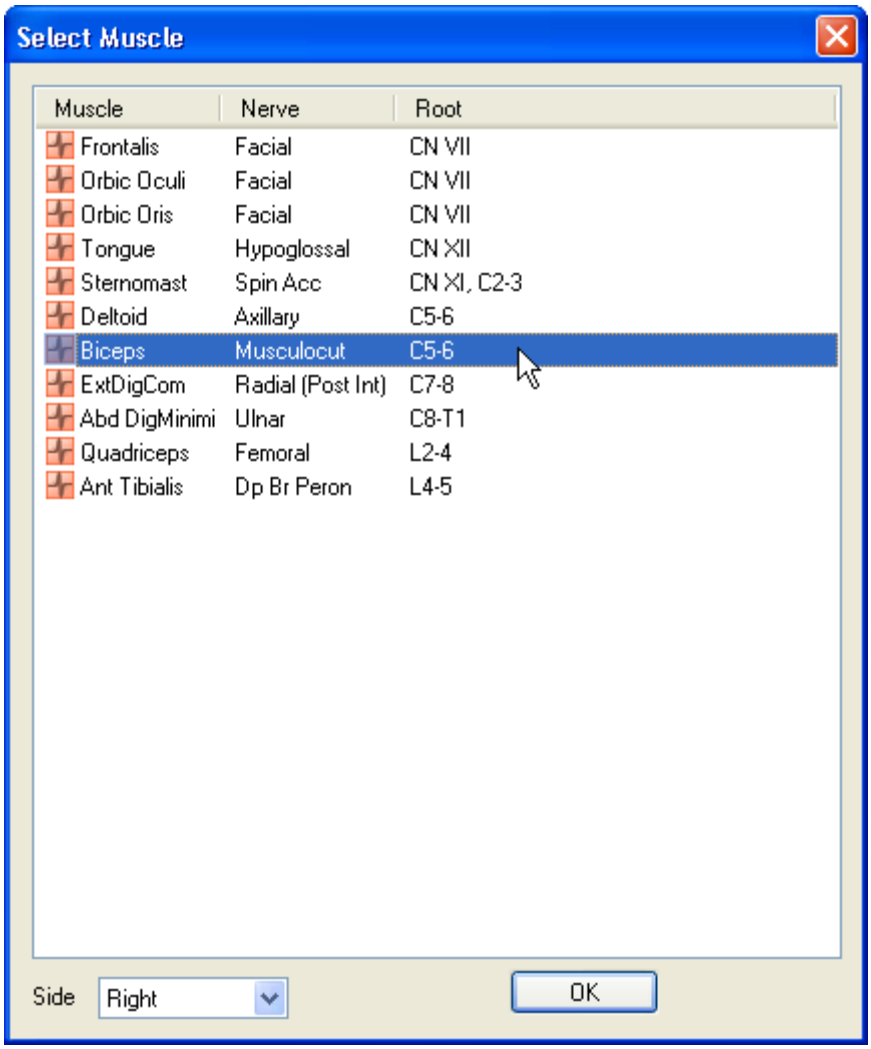
Click here, to go to this topic.

Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the Real Time SFEMG Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the Real Time SFEMG Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight**

the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

 Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

 Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

Real Time SFEMG Trace Window

The contents of the Trace Area will varying depending on whether the program is in the **Acquisition** or **Analysis** modes.

Acquisition Mode

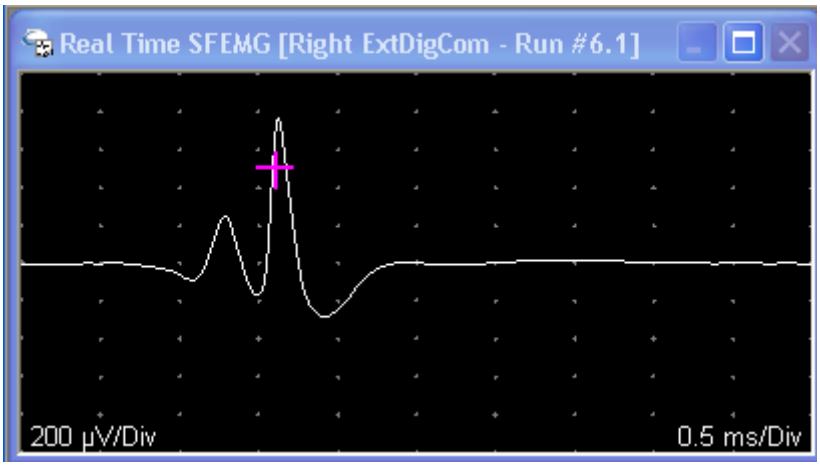
Displays the volitional SFEMG activity. Adjust the Gain and Sweep Speed by using **Knob #4 (Gain / Sweep)** on the Sierra Wave base unit. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

Adjust the **Trigger Level and Delay** by using **Knob #3 (Trig Lev /Trig Del).** Turn this knob to move the position of the trigger level (horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the sweep is added to the capture buffer and the Peak Detect window is updated. Press the knob to activate **Trig Del** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in 0.1 division increments. Changing the delay point allows you to see more or less data after the triggering potential.

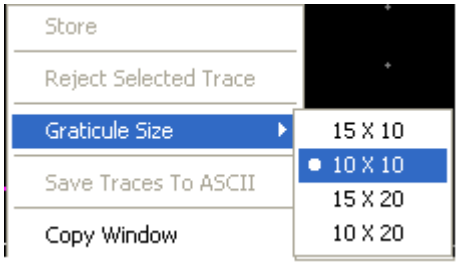
 The **mouse** can also be used to move the **Trigger Level/Delay** indicator.

The Peak Detect window (& trace buffer) are automatically cleared whenever the trigger indicator is moved a significant amount. This feature can be disabled in the Real Time SFEMG Test Setup window.

Right-clicking on the trace area displays a menu of functions that can be used.



Trace window in Real Time SFEMG Acquisition mode.



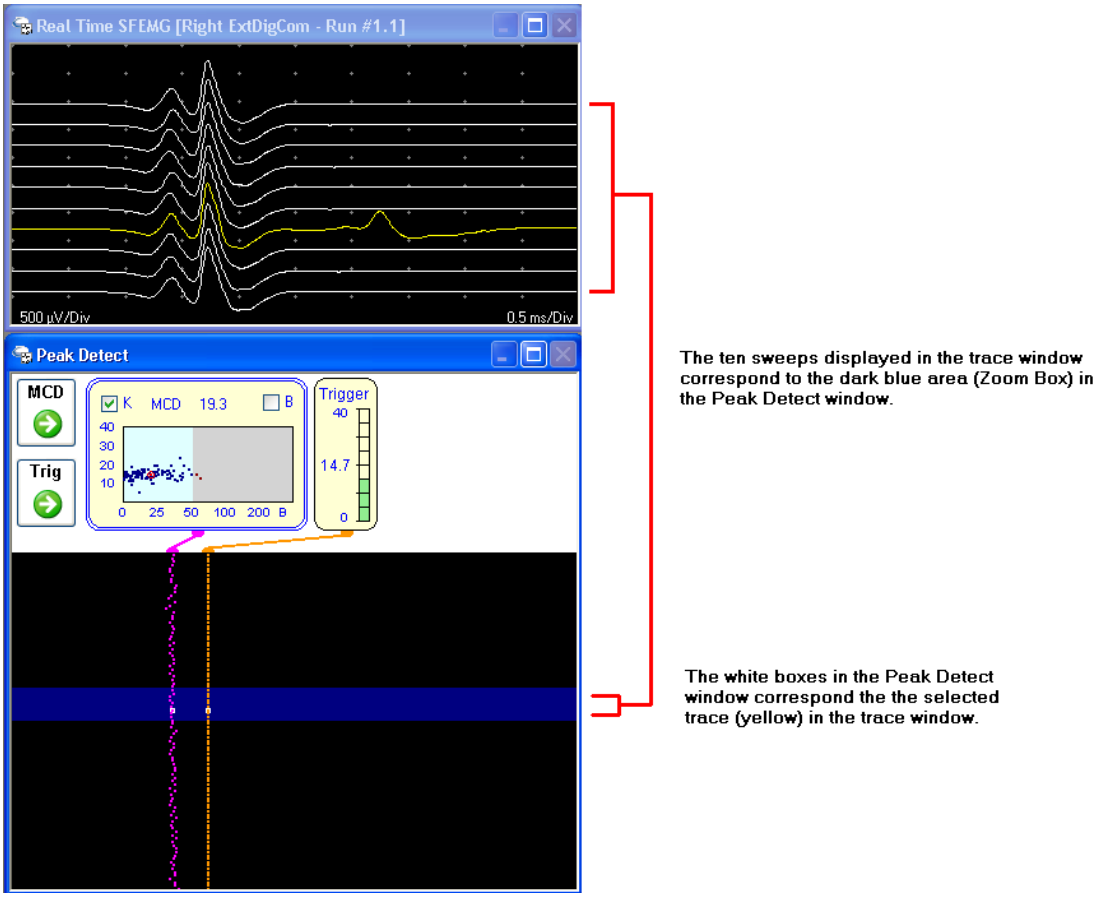
Right-click menu.

Graticule Size: The Real Time SFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

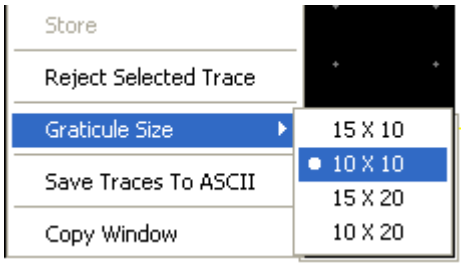
Copy Window: Copies the contents of the Real Time SFEMG trace window to the clipboard.

Analysis Mode

Displays the traces in the capture buffer in groups of ten. Right-clicking on the trace area displays a menu of functions that can be used.



Trace window in Real Time SFEMG Analysis mode.



Right click menu.

Store: Stores the run to disk. This is the same function as pressing the Store key on the base unit.

Reject Selected Trace: Marks the selected trace as "manually rejected" which colors it light-blue and removes it from the analysis.

Graticule Size: The Real Time SFEMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Save Traces to ASCII: Allows all the displayed traces to be output to a comma separated values file (*csv). For more information on using the ASCII Output Utility click here.

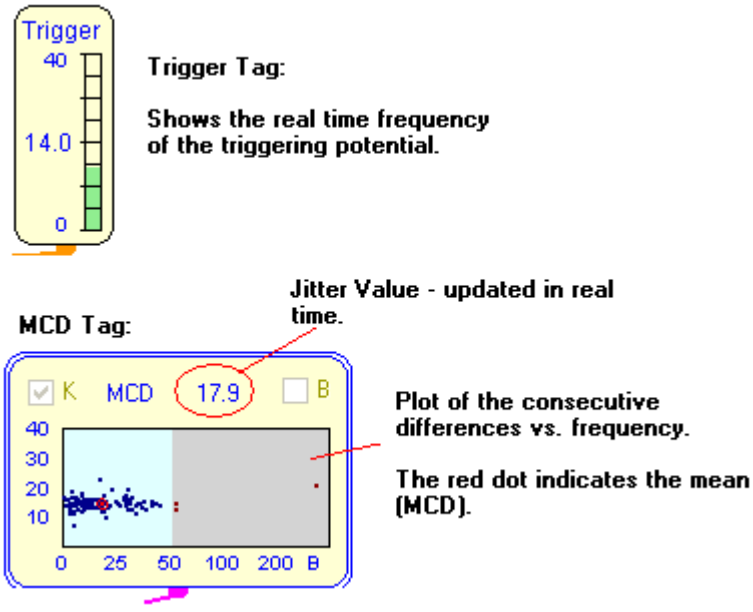
Copy Window: Copies the contents of the Real Time SFEMG trace window to the clipboard.

Peak Detect Window

The Peak Detect window is composed of two areas; the **Peak Tag** area and the **Peak Plot** area. Both of these areas are updated in real time during data acquisition. Peak detection is based on an algorithm that uses a combination of amplitude, sharpness, and repeatability.

Peak Tag Area:

This area displays a firing frequency tag for the triggering potential and a consecutive discharge vs. frequency plot for up to four other peaks.



The dividing line between the light blue and gray areas is the individual jitter norm that has been entered for the muscle.

By default, the **Keep (K)** box is checked for each detected peak. If you do not wish to keep the data for a particular peak then you should un-check this box. When the Store key is pressed, all peaks with a check mark in the **Keep (K)** box will be added to the results table.

If a check mark appears in the **Block (B)** box this indicates that the program has detected blocking for that peak. You can override the program by un-checking this box. When the Store key is pressed, all peaks with a check mark in the **Block (B)** box will have the notation of "Yes" entered in the Blocks column of the results table.

If the jitter value is normal for the individual potential pair, the **Block (B)** box will not be automatically checked by the program as this is probably due to artifact in the data. Blocking does not occur when the jitter is normal.

If there is more than one peak detected, use the **Next Tag button** 

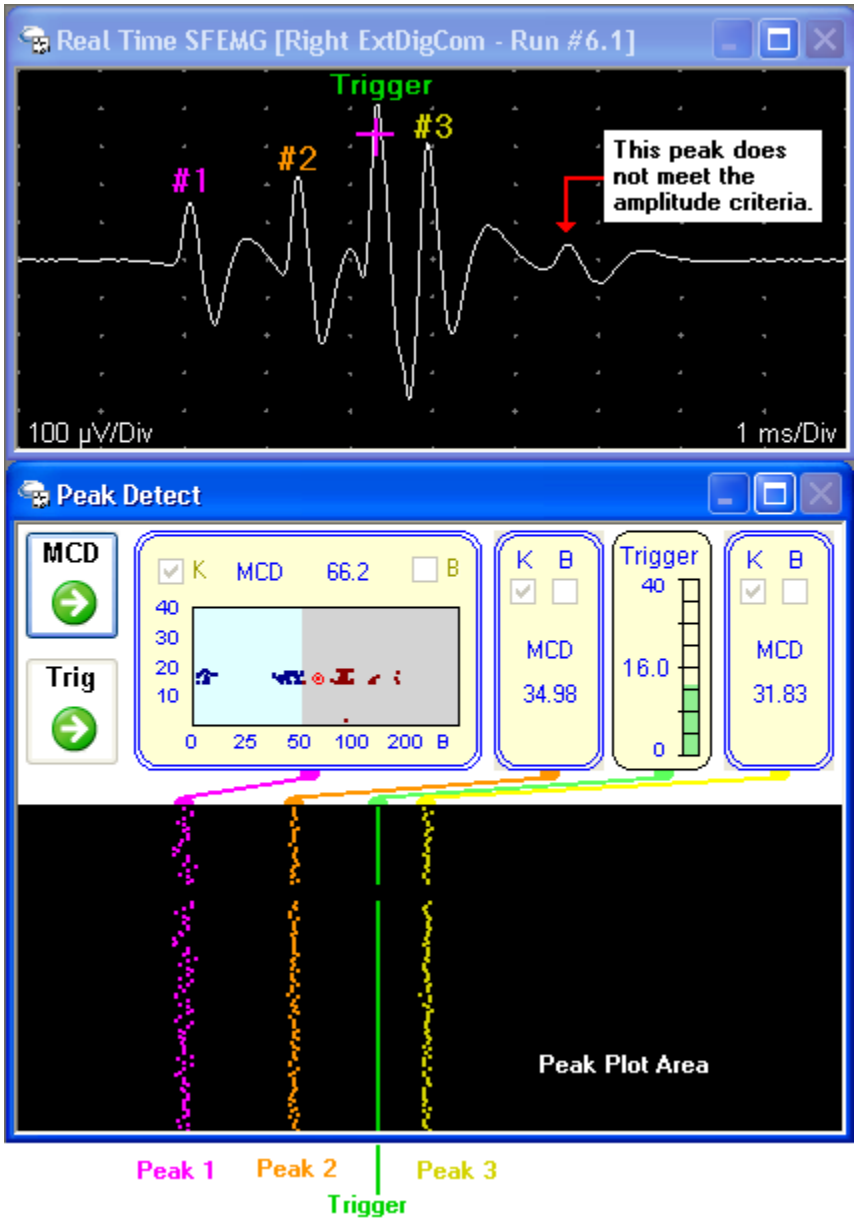
to expand the other MCD tags.

Use the **Change Trigger button** 

when you would like to select a different potential as the trigger peak. All jitter data is automatically recalculated when the trigger is changed.

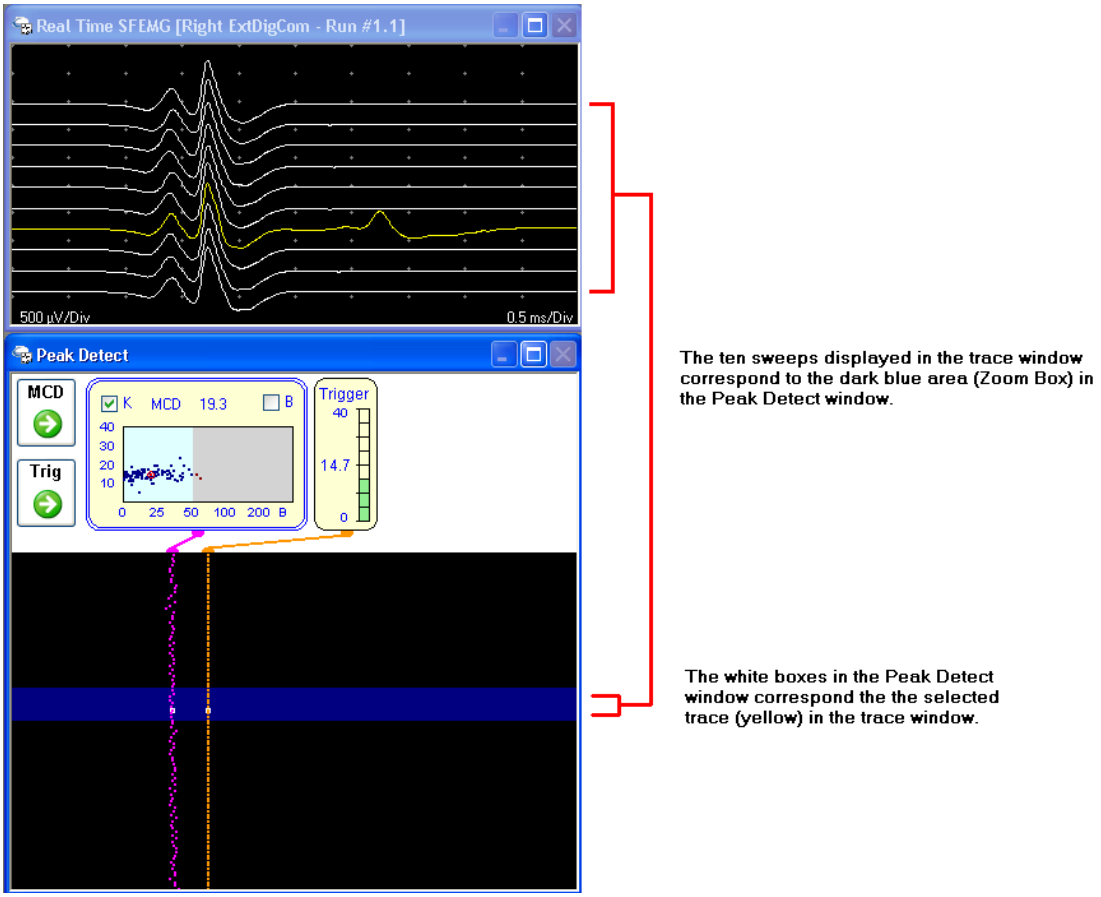
Peak Plot Area:

For each captured trace a colored dot is drawn representing the peak of the triggering potential and up to four other time-locked peaks. Each peak is given a unique color. This area is updated in a waterfall fashion, one complete cycle through this area represents 100 captured traces.



Peak Plot Area, showing relationship to peaks in the Trace window.

In analysis mode, this area shows a dark-blue highlight, called the Zoom Box.



Peak Plot Area, in analysis mode with Zoom Box.

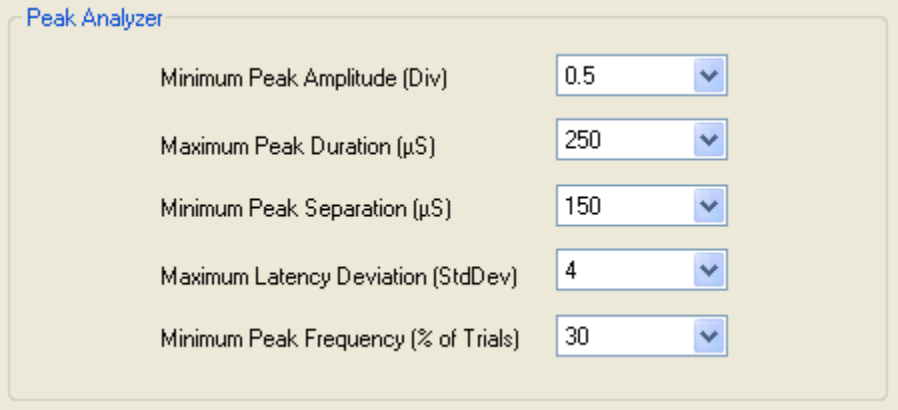
Peak Detection Criteria

The following five criteria are used to determine a valid peak:

1. **Peak Amplitude** - initial peak detection is based on amplitude. A peak is detected if the 'baseline-to-peak' or 'trough-to-peak' amplitude exceeds 0.5 or 0.25 divisions. So, if the amplitude criteria is set to 0.5 and the gain is set to 100 uV/Div, the signal must be at least 50 uV in amplitude to be considered as a possible peak. This criteria is used to keep spurious baseline noise from being detected as peaks. The default value is **0.5** divisions.

2. **Peak Duration (Width)** - when a peak is found its width (duration) is measured at the halfway point of its amplitude. We go down from the peak on each side to the halfway point and then measure the duration across this imaginary line. The width, or duration, must be less than or equal to 250, 300, or 350 us. If it is greater than this it is not 'spikey' or 'sharp' enough to be included in the analysis. The default value is **250** us.

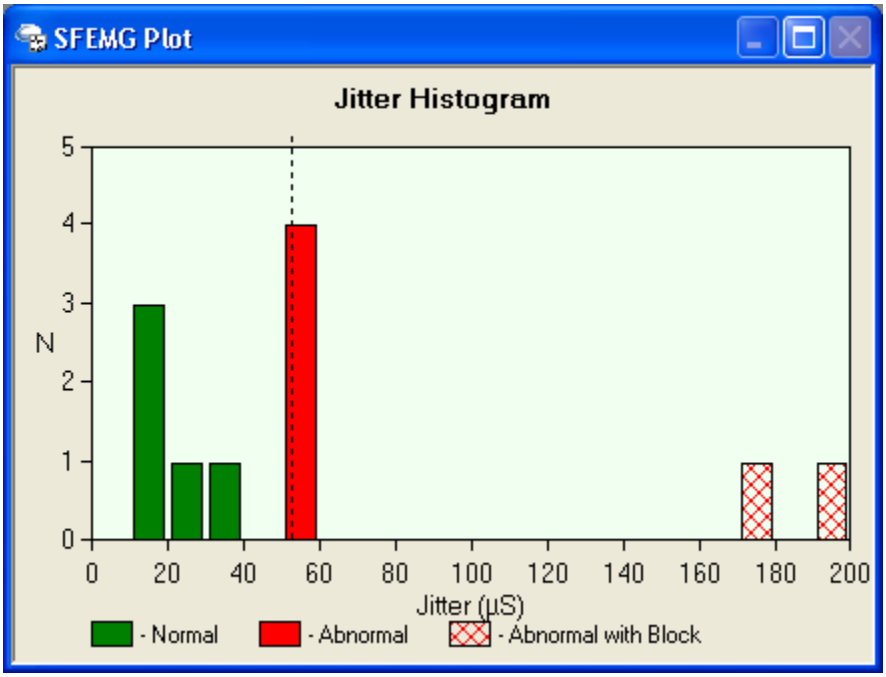
3. **Peak Separation** - a peak must be separated from other peaks by at least 150, 100, or 50 us. The default value is **150** us.
4. **Latency Deviation** - the peak latency (or position) must be within +/- 4, 3, or 2 standard deviations of the mean latency for that peak. The default value is **4** SD.
5. **Peak Frequency** - the peak must occur in at least 30, 20, 10 or 0% of the trials, or it will be excluded. The default value is **30**%.



The peak detection criteria must be adjusted prior to data acquisition.

Jitter Histogram Window

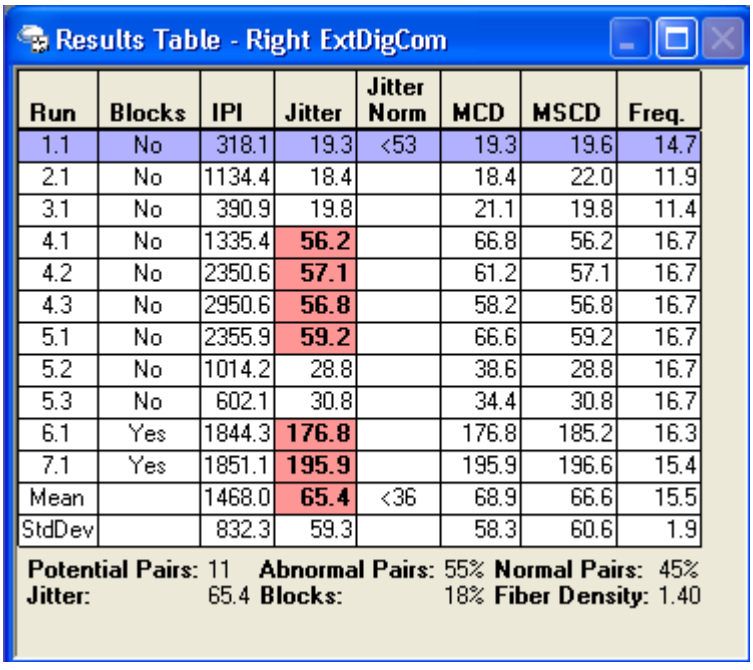
This histogram provides a quick summary of the data collected for the muscle. The vertical axis marks the count, while the horizontal axis indicates jitter (in microseconds, us). The height of colored bar graphs indicates the number of runs containing that amount of jitter. Normal jitter is indicated by green bars, abnormal jitter as red bars, and abnormal jitter with blocking as red cross-hatched bars. A dashed line marks the jitter norm for individual potential pairs in the muscle.



Jitter Histogram.

Table Options

Clicking on a row in the Results Table highlights that row and allows that run's trace data to be reviewed. Right-clicking within the table will display a menu of options.



Run	Blocks	IPI	Jitter	Jitter Norm	MCD	MSCD	Freq.
1.1	No	318.1	19.3	<53	19.3	19.6	14.7
2.1	No	1134.4	18.4		18.4	22.0	11.9
3.1	No	390.9	19.8		21.1	19.8	11.4
4.1	No	1335.4	**56.2**		66.8	56.2	16.7
4.2	No	2350.6	**57.1**		61.2	57.1	16.7
4.3	No	2950.6	**56.8**		58.2	56.8	16.7
5.1	No	2355.9	**59.2**		66.6	59.2	16.7
5.2	No	1014.2	28.8		38.6	28.8	16.7
5.3	No	602.1	30.8		34.4	30.8	16.7
6.1	Yes	1844.3	**176.8**		176.8	185.2	16.3
7.1	Yes	1851.1	**195.9**		195.9	196.6	15.4
Mean		1468.0	**65.4**	<36	68.9	66.6	15.5
StdDev		832.3	59.3		58.3	60.6	1.9

Potential Pairs: 11 **Abnormal Pairs:** 55% **Normal Pairs:** 45%
Jitter: 65.4 **Blocks:** 18% **Fiber Density:** 1.40

Real Time SFEMG Results Table

Right-click menu.

Font Size: The font size of the table can be increased or decreased. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

Copy Table: Copies the contents of the Real Time SFEMG table to the Windows clipboard.

Delete Run: This will delete the highlighted row from the table and all the data for that run.

Swap Jitter Value: Selecting this option will cause the larger value between MCD and MSCD to be displayed in the Jitter field. By default, the lower value of the two is displayed in the Jitter field.

Table Columns:

Run – indicates the run #. If a run contains more than one analyzed potential pair, it is indicated by .2, .3, .4. If the run was acquired using stimulation, an 's' will be added to this value.

Blocks – a value of "Yes" indicates blocking occurred.

IPI – displays the mean Inter-Potential Interval in microseconds (usec).

Jitter – displays the lowest value of either the MCD or MSCD in microseconds (usec). The user can right-click on this value and select Swap Jitter Value, this will display the larger of the two values in this field.

Jitter Norm – the value on the first row of the table is the jitter norm for individual potential pairs. The value in the mean row of the table is the overall MCD jitter norm for the muscle.

MCD – the jitter as calculated by using the Mean Consecutive Difference for the run.

MSCD – the jitter as calculated by using the Mean Sorted Consecutive Difference for the run.

Freq. – displays the mean firing frequency of the triggering potential in hertz (Hz).

Summary Data:

Potential Pairs - displays the total number of potential pairs (automatic & manual) that have been recorded.

Abnormal Pairs % - indicates the percentage of runs with increased jitter for individual potential pairs.

Normal Pairs % - indicates the percentage of runs with normal jitter for individual potential pairs.

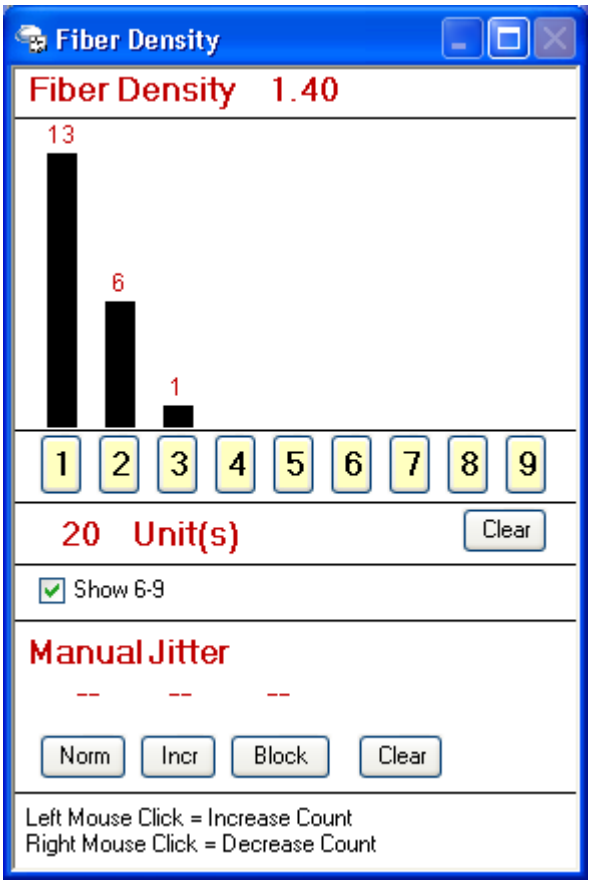
Jitter - displays the mean jitter value for the muscle.

Blocks % – indicates the percentage of runs with blocking potentials.

Fiber Density - displays the fiber density value from the Fiber Density window.

Fiber Density

The top portion of the **Fiber Density** window is used to record the results of fiber density studies. Count the number of time-locked potentials in the trace and then record that value by clicking on the corresponding button in the Fiber Density window. The program computes the fiber density by taking the total count and dividing it by the number of entries (units). The fiber density value is recorded in the results table and is included in reports.



Fiber Density window.

In the above example:

Fiber Density = (13 x 1) + (6 x 2) + (1 x 3) / (13 + 6 + 1)

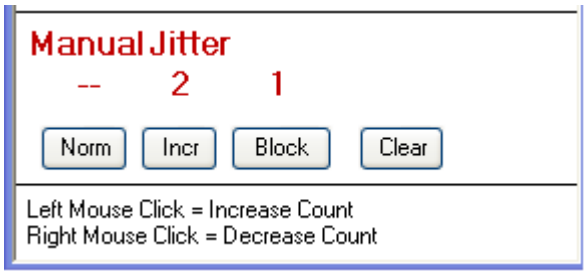
= 13 +12 + 3 / 20

= 28 / 20

= 1.40

Manual Jitter

Use the buttons in the bottom portion of the Fiber Density window to manually record **Normal** , **Increased,** or **Blocking** potential pairs that are not detected by the automatic peak detection algorithm.



These values are automatically included in the % Normal Pairs, % Abnormal Pairs, and % Blocks summary calculations.

Deleting a Run

To **Delete** a stored Real Time SFEMG run, perform one of the following procedures.

Using the Study Window:

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted and the mean and standard deviation values in the Results table are automatically re-calculated.

Using the Results Table:

- **Right click** over the row in the table corresponding to the run you want to delete.
- From the pop-up menu, select **Delete Run**.

Reviewing a Run

To review a Run, follow these steps.

- **Select the Run #** you want to view by performing one of the following.
  - **Turn Knob #1 (Select Run)** until the desired **run #** is highlighted.
  - **Left click** the mouse over the desired **run #** in the **Study** window.
  - **Left click** the mouse over the desired **run #** within the **Results table**.

The data for that run will be displayed in the Trace and Peak Detect windows.

Saving Changes to Real Time SFEMG Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the Real Time SFEMG test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

Macro EMG

Performing Macro EMG

Select the Macro EMG Test:

- **If a Study has already been selected**, simply click on a Macro EMG muscle name (i.e., Right Biceps) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual Macro EMG test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that when a muscle is selected, it is displayed within the Study window.

Once the muscle has been selected. Follow these steps for performing routine Macro EMG data acquisition and analysis:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate. Macro EMG utilizes a 2-Channel recording setup.

Typical Settings

	Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
Channel 1: SFEMG signal	50 to 200	10 kHz	500	0.5
Channel 2: Averaged Macro signal	50 to 200	10 kHz	10 to 30	5.0

   Connect the Macro needle electrode to channel 1. Use a reference jumper to connect the cannula of the Macro needle to the active input of channel 2. Connect a surface reference electrode to the reference input of channel 2.

2. **Verify the Side**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Insert the Macro Needle Electrode.**

Move the needle until a stable signal with at least one sharp negative peak is shown on the single fiber channel.

4. **Adjust the Gain and Sweep Speed as necessary.**

   During Macro data acquisition you can easily adjust the Gain and Sweep Speed by using **Knobs #3 and #4** on the Sierra Wave base unit. **Knob #3 (SF Gain/SF Sweep)** is used to adjust the SFEMG signal settings and **Knob #4 (Mcr Gain/Mcr Sweep)** can be used to adjust the Macro signal settings. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

   You can also use the mouse to change these settings in the **Macro EMG Controls** toolbar.

Macro EMG controls toolbar.

5. **Adjust the Volume**

   Increase or decrease the Sierra Wave's internal speaker by using the **Volume knob** on the left hand side of the base unit.

6. **Adjust Trigger Level & Delay**

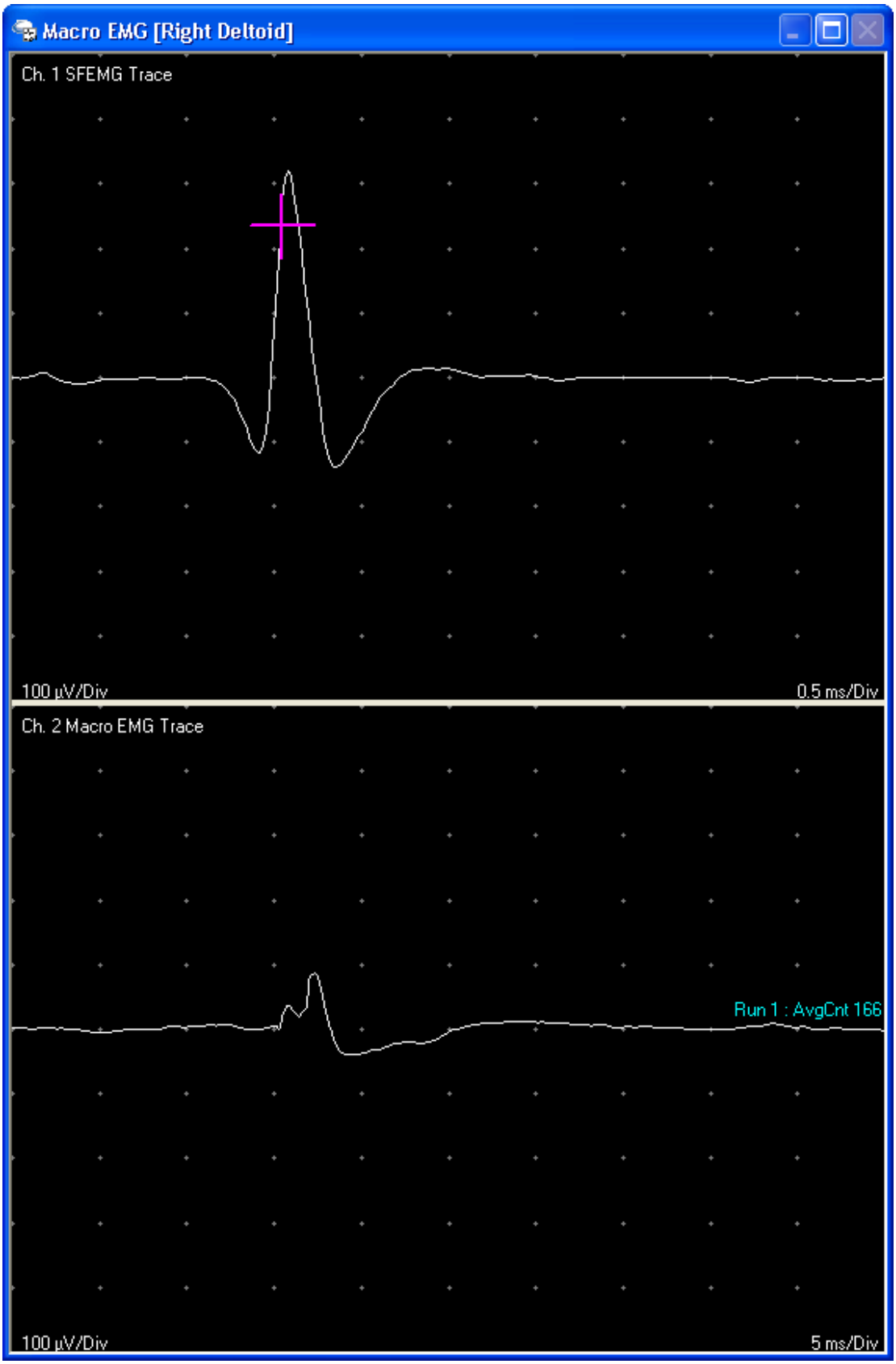
   Adjust the trigger/delay cursor so that you can trigger on the sharp negative peak. **Knob #2 (Trig Level /Trig Delay)** defaults to the **Trig Level** mode, turn this knob to move the position of the trigger level (horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the macro signal average count is incremented. Press the knob to activate **Trig Delay** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in one division increments. Changing the delay point allows you to see more or less data after the triggering potential.

   The **mouse** can also be used to move the Trigger Level/Delay indicator.

   The Macro trace **average count is automatically reset** whenever the position of the trigger & delay indicator is changed.

7. **Acquire Data**

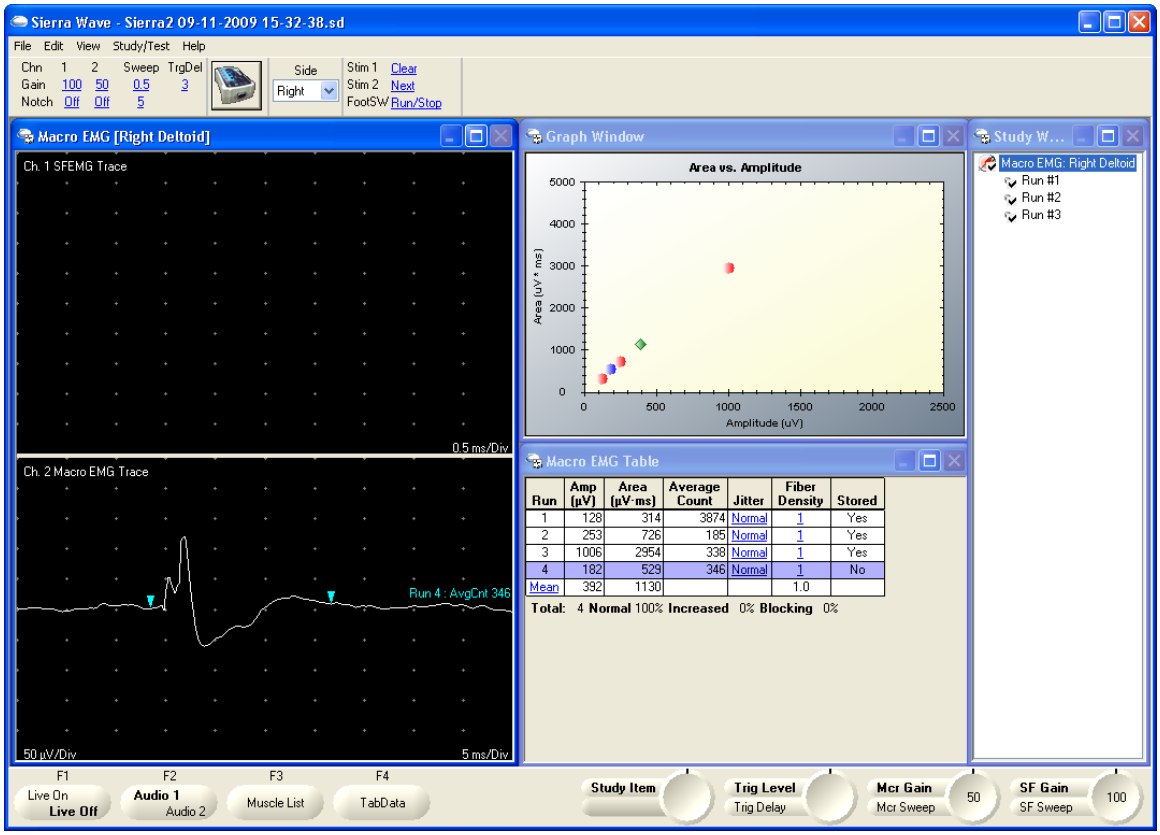
   Once the appropriate SFEMG signal is located and the Trigger and Delay positions have been adjusted appropriately, allow the Macro signal to average until a stable baseline is achieved in the Macro trace.


Macro EMG [Right Deltoid]
Ch. 1 SFEMG Trace
100 µV/Div
0.5 ms/Div
Ch. 2 Macro EMG Trace
Run 1 : AvgCnt 166
100 µV/Div
5 ms/Div

Macro EMG acquisition mode. The SFEMG trace and trigger/delay indicator are shown in the top half of the window. The averaged Macro trace is shown in the bottom half of the window. The current average count is shown in the trace label of the Macro trace.

8. Stop Data Acquisition

Once the Macro signal is obtained, press the **Run/Stop key** on the Sierra Wave base unit or press the **Footswitch** to stop data acquisition. This will change the display to the **Analysis mode**.



Macro EMG Analysis mode.

9. Verify the Position of the Onset and End Cursors

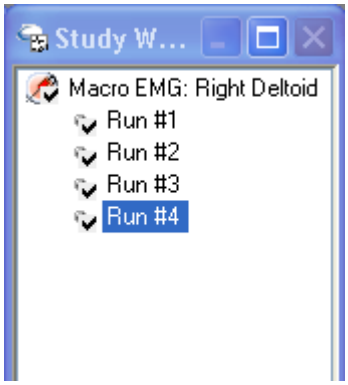
Check the position of the onset and end cursors (shown in light-blue) on the Macro trace. The maximum peak amplitude and area under the curve are calculated between these two cursors. Adjust the positions of these cursors by dragging them with the mouse.

The **run #**, **amplitude (uV)**, **area (uV-ms)** and **average count** will be displayed in the results table. The data for the current run is shown in the Area vs. Amplitude graph as a **blue circle**.

10. Store the Run

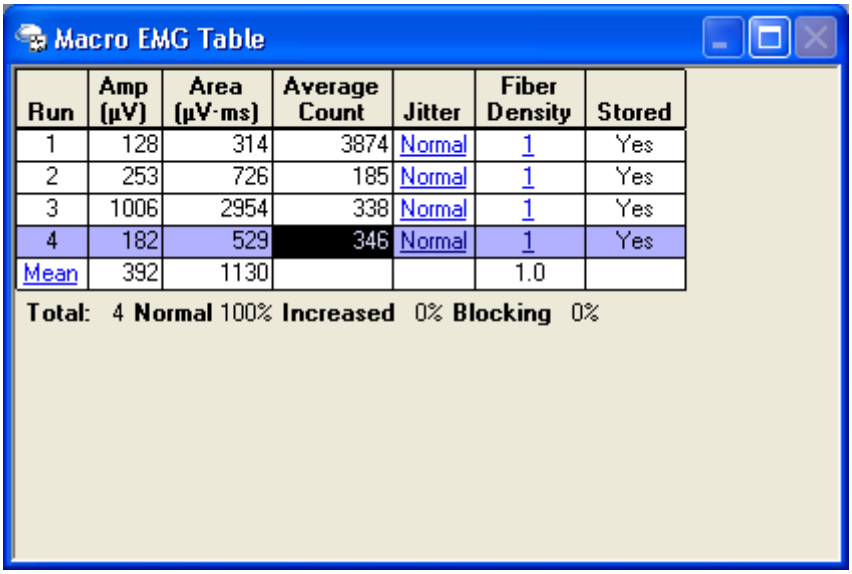
Press the **Store key** on the Sierra Wave base unit to **keep the run**. In the Results Table the "Stored" field will change from No to Yes.

As each Macro EMG run is stored, you will see a new "node" appear in the Study window below the muscle name. The example below shows four runs stored for the Right Deltoid muscle.



If you decide not to keep the run, do not press the Store key, simply return to the Acquisition mode by pressing the **Run/Stop key** and the run will be discarded.

The **Results Table** records the analysis results for each run and calculates the **mean** or **median** values.



Macro EMG Results Table

Run – indicates the run #.

Amp (uV) - maximum amplitude between the onset and end cursors, displayed in microvolts (uV).

Area (uV-ms) - area under the negative & positive portions of the curve between the onset and end cursors, displayed in microvolt/millisecond units.

Average Count - displays the number of averages obtained for that run.

Jitter - optional field for recording a qualitative indication of the jitter observed for the run. Choices are Normal, Increased, and Blocking.

Fiber Density - optional field for recording the fiber density observed for the run.

Stored – indicates if the run has been stored to disk.

Mean / Median - this setting determines how the data for all the runs is summarized. If set to mean, then the summarized data for amplitude and area is shown as the mean values. If set to median, then the summarized data for amplitude and area is shown as the median values. The green diamond in the Area vs. Amplitude graph corresponds to these values.

Fiber Density is always displayed as the mean value, regardless of this setting.

11. Acquire additional Macro EMG Runs.

Press the **Run/Stop key** to return to **Acquistion mode** and repeat **steps 6 through 10** to acquire additional Macro EMG runs. Typically 20 runs should be collected for the muscle.

12. Select Next Muscle (optional)

From Acquisition mode, turn **Knob #1 (Study Item)** to highlight the next muscle in the Study window. If the muscle you want to examine is not displayed within the Study window, press **F3 (Muscle List)** and select the next Macro EMG muscle from the list.

Move the Macro EMG Needle Electrode to the new muscle and repeat the above steps as necessary.

 It is a good idea to turn Off the preamplifier or turn down the Volume when moving the needle electrode to a new location.

13. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

14. Next Test (optional)

- Use **Knob #1 (Study Item)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (Macro EMG)

For Macro EMG, the functions assigned to the Sierra Wave base unit's Knob and F Key controls are the same in Acquisition and Analysis modes.

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Trig Lev / Trig Delay - this knob defaults to the **Trig Lev** mode, turn the knob to change the vertical position of the trigger level indicator. Press the knob to activate the **Trig Delay** mode, then turn to change the trigger delay position from 1 to 9 divisions in 0.1 division increments.

Mcr Gain / Mcr Sweep - turn the knob to change the gain of the Macro EMG trace in channel 2. Press the knob, then turn to change the sweep speed of the Macro EMG trace.

SF Gain / SF Sweep - turn the knob to change the gain of the Single Fiber EMG trace in channel 1. Press the knob, then turn to change the sweep speed of the Single Fiber EMG trace.

F Keys

Live On / Live Off - selecting Live On will show the live Macro EMG trace above the averaged Macro trace.

Audio 1 / Audio 2 - determines which channel is sent to the internal speaker.

Muscle List - opens the Macro EMG Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData Summary window.

Macro EMG Test Setup

Macro EMG test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

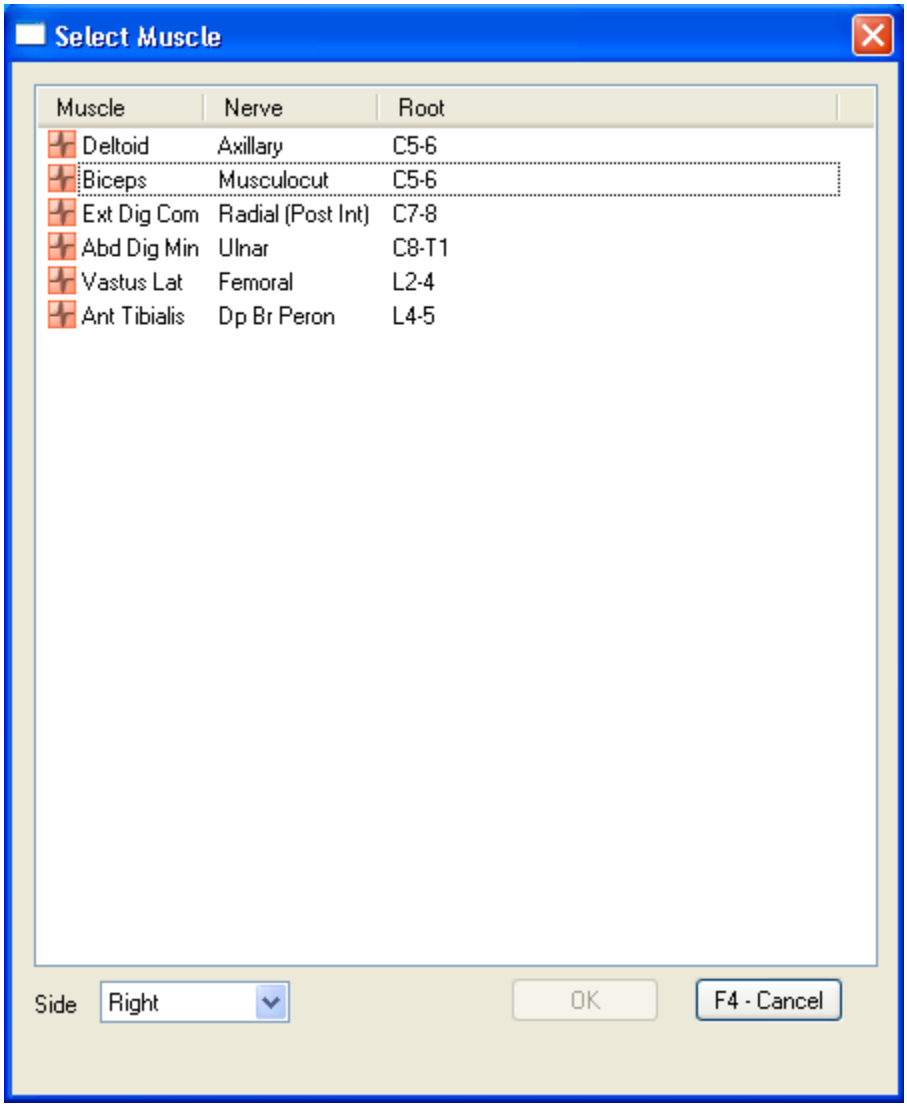
Click here, to go to this topic.

Muscle List (F3)

The **F3 (Muscle List)** function key is a convenient way to add muscles to the Study window after a Study List has been selected or after the Macro EMG Test Protocol has been loaded.

To Add a Muscle to the Study Window

1. From within the Macro EMG Test Protocol, press the **F3 (Muscle List)** function key. The **Select Muscle** window will be displayed.



F3 - Select Muscle window.

2. To add a **single muscle**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted line drawn around the muscle name. **Press** the knob to **highlight** the muscle. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

    - **Using the Mouse** - **verify the Side** parameter and then **double click** on the **muscle name**.

3. To add **multiple muscles**, perform one of the following.

    - **Using the Knobs** - turn **Knob #1 (Muscle Sel / Toggle)** until the appropriate **muscle name** is selected, this is indicated by a dotted

line drawn around the muscle name. **Press** the knob to **highlight** the muscle. Repeat this process until all of the muscles you want to add are highlighted. **Verify the Side** parameter, use **Knob #2 (Side)** to change this if necessary. **Press** the **OK** key on the Sierra Wave base unit.

- **Using the Mouse** - **single click** the mouse over the appropriate muscle names. Once all of the muscles have been selected, **verify the Side** parameter and then click **OK**.

Setting the **Side** parameter to **Left & Right** will add the muscle to the Study window twice, once for the Left and once for the Right.

Adding muscles to the Study window in this manner is only temporary. To add muscles to a Study List permanently, review the help topic "Changing an Existing Study".

Macro EMG Trace Area

The contents of the Macro EMG Trace Area will varying depending on whether the program is in the **Acquisition** or **Analysis** mode.

Acquisition Mode

Displays the volitional SFEMG trace in the top half of the window and the averaged Macro EMG trace in the bottom half of the window.

Adjust the Gain and Sweep Speed by using **Knobs #3 and #4** on the Sierra Wave base unit. **Knob #3 (SF Gain/SF Sweep)** is used to adjust the SFEMG signal settings and **Knob #4 (Mcr Gain/Mcr Sweep)** can be used to adjust the Macro signal settings. Simply turn the knob to adjust the gain, to change the sweep speed, press the knob first to toggle it to the sweep mode, then turn to change the sweep speed.

You can also use the mouse to change these settings in the **Macro EMG Controls** toolbar.

Macro EMG controls toolbar.

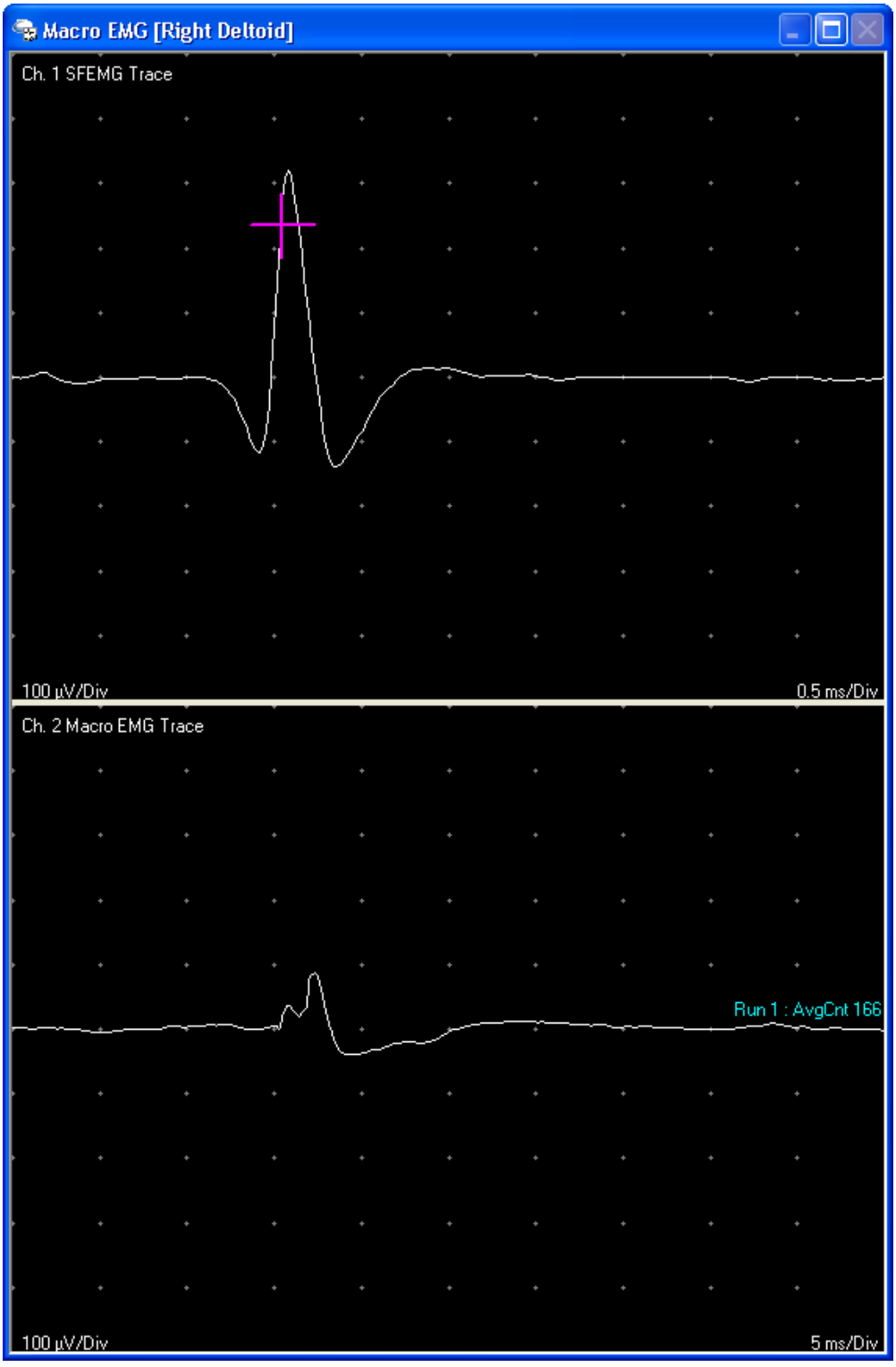
Adjust the trigger/delay cursor so that you can trigger on the sharp negative peak of the SFEMG trace. **Knob #2 (Trig Level /Trig Delay)** defaults to the **Trig Level** mode, turn this knob to move the position of the trigger level

(horizontal portion of purple crosshair) up or down within the trace window. Each time a SFEMG potential crosses the trigger level the macro signal average count is incremented. Press the knob to activate **Trig Delay** mode then turn to move the delay point (vertical portion of purple crosshair) left or right in one division increments. Changing the delay point allows you to see more or less data after the triggering potential.

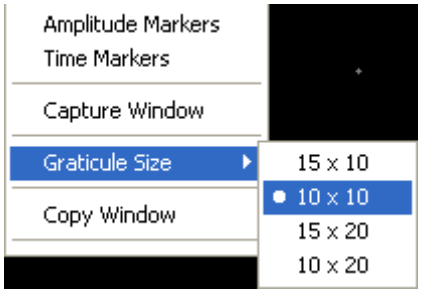
 The **mouse** can also be used to move the Trigger Level/Delay indicator.

 The Macro trace **average count is automatically reset** whenever the position of the trigger & delay indicator is changed.

Right-clicking on the trace area displays a menu of functions that can be used.



Macro EMG acquisition mode. The SFEMG trace and trigger/delay indicator are shown in the top half of the window. The averaged Macro trace is shown in the bottom half of the window. The current average count is shown in the trace label of the Macro trace.



Right-click menu of SFEMG trace area.

Amplitude Markers: Enables amplitude markers within the SFEMG trace area.

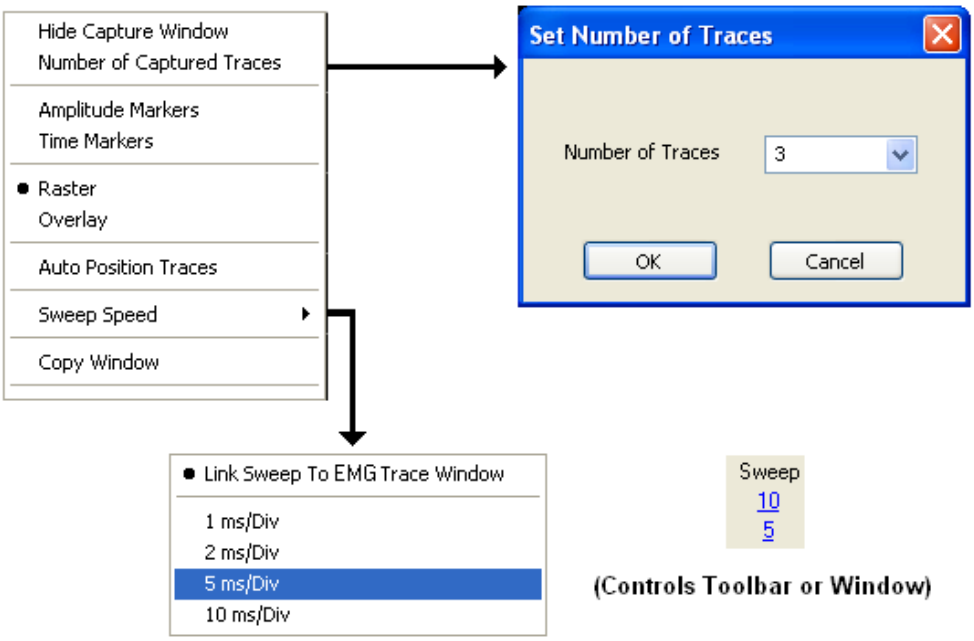
Time Markers: Enables time markers within the SFEMG trace area.

Graticule Size: The Macro EMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Capture Window: When this feature is enabled the SFEMG trace area is split into two sections; the top section shows the live SFEMG trace and the trigger level indicator line, the bottom section shows a rastered display of the most recently captured traces.

Capture Window Options.

When the Capture Window is enabled, right clicking within the capture window trace area will display a pop-up menu of display options.



- **Hide Capture Window** – turns off the capture window.
- **Number of Captured Traces** - changes the number of traces displayed in the captured window trace area. Select 3, 5, or 10 from the drop down list or type in any number between 2 and 100.
- **Amplitude Markers** – enables amplitude markers in the captured window area.
- **Time Markers** – enables time markers in the captured window area.
- **Raster / Overlay** – sets the position of the captured window traces as either rastered or overlayed (i.e., superimposed).
- **Auto Position Traces** - if captured window traces have been moved up/down using the mouse, this option will return the traces to their original positions.
- **Sweep Speed** – the sweep speed of the Live and Capture Window areas can be set independently.
    - **Link Sweep to EMG Trace Window** – automatically sets the captured window trace area to the same sweep speed as the Live trace.
    - **1, 2, 5, 10 ms/Div** – sets the captured window trace sweep speed to the selected value. Dual sweep values are displayed in the Controls Toolbar or Amplifier

Controls window when the captured window sweep speed is set differently than the Live trace sweep speed.

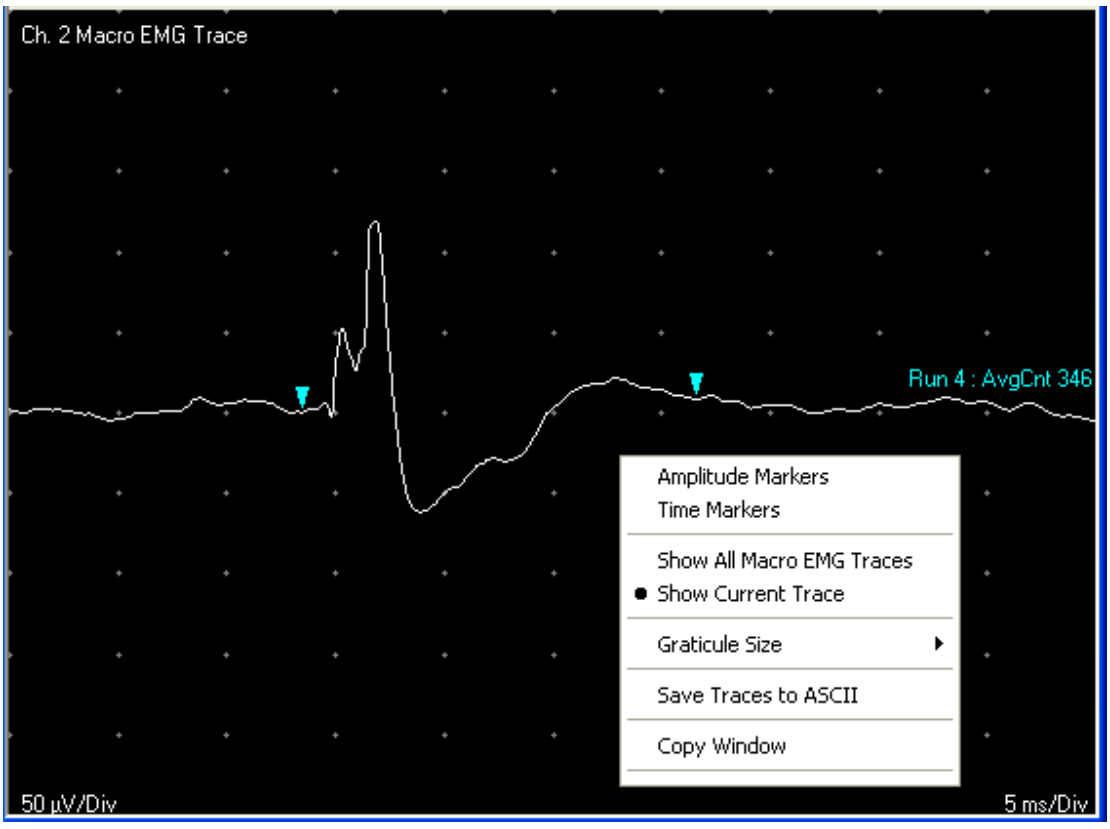
- **Copy Window** - copies the contents of the entire Macro EMG trace window to the clipboard.

Enabling the Capture Window Display as your default setting for Macro EMG.

The status of the Capture Window display feature and the number of traces displayed within the window can be saved as part of the default settings for the Macro EMG test protocol. With the feature enabled, simply select **Save Test Parameters** from the **Edit** menu.

Analysis Mode

The Analysis mode shows the final averaged Macro trace in the bottom half of the window. Nothing is displayed in the top half of the window. Right-clicking on the Macro trace area displays a menu of functions that can be used.



Final averaged Macro trace and right-click menu options.

Amplitude Markers: Enables amplitude markers within the Macro trace area.

Time Markers: Enables time markers within the Macro trace area.

Show All Macro EMG Traces: When selected all the macro traces for every run in the results table will be displayed.

Show Current Trace: When selected the macro trace for the currently selected run in the results table will be displayed.

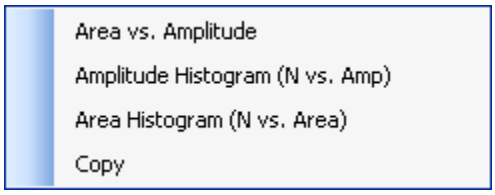
Graticule Size: The Macro EMG Trace window is divided into a grid pattern using vertical and horizontal divisions or graticules. The grid pattern can be changed by altering the number of these divisions. The first number is for the number of vertical divisions, the second number is for the number of horizontal divisions.

Save Traces to ASCII: Allows all the traces in the Macro trace area to be output to a comma separated values file (*csv). For more information on using the ASCII Output Utility click here.

Copy Window - copies the contents of the entire Macro EMG trace window to the clipboard.

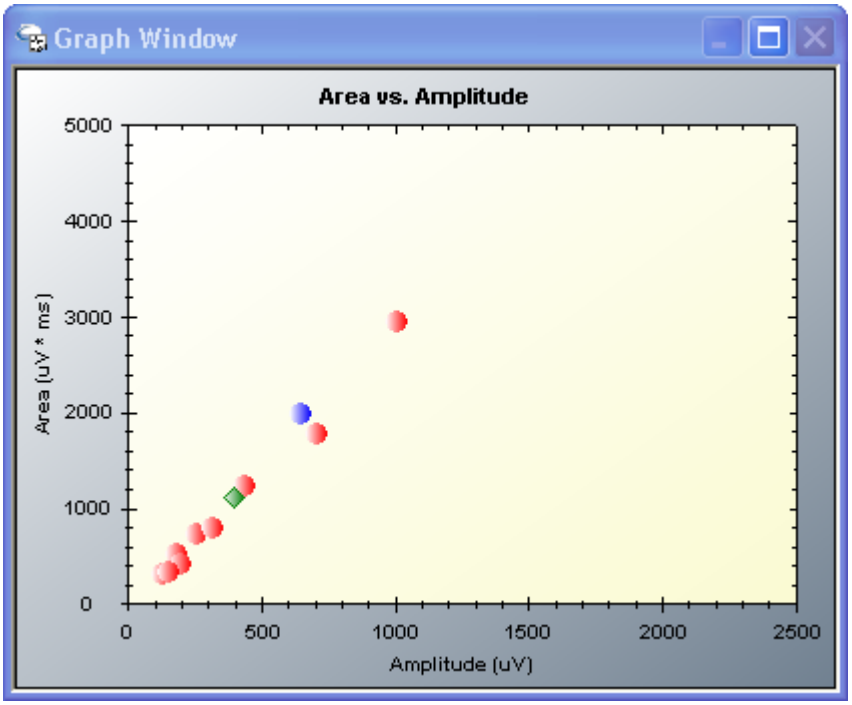
Macro EMG Graph Options

The graph window can display an Area vs. Amplitude plot or two histogram data plots. **Right-click** over this window to select the plot you would like to view.



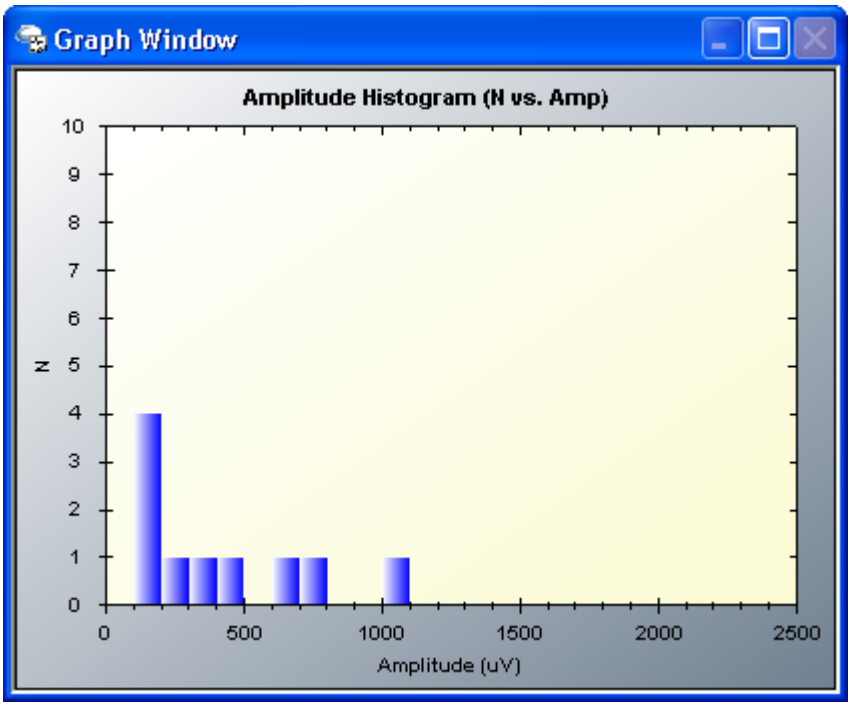
Area vs. Amplitude:

This graph displays the Area (uV-ms) on the Y-axis and the Amplitude (uV) on the X-axis. For each run, one data point is plotted. The blue circle indicates the data point for the currently selected run in the Results Table. Red circles are the data points for the other stored runs in the Results table. The green diamond indicates the mean or median data point for the all the runs.



Amplitude Histogram:

Displays the distribution of the amplitude values in a bar graph format. The height of each bar indicates the counts (N) for each value of amplitude.



Area Histogram:

Displays the distribution of the area values in a bar graph format. The height of each bar indicates the counts (N) for each value of area.

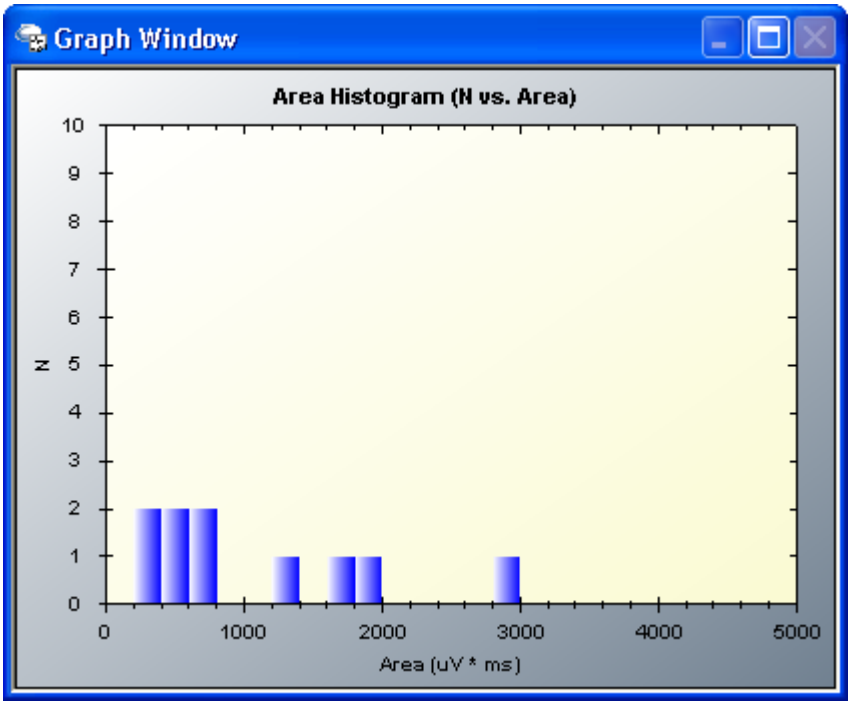
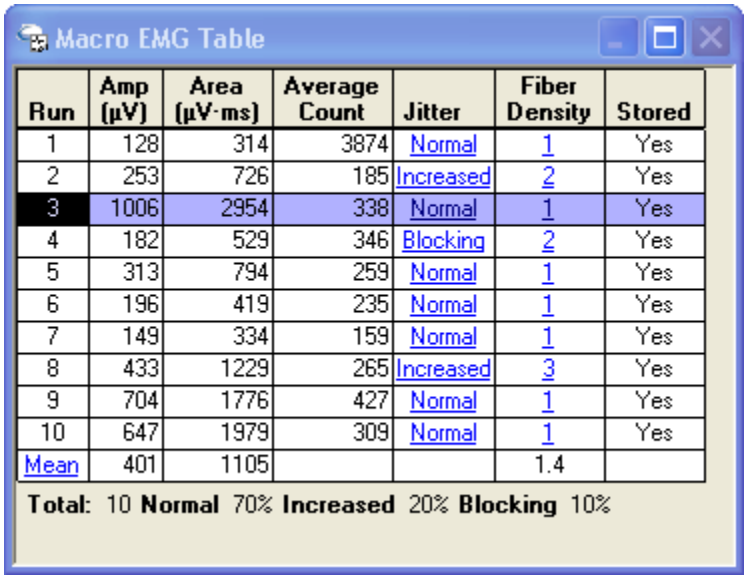


Table Options

Clicking on a row in the Results Table highlights that row and allows that run's trace data to be reviewed. Right-clicking within the table will display a menu of options.

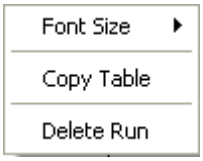


Macro EMG Table

Run	Amp (µV)	Area (µV-ms)	Average Count	Jitter	Fiber Density	Stored
1	128	314	3874	Normal	1	Yes
2	253	726	185	Increased	2	Yes
3	1006	2954	338	Normal	1	Yes
4	182	529	346	Blocking	2	Yes
5	313	794	259	Normal	1	Yes
6	196	419	235	Normal	1	Yes
7	149	334	159	Normal	1	Yes
8	433	1229	265	Increased	3	Yes
9	704	1776	427	Normal	1	Yes
10	647	1979	309	Normal	1	Yes
Mean	401	1105			1.4	

Total: 10 **Normal** 70% **Increased** 20% **Blocking** 10%

Macro EMG results table.



Right-click menu.

Font Size: The font size of the table can be increased or decreased. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

Copy Table: Copies the contents of the Macro EMG results table to the Windows clipboard.

Delete Run: This will delete the highlighted row from the table and all the data for that run.

Column Definitions:

Run – indicates the run #.

Amp (uV) - maximum amplitude between the onset and end cursors, displayed in microvolts (uV).

Area (uV-ms) - area under the negative & positive portions of the curve between the onset and end cursors, displayed in microvolt/millisecond units.

Average Count - displays the number of averages obtained for that run.

Jitter - optional field for recording a qualitative indication of the jitter observed for the run. Choices are Normal, Increased, and Blocking.

Fiber Density - optional field for recording the fiber density observed for the run.

Stored – indicates if the run has been stored to disk.

Mean / Median - this setting determines how the data for all the runs is summarized. If set to mean, then the summarized data for amplitude and area is shown as the mean values. If set to median, then the summarized data for amplitude and area is shown as the median values. The green diamond in the Area vs. Amplitude graph corresponds to these values.

 Fiber Density is always displayed as the **mean** value, regardless of this setting.

Total: indicates the total number of runs in the table.

Normal – indicates the percentage of runs with normal jitter.

Increased - indicates the percentage of runs with increased jitter.

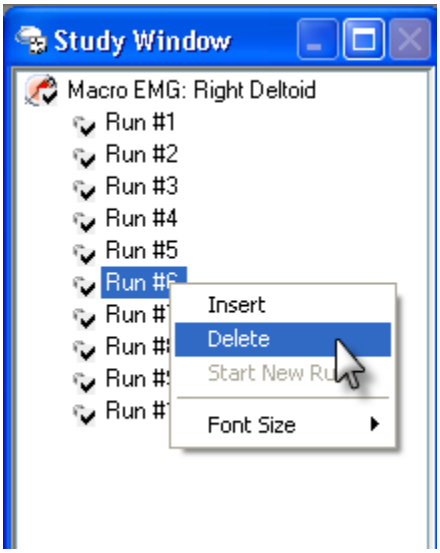
Blocking - indicates the percentage of runs with blocking.

Deleting a Run

To **Delete** a stored Macro EMG run, perform one of the following procedures.

Using the Study Window:

- **Right click** the mouse **over the Run #** you want to delete in the **Study** window.
- From the pop-up menu, select **Delete**.
- A confirmation message will be displayed, click **OK**.
- The Run is deleted and the mean/median values in the Results table are automatically re-calculated.



Using the Results Table:

- **Right click** over the row in the table corresponding to the run you want to delete.
- From the pop-up menu, select **Delete Run**.

Reviewing a Run

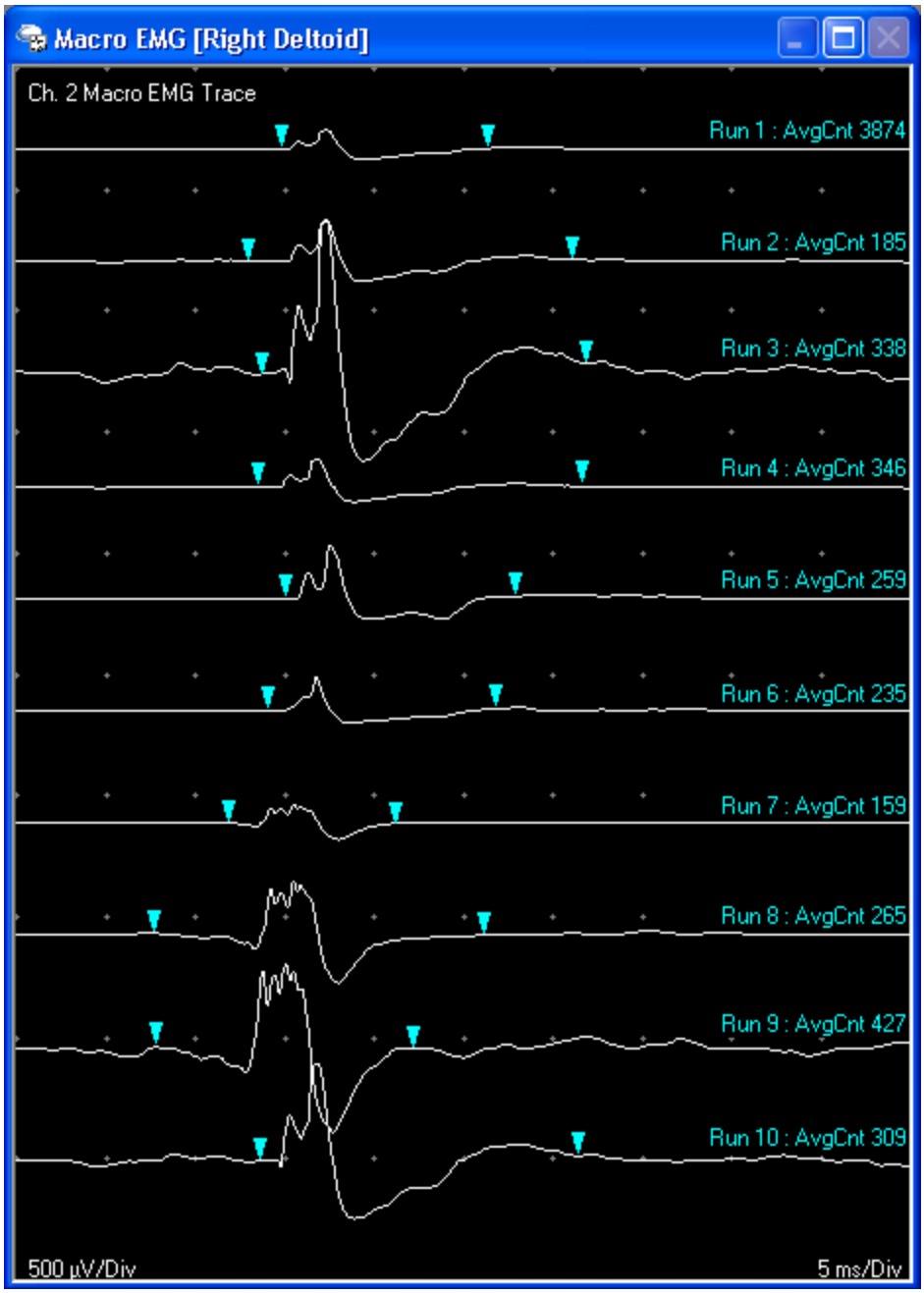
To review a Run, follow these steps.

- **Select the Run** # you want to re-analyze by performing one of the following.
  - **Left click** the mouse over the desired **run #** in the **Study** window.
  - **Left click** the mouse over the desired **run #** within the **Results table**.

Displaying all Macro Traces

To display all the Macro traces for every run in the results table.

- Right-click over the Macro trace area and select **Show All Macro EMG Traces**.



Macro EMG trace window showing all traces.

Saving Changes to Macro EMG Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the Macro EMG test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

EPs (SEP, AEP, VEP, P300)

SEP Basic Steps

This topic is a repeat of the basic SEP steps found in the **Getting Started** chapter.

Select the SEP Test:

- **If a Study has already been selected**, simply click on the SEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the SEP test protocol from the **Study/Test** menu.

Once the SEP test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

   To view a common **3 Channel Median SEP** setup, Click here.

   To view a common **3 Channel Tibial SEP** setup, Click here.

2. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected SEP test.

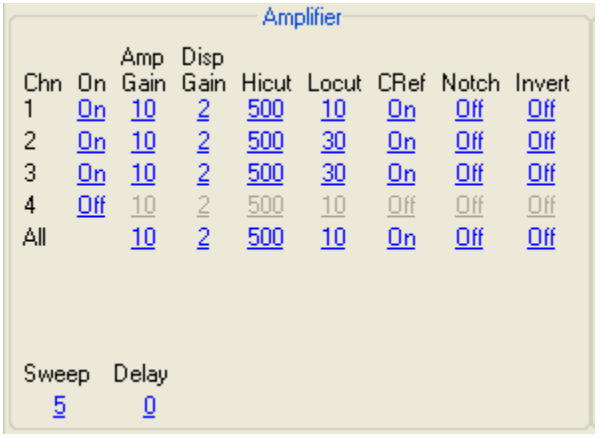
Typical Settings

	Display Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
Upper Limb SEP	1 to 5	3k to 500	10	5.0
Lower Limb SEP	1 to 5	3k to 500	10	10.0

A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the

montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

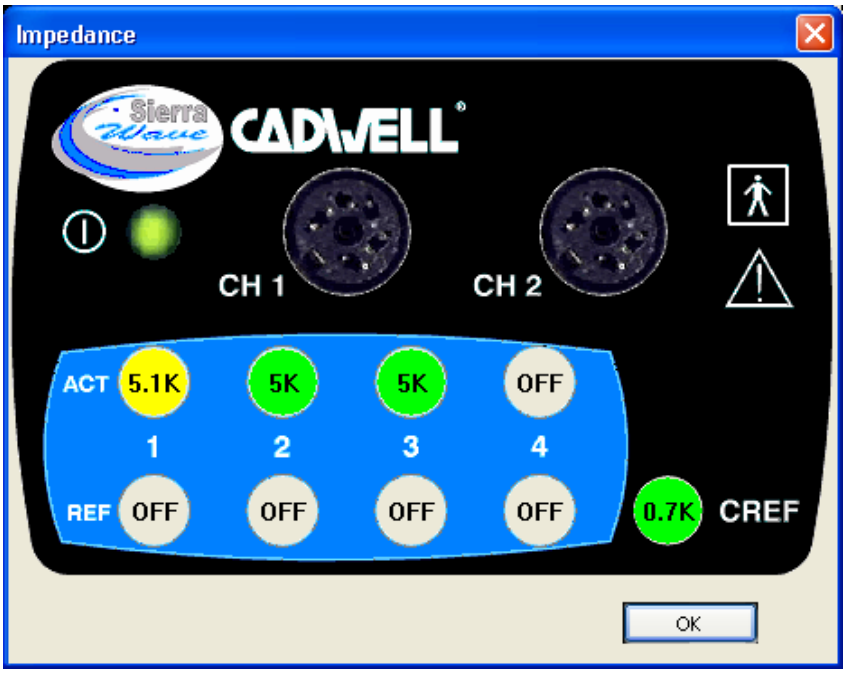
The **Notch** filter is typically not used during SEP recordings and should remain **OFF**.



Median SEP default Amplifier Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 1, 2 and 3 have the CREF input enabled, channel 4 is turned Off.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

 When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Select Side of Stimulation

Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings and Polarity

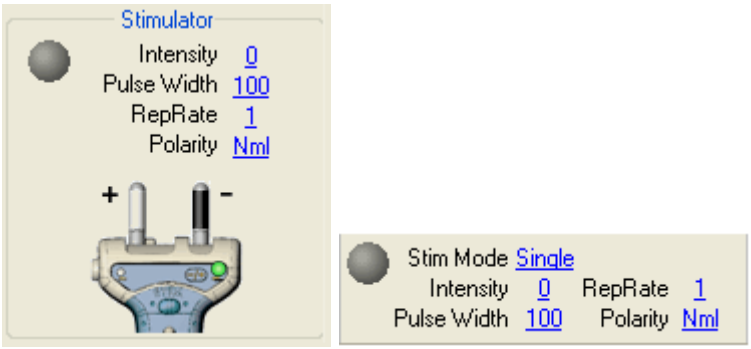
Apply the stimulating electrodes (bar electrode or individual electrodes) to the patient. Connect the stimulating electrodes to the end of the hand-held electrical stimulator (remove the probe tips from the end of the stimulator). The **proximal** stimulating electrode should be connected to the **Cathode (-)** and the **distal** stimulating electrode should be connected to the **Anode (+)**.

Intensity - start at zero milliamps and after data acquisition is started increase slowly until a visible muscle twitch is seen.

Pulse Width - typically set to 100 or 200 microseconds.

Rep Rate - typically between 2 to 5 Hz and not directly divisible into 60 (e.g., 2.11, 2.66, 4.77).

Polarity - set to **Normal (Nml)** mode.



Controls Window. Controls Toolbar.

SEP Stimulator Controls

6. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

Example SEP Averager settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

7. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. **Slowly turn up the stimulus intensity level** until a visible muscle twitch is observed. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in purple.

The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

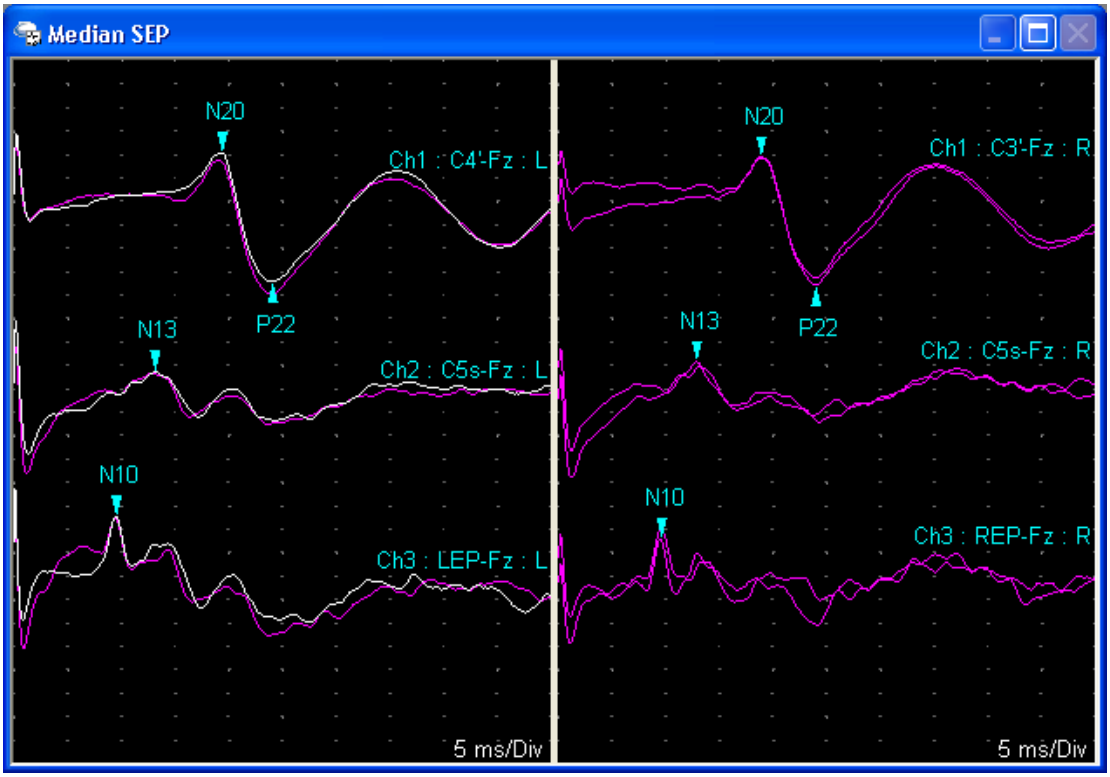
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example 3 Channel Median SEP, Left and Right.

8. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply click on the Trial you want to move with the left mouse button and drag the trial to its new location. If you want to move an individual Trace, not the entire Trial, first right-click the mouse over the Trace window and remove the check mark in front of "Trial Selection Mode".
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trial / Move)** to select and move trials. To move individual traces, first press the **F4 (Trial / Trace)** function key to change the selection mode.

When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

9. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trial to select it**, the trial will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trial to select it**, the trial will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial)** to select a trial, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trial. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

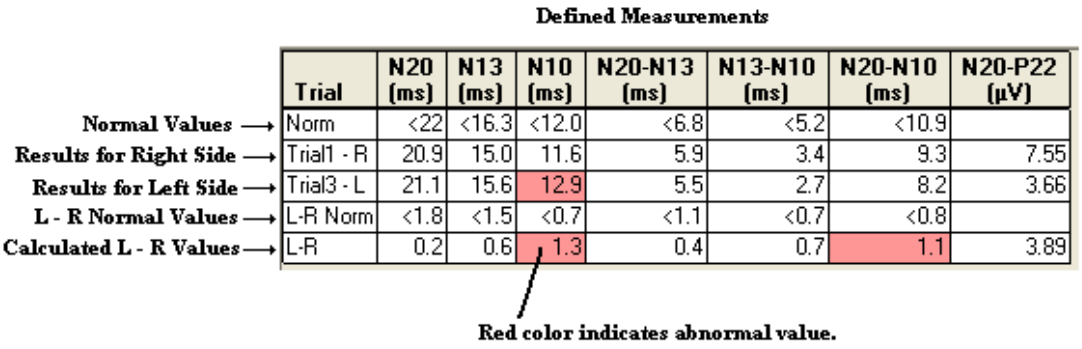
After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the SEP Test Protocol setup topic.

To adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial)** to select the trial with the cursors you need to adjust, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

  After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



Trial	N20 (ms)	N13 (ms)	N10 (ms)	N20-N13 (ms)	N13-N10 (ms)	N20-N10 (ms)	N20-P22 (µV)
Norm	<22	<16.3	<12.0	<6.8	<5.2	<10.9	
Trial1 - R	20.9	15.0	11.6	5.9	3.4	9.3	7.55
Trial3 - L	21.1	15.6	12.9	5.5	2.7	8.2	3.66
L-R Norm	<1.8	<1.5	<0.7	<1.1	<0.7	<0.8	
L-R	0.2	0.6	1.3	0.4	0.7	1.1	3.89

Example Median SEP Cursor Table.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trial.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test**

AEP Basic Steps

This topic is a repeat of the basic AEP steps found in the **Getting Started** chapter.

Select the AEP Test:

- **If a Study has already been selected**, simply click on the AEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the AEP test protocol from the **Study/Test** menu.

Once the AEP test has been selected. Follow these steps for performing data acquisition:

1. **Apply electrodes to the patient and connect to amplifier**

   Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected AEP test.

   Typical AEP Settings

   Display Gain = 0.2 to 0.5 uV/Div

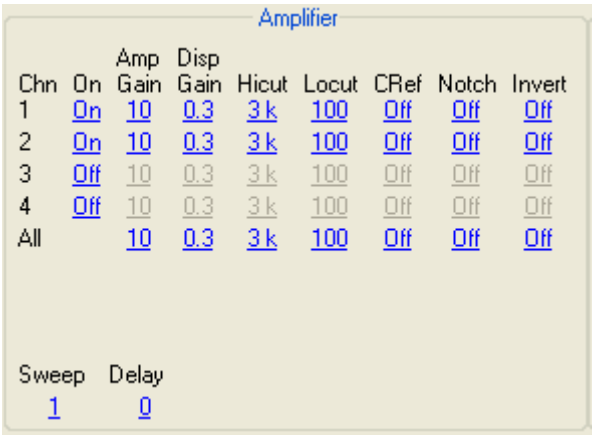
   Hicut = 3k Hz

   Locut = 100 Hz

   Sweep Speed = 1.0 ms/Div

   A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

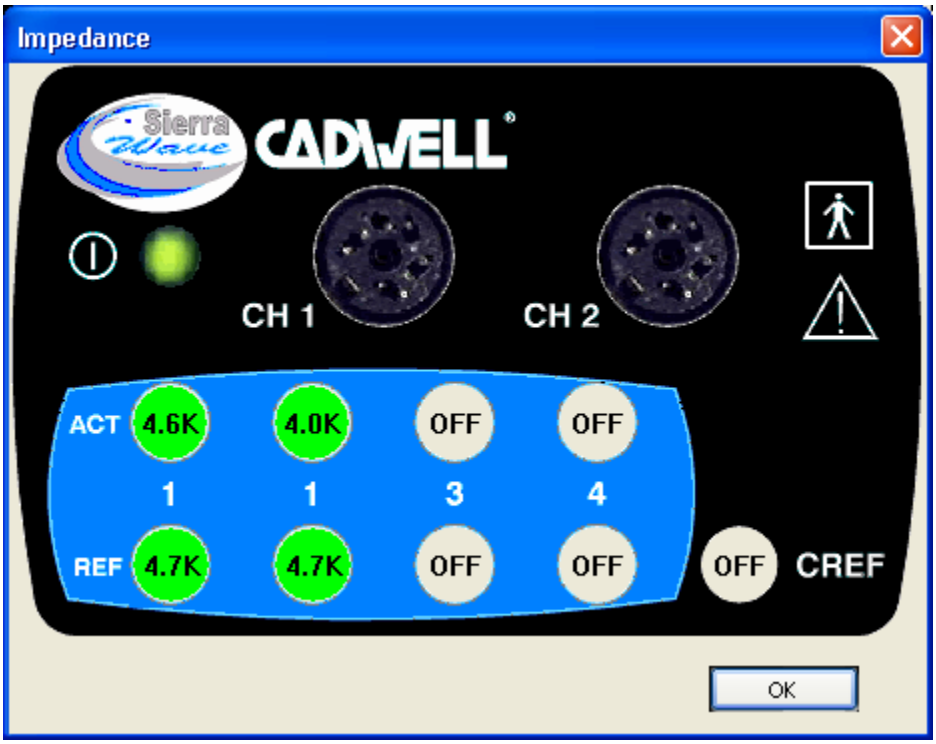
   The **Notch** filter is typically not used during AEP recordings and should remain **OFF**.



2Ch. AEP Default Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 3 & 4 are turned Off. CREF is turned OFF.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

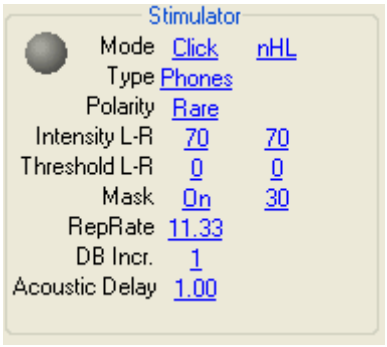
When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Select Side of Stimulation

Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings

Apply the stimulator (headphones or inserts) to the patient, the red headphone/insert should be placed on the patient's right side, the left headphone/insert should be placed on the left. Connect the stimulator to the back of the Sierra Wave base unit.



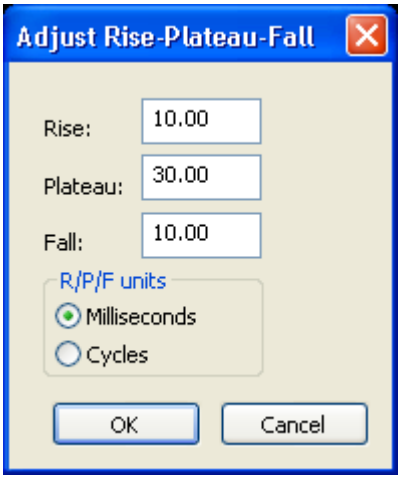
AEP Stimulator Settings - Controls Window

AEP Stimulator Settings - Controls Toolbar

Mode: Click here to select the auditory stimulus type, choose either **Click**, **Tone**, **Pip202**, or **Pip212**.

- **Click** - this is a 100 microsecond click stimulus.
- **Tone** - this is a 10-30-10 tone burst stimulus. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time. This stimulus is typically used for long latency auditory evoked potentials.

- **Pip 202** or **Pip 212** - these are also tone stimuli but their rise, plateau, and fall times are measured in cycles rather than milliseconds. The 2-0-2 Pip has a 2 cycle rise, 0 cycle plateau, and 2 cycle fall. The 2-1-2 Pip has a 2 cycle rise, 1 cycle plateau, and a 2 cycle fall.
- **Frequency** - when Tone, PiP202, or PiP212 are selected a Frequency setting will be displayed. Click here to select the frequency of the tone/pip. The choices are 250, 500, 750, 1000, 2000, 3000, 4000, 6000, and 8000 Hz.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

- **Envelope** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.

Type: Click here to select the type of stimulus delivery hardware, choose either **Phones** or **Inserts**.

When **Inserts** are selected the program will **automatically subtract 1.0 milliseconds** from all latency calculations to compensate for the delay produced by the plastic tubing. This delay value can be modified by clicking on the **Acoustic Delay** value. This value does not shift the displayed trace.

Polarity: Click here to set the stimulus polarity, the choices vary depending on the stimulus type.

- **For Click** - choose either **Rarefaction**, **Condensation**, or **Alternating** polarity.
- **For Tone or Pip** - choose either **Negative**, **Positive**, or **Alternating** polarity.

Intensity L-R: Click here to set the starting stimulus intensity value. The first column is for the left side, the second column is for the right side.


To avoid excessive auditory stimulation, ensure that the stimulus intensity never exceeds 75 dB above the hearing threshold.

Threshold L-R: Indicates the behavioral threshold value. The first column is for the left side, the second column is for the right side. During data acquisition the Threshold values are added to the Intensity values to produce the stimulus at the headphones/inserts. See step #6 for instructions on determining thresholds.

Intensity Units: Choose either **nHL** (normalized hearing level) or **SPL** (sound pressure level). When SPL is selected the Threshold settings are disabled.

dB Incr: Click here to change the intensity value scale. The default setting is 1 dB increments, choices are 1, 2, 5 and 10.

Mask: Click here to set the "white" noise masking as either **On** or **Off** and to set the level for the non-stimulated ear. The amount selected is the number of dB's below the Intensity value. This is known as differential masking and allows the intensity of the masking noise to decrease automatically as the intensity of the stimulus is decreased.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz).

6. Determine Behavioral Threshold Levels (optional)

There are two specially designated knobs for setting the behavioral threshold levels. **Knob #2 (L Thresh/Off)** and **Knob #3 (R Thresh/Off)**. To determine the threshold levels follow these steps.

I. **Turn Knob #2**. Stimuli will be automatically delivered to the left ear and the threshold value for the left ear will turn "yellow".

II. **Continue to turn** Knob #2 until the patient can definitely hear the stimulus.

III. Slowly turn Knob #2 in the reverse direction to **decrease** the threshold level. Keep decreasing the level until the patient signals that they can no longer hear, or can just barely hear, the stimulus.

IV. **Press Knob #2** to stop stimulus delivery and set the threshold value for the left ear.

V. **Repeat** the above steps for the right ear using **Knob #3**.

The threshold value is automatically added to the intensity value to obtain the output level for the stimulator. For example, if the left intensity was set to 70 dB and the left threshold was determined to be 12 dB, the actual output intensity from the stimulator would be 82 (70 + 12).

7. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

AEP Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

8. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in purple.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

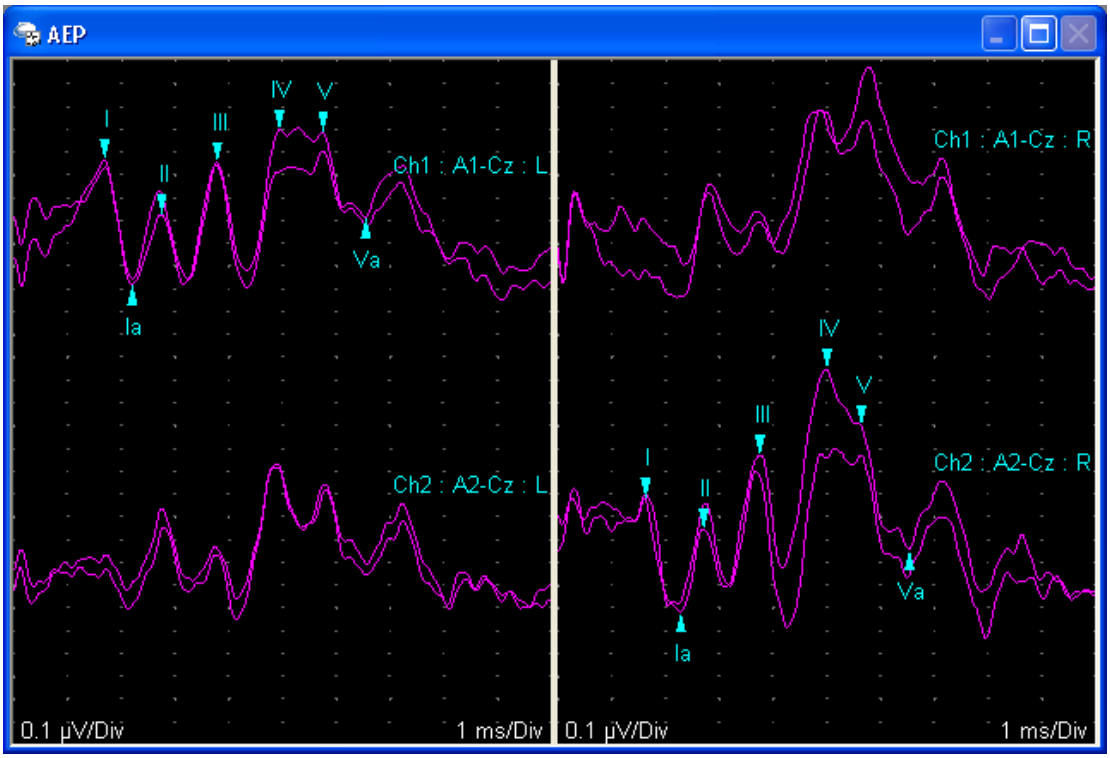
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example 2 Channel AEP, Left and Right.

9. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply click on the Trace you want to move with the left mouse button and drag the trace to its new location.
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

  When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

10. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

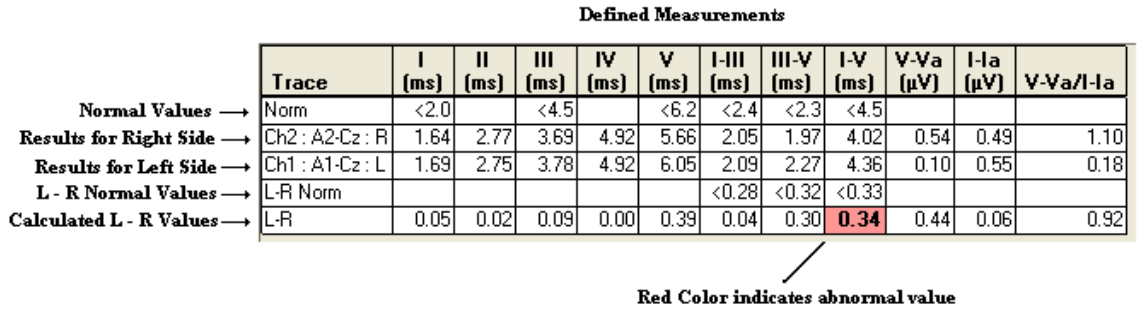
After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the AEP Test Setup topic.

To adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



AEP cursor table example.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trace.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

11. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

12. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

VEP Basic Steps

This topic is a repeat of the basic VEP steps found in the **Getting Started** chapter.

Select the VEP Test:

- **If a Study has already been selected**, simply click on the VEP test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the VEP test protocol from the **Study/Test** menu.

Once the VEP test has been selected. Follow these steps for performing data acquisition:

1. Apply electrodes to the patient and connect to amplifier

Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. Verify Amplifier Settings

Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected VEP test.

Typical VEP Settings

Display Gain = 5 uV/Div

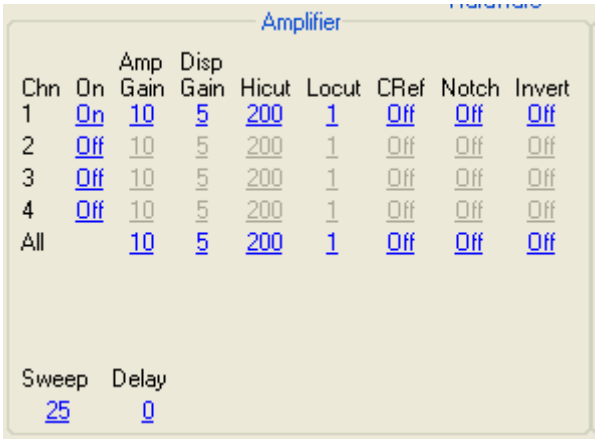
Hicut = 200 Hz

Locut = 1 Hz

Sweep Speed = 25 ms/Div

A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

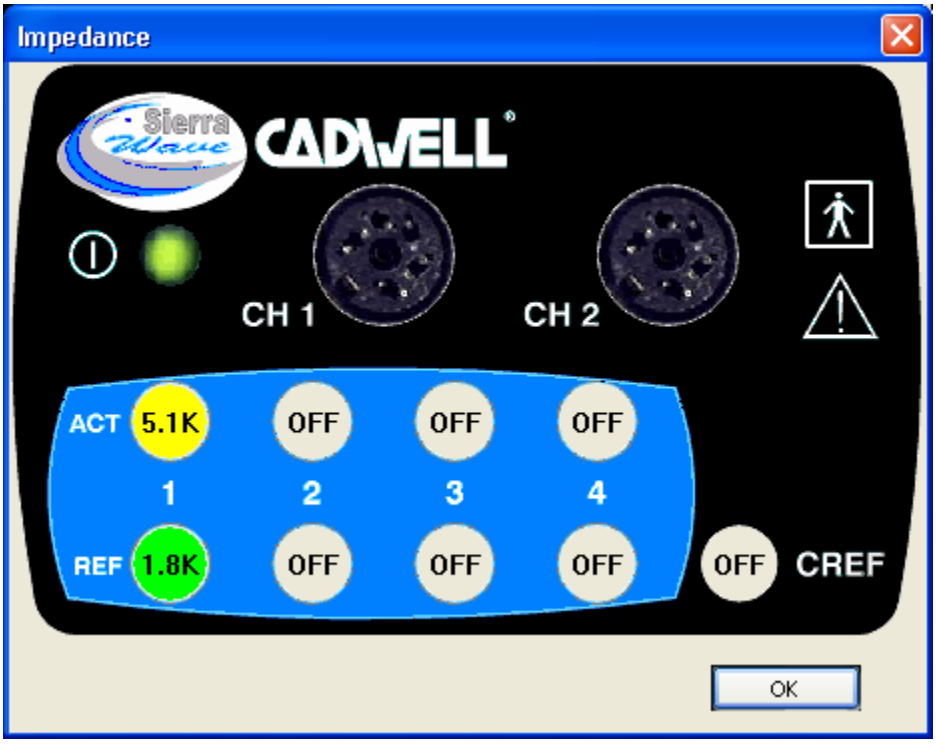
The **Notch** filter is typically not used during VEP recordings and should remain **OFF**.



Default VEP Amplifier Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channels 2, 3, & 4 are turned Off. CREF is turned Off for Channel 1.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

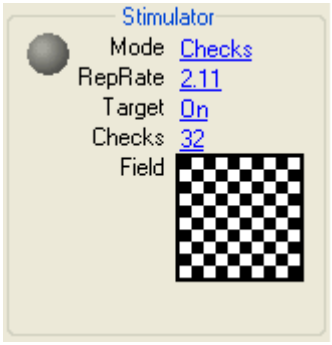
When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. **Select Side of Stimulation**

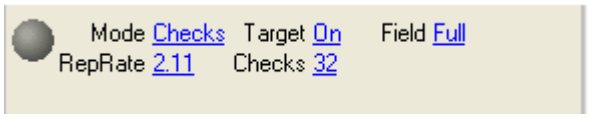
Make sure the appropriate side, **Right** or **Left**, is selected.

5. Check Stimulator Settings

Connect the VEP stimulator to the appropriate connector on the back of the Sierra Wave base unit. Position the stimulator at the required distance from the patient. Cover the non-stimulated eye.



VEP Default Stimulator Settings - Controls Window



VEP Stimulator Settings - Controls Toolbar

Mode: Click here to select the type of visual stimulus. Choices are **Checks**, **Goggles**, **LED**, and **Flash**.

- **Checks** - selects a reversing black & white checkerboard pattern. When checks are selected as the stimulus type the following additional parameters are available.
    - **Target** - select either On or Off. When turned On a small target is positioned in the center of the black & white monitor, the patient should focus on this target during data acquisition.
    - **Checks** - click here to select the number of checks displayed across a horizontal row. The choices are 1, 2, 4, 8, 16, 32, 64, and 128 (default is 32 checks with monitor positioned about 1 meter from patient).
    - **Field** - click in this area to select the field of stimulation. The choices are Full Field, Upper Half, Right Half, Lower Half, Left Half, Left Upper Quarter, Right Upper Quarter, Right Lower Quarter, and Left Lower Quarter (default is Full Field).
- **Goggles** - selects the LEG Goggles.
- **LED** - selects the 3 inch hand held LED checkerboard stimulator.
- **Flash** - selects the strobe flash stimulator.

Rep Rate: Click here to set the repetitive stimulus rate, in pulses per second (Hz).

If you are using a **LCD Television Monitor**, rather than a **CRT Monitor**, please refer to the document **"291218-933 - Setup Instructions for LCD Checkerboard Monitor.pdf"**. LCD monitors have different screen drawing characteristics than CRT monitors, and as such a compensatory delay (or offset) has to be determined and entered into the Sierra Wave program before an LCD monitor can be used. Without this delay value entered into the program the latency of the visual evoked potentials will be greatly prolonged.

6. Verify Averager Settings

Shutoff - This is the number of responses that will be averaged together to produce the final results. When the shutoff count is reached stimulation will automatically be stopped.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

VEP Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

 You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

7. Acquire Responses

A. Start Data Acquisition.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in purple.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces.

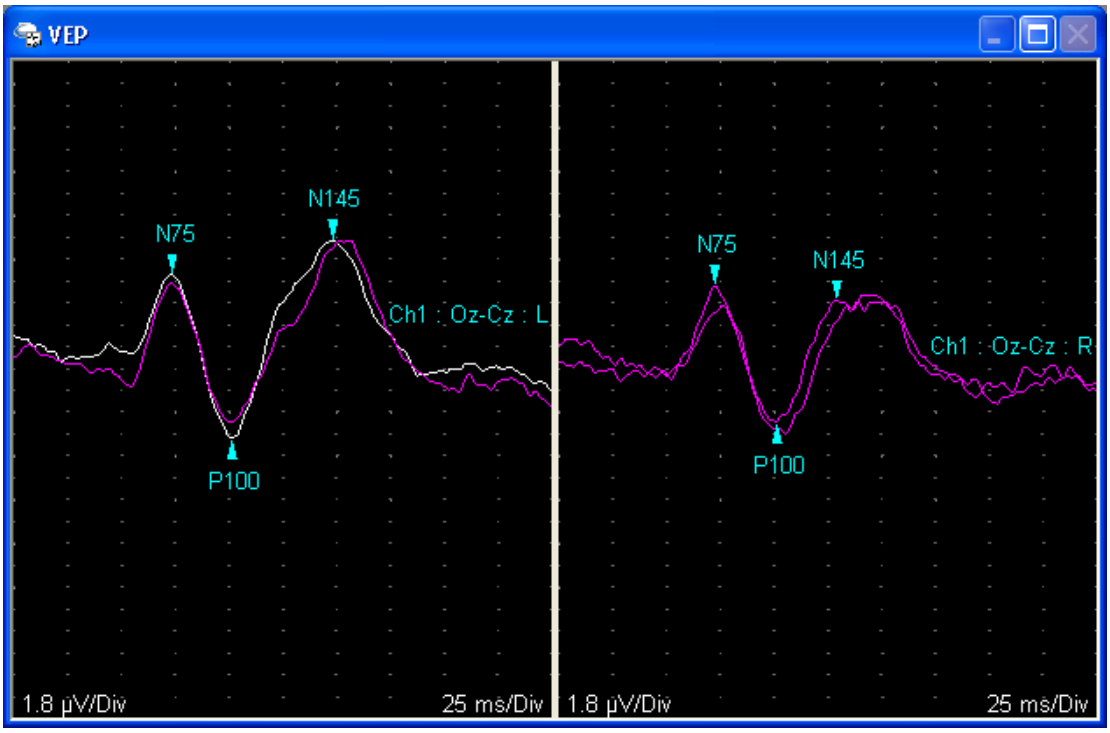
E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Change Side of Stimulation.

To acquire traces for the opposite side, change the **Side** setting in the **EP Controls** window. If you are using the Split Screen feature the active (white) traces will automatically move to the opposite side of the Trace window.

G. Repeat steps A - E and collect data for the opposite side.



Example VEP, single channel recording, Left & Right.

8. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply click on the Trace you want to move with the left mouse button and drag the trace to its new location.
- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up

menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

9. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 For information on configuring the Auto Cursors, see the VEP Test Setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is

selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

Defined Measurements

	Trace	N75 (ms)	P100 (ms)	N145 (ms)	N75-P100 (µV)
Results for Right Side →	Ch1 : Oz-Cz : R	72.3	101.2	128.9	11.18
Results for Left Side →	Ch1 : Oz-Cz : L	73.4	101.2	148.0	13.39
Calculated L - R Values →	L-R	1.2	0.0	19.1	2.21

VEP cursor table example.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trace.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

P300 Basic Steps

This topic is a repeat of the basic P300 steps found in the **Getting Started** chapter.

Select the P300 Test:

- **If a Study has already been selected**, simply click on the P300 test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the P300 test protocol from the Study/Test menu.

Once the P300 test has been selected. Follow these steps for performing data acquisition:

1. Apply electrodes to the patient and connect to amplifier

Determine the number of channels that will be recorded and the electrodes that will be required for each channel. Apply the recording electrodes and ground electrode to the patient and connect to the Sierra Wave amplifier.

2. Verify Amplifier Settings

Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the selected P300 test.

Typical P300 Settings

Display Gain = 2.0 uV/Div

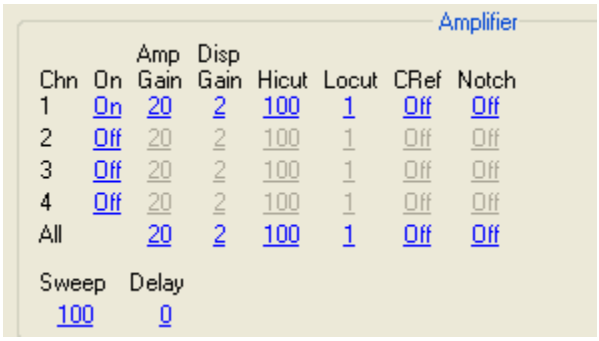
Hicut = 30-100 Hz

Locut = 1 Hz

Sweep Speed = 75 - 100 ms/Div

A **Common Reference (CREF)** input is available on the 4 Channel Amplifier. The status of the CREF input, **Off** or **On** for each channel, will depend on the montage chosen for the test. If the amplifier channel should use its corresponding individual reference input (i.e., reference 1, 2, 3, or 4) the CREF setting should be set to **OFF**. If the channel should not use its individual reference input, but should use the CREF input in its place, then the CREF setting should be set to **ON**.

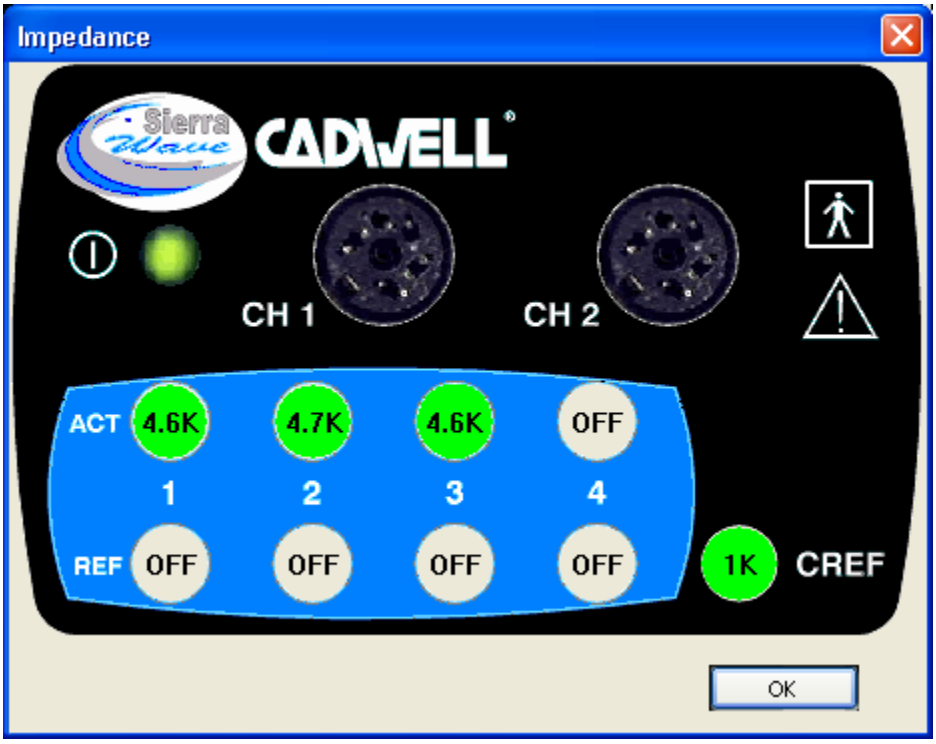
The **Notch** filter is typically not used during P300 recordings and should remain **OFF**.



3 Ch. P300 Settings.

3. Check Impedances

Press the **Imped** key on the Sierra Wave base unit. The impedance window displays a picture of the front of the amplifier.



Impedance window. Channel 4 is turned Off. CREF is turned ON for Channels 1 & 2 & 3.

The **Active** (black) and **Reference** (red) inputs are displayed for each channel as well as the **CREF** input (4 Channel Amplifier only). The **Ground** input is not included in impedance measurements.

If a Channel is turned Off, no impedance values will be calculated for either the active or reference inputs and the word "Off" is displayed over the inputs of that channel.

When the CREF input is enabled (i.e., ON) for a channel, that channel's reference input will not show an impedance value and will have the word "Off" over the reference input. An impedance value for the CREF input will be displayed.

Impedances less than 5k Ohms (kilo-ohms) are displayed in green. Values between 5.1 and 20 are displayed in yellow. Values greater than 20 are displayed in red.

To close the impedance window, press the **Imped key again** or click the **OK** button.

When performing evoked potential studies all impedances should be **less than 5k Ohms**.

4. Check Stimulator Settings

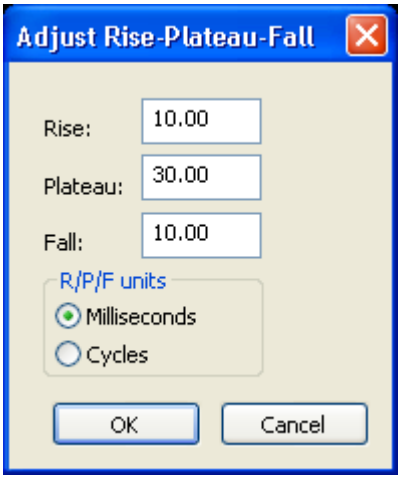
Clinical recordings of the P300 are generally performed using a binaural auditory tone stimulus, commonly referred to as the auditory odd-ball paradigm. Typically, two easily discriminable tones of different pitches are presented in random order. One of the two tones occurs more often than the other and is designated the Common tone. The other tone is designated the Rare tone. This outline will assume that an auditory stimulus will be used for both the Common and Rare stimuli.

Apply the stimulator (headphones or inserts) to the patient, the red headphone/insert should be placed on the patient's right side, the blue headphone/insert should be placed on the left. Connect the stimulator to the back of the Sierra Wave base unit.

P300 Stimulator Controls Toolbar

Common Stim: These settings are used to configure the Common stimulus.

- **Type** - can be set to Audio, Visual, Electrical, or '.Wav' file. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.
- **Frequency** - click here to select the frequency of the tone. The default setting is **1000** Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.
- **Env.** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.



Change the rise, plateau, and fall values for a Tone or Pip.

Rare Stim: These settings are used to configure the Rare stimulus.

- **Type** - can be set to Audio, Visual, Electrical, or '.Wav' file. Audio is the default setting.
- **Mode** - can be set to Click, Pip 202, Pip 212, or Tone. Tone is the default setting and it is a 10-30-10 tone burst. It has a 10 millisecond rise time, a 30 millisecond plateau, and a 10 millisecond fall time.
- **Int** - sets the intensity of the common stimulus in nHL values. 65 dB is the default setting.
- **Frequency** - click here to select the frequency of the tone. The default setting is **3000** Hz.
- **Side** - can be set to Right, Left, or Bilateral. The default setting is Bilateral.
- **Env.** - when Tone, Pip202, or Pip212 are selected a stimulus envelope can be selected here. Choices are None, Linear, Blackman, Hanning, and Gaussian.
- **R/P/F** - when Tone, Pip202, or Pip212 are selected the rise, plateau, and fall values are shown here. Click here to change these values.

RepRate: Click here to set the repetitive stimulus rate, in pulses per second (Hz). The default setting is 0.97.

Rare %: Click here to set the percentage of Rare stimuli that will be delivered. The default setting is 20 %.

To avoid excessive auditory stimulation, ensure that the stimulus intensity never exceeds 75 dB above the hearing threshold.

5. Verify Averager Settings

AvgCnt - The second number displayed here is the total number of stimuli (Common + Rare) that will be delivered. When this number is reached stimulation will automatically be stopped. The default is 200 (160 Common, 40 Rare).

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the number of stimuli/sweeps that have been rejected for both the Common and Rare stimuli will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

P300 Default Averager Settings.

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline. If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average. If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

6. Acquire Responses

A. Start Data Acquisition.

It is important that the patient attend to the stimuli. This is facilitated by having the patient keep a mental record of the number of Rare tones (i.e., higher pitched tones) that are presented during the test. Drowsiness should be avoided, as well as distracting noises.

Press the **Run/Stop key** to start stimulus delivery and data acquisition. The average count **(AvgCnt)** should start to increment and the traces will begin to take shape.

The P300 program has dual averager banks. The Common stimuli are averaged in the first averager bank and the corresponding traces are displayed in the left half of the trace window. The Rare stimuli are averaged in the second averager bank and the corresponding traces are displayed in the right half of the trace window.

Adjust the vertical size of the all traces by turning **Knob #4 (Gain)**. To adjust the gain of an individual trace, change the corresponding gain setting in the amplifier section of the **EP Controls** window.

Press the **F3 (Smooth)** function key during acquisition to remove high frequency noise from the active (white) traces.

B. Store the first trial.

When the Shutoff count is reached, stimulation will stop automatically. Press the **Store key** to store the active (white) traces. A copy of the active traces will appear on the screen and are displayed in a purple color.

 The **Store key** can be pressed before the Shutoff count is reached. This will cause the currently active traces to be stored, the average count will be reset to zero, and stimulation will continue automatically on a new set of traces.

Ask the patient how many Rare stimuli they counted. Compare this with the number shown in the AvgCnt column.

C. Clear the Average Count.

Press the **Clear key** to reset the average count (AvgCnt) back to zero. The active (white) traces will be reset to flat lines.

D. Acquire a second Trial

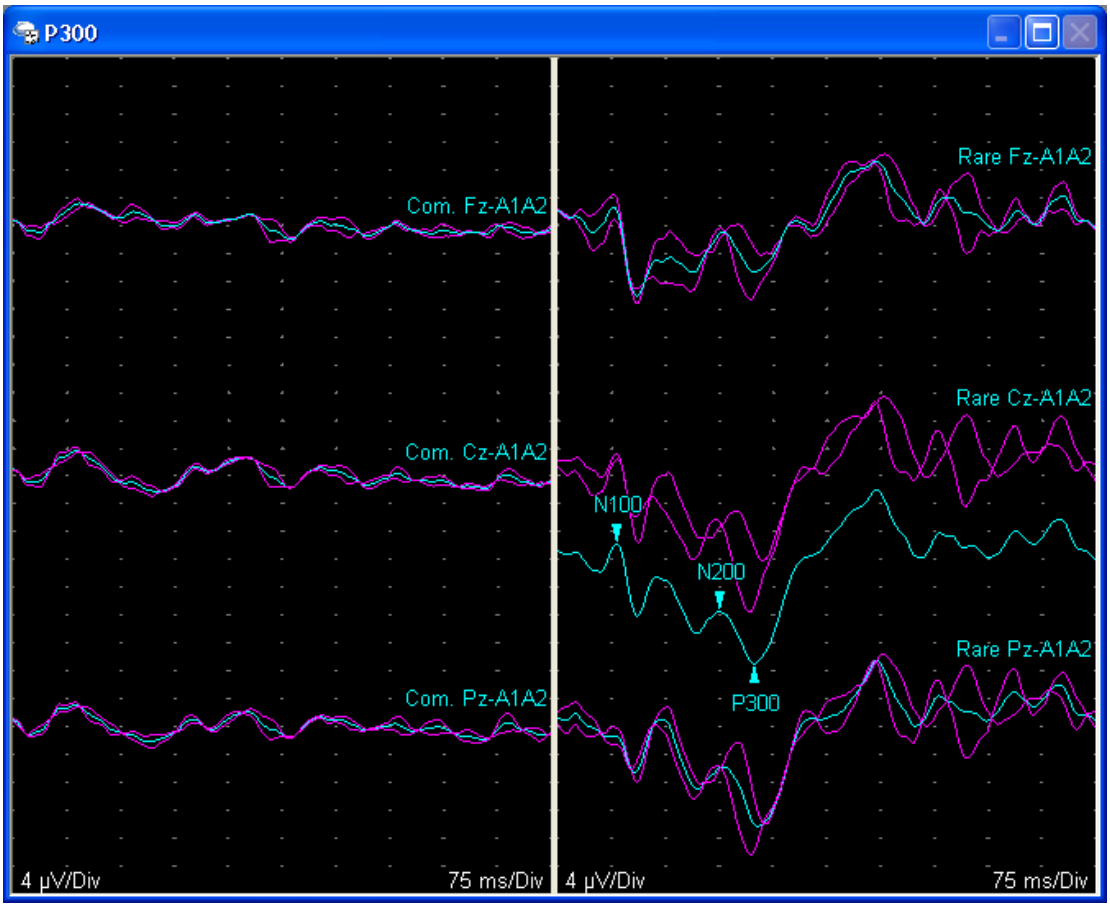
Press the **Run/Stop key** to start stimulus delivery and data acquisition again. Generally, two trials should always be acquired when performing evoked potentials to show replication of the traces. Again, ask the patient to count the Rare stimuli.

E. Store second trial and Clear.

After the Shutoff count is reached for the second trial, press the **Store key** to store the active (white) traces. Press the **Clear key** to reset the average count to zero.

F. Perform a Grand Average (Optional)

Press the **F7 (Grand Avg)** function key. Performing a Grand Average can enhance the principle peaks. A 'blue' trace, representing the grand average of all traces acquired from that channel, will be shown for each channel in the montage.



Example 3 Channel P300. Cursors have been placed on the Grand Average trace for the Cz-A1A2 channel.

7. Trace Positioning (optional)

If the position of the traces needs to be adjusted, follow one of these procedures.

- **Using the Mouse** - simply **click on the Trace you want to move with the left mouse button** and drag the trace to its new location.

- **Using the Knobs** - press the **F6 (Position) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the position mode controls. Use **Knob #1 (Sel Trace / Move)** to select and move traces.

  When positioning is completed, press the **F6 (Position)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Position mode.

- **Using the Trace Position Settings** - right-click the mouse over the Trace window and select **Trace Position Settings** from the pop-up menu. Change the settings for **Start Position**, **Trial Offset**, and **Channel Offset** and click **OK**.

8. Place Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trace to select it**, the trace will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trace and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select a trace, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trace. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

  After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

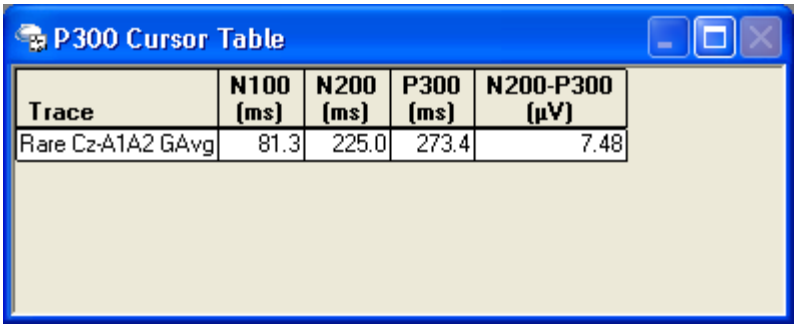
 For information on configuring the Auto Cursors, see the P300 Test Setup topic.

To Adjust the positions of the Cursors, follow one of these procedures.

- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.

- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trace)** to select the trace with the cursors you need to adjust, when selected the trace will be displayed in yellow. Once the appropriate trace is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.



Trace	N100 (ms)	N200 (ms)	P300 (ms)	N200-P300 (µV)
Rare Cz-A1A2 GAvg	81.3	225.0	273.4	7.48

P300 cursor table example.

Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

9. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

10. Next Test

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

SEP Knobs and Fkeys

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press this knob to switch to the **Pulse Width** mode and turn to change the value of the electrical stimulus pulse width, the current pulse width value (in microseconds) will be displayed on the knob icon.

Gain - this knob can be used to increase or decrease the gain (uV/Div) of the Trace window.

F Keys

Avg / Live - defaults to **Avg** mode, in this mode the Trace window displays the results of the current running average. Press to activate **Live** mode, in Live mode the Trace window displays the un-averaged incoming data. Live mode is useful when troubleshooting artifact problems.

Stim Avg / Stim On - defaults to **Stim Avg** mode, in this mode the averager is synchronized with stimulus delivery and the Run/Stop key is used to start and stop both simultaneously. Press to activate **Stim On** mode, in this mode the stimulator is automatically turned ON and the averager can be turned On or Off independently of the stimulator using the Run/Stop key.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

TabData - opens the TabData Summary window.

Cursor mode

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trial. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trial. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trial - turn this knob to select an SEP trial. When selected, the trial will be displayed in yellow.

Gain - turn this knob to change the gain of the selected SEP trial. The current gain setting for the trial is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trial.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trial.

All On / All Off - defaults to **All On** mode. Press to hide all cursors on all trials.

Position mode

Knobs

Sel. Trial / Move - defaults to **Select Trial** mode, turn this knob to select a stored SEP trial. When selected, the trial will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trial up or down within the Trace window.

Move Active - turn this knob to move the active (white colored) trial up or down within the Trace window.

Sel. Trial / Delete - turn this knob to select a stored SEP trial. When selected, the trial will be displayed in yellow color. Press the knob to permanently delete the selected trial.

Gain - turn this knob to change the Gain of the selected SEP trial. The current gain setting for the trial is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces from each channel are separated according to the Trace Position Settings.

Pressing this key switches to **Overlay** mode which will superimpose all traces from each channel on top of one another.

Smooth All - each time this key is pressed all the traces within the Trace window will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Trace / Trial - defaults to **Trial** mode, in Trial mode the select knobs (Knobs #1 and #3) will function to select a complete trial. Press to activate **Trace** mode, in Trace mode the select knobs will function to select individual traces rather than complete trials.

AEP Knobs and Fkeys

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

L. Thresh / Off - used to determine and set the behavioral threshold for the **Left ear**. Turning the knob begins stimulus deliver in the left ear. Continue to turn to increase the intensity of the stimulus. Once the

behavioral threshold for the patient is determined, press the knob to turn off stimulus delivery and set the threshold value.

R. Thresh / Off - used to determine and set the behavioral threshold for the **Right ear**. Turning the knob begins stimulus deliver in the left ear. Continue to turn to increase the intensity of the stimulus. Once the behavioral threshold for the patient is determined, press the knob to turn off stimulus delivery and set the threshold value.

Gain - this knob can be used to increase or decrease the gain (uV/Div) of the Trace window.

F Keys

Avg / Live - defaults to **Avg** mode, in this mode the Trace window displays the results of the current running average. Press to activate **Live** mode, in Live mode the Trace window displays the un-averaged incoming data. Live mode is useful when troubleshooting artifact problems.

Stim Avg / Stim On - defaults to **Stim Avg** mode, in this mode the averager is synchronized with stimulus delivery and the Run/Stop key is used to start and stop both simultaneously. Press to activate **Stim On** mode, in this mode the stimulator is automatically turned ON and the averager can be turned On or Off independently of the stimulator using the Run/Stop key.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

TabData - opens the TabData Summary window.

Cursor mode

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the

selected trace. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trace. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trace - turn this knob to select an AEP trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected AEP trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trace.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trace.

All On / All Off - defaults to **All On** mode. Press to hide all cursors on all traces.

Position mode

Knobs

Sel. Trace / Move - defaults to **Select Trace** mode, turn this knob to select a stored AEP trace. When selected, the trace will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trace up or down within the Trace window.

Move Active - turn this knob to move both of the active (white colored) traces up or down within the Trace window.

Sel. Trace / Delete - turn this knob to select a stored AEP trace. When selected, the trace will be displayed in yellow color. Press the knob to permanently delete the selected trace.

Gain - turn this knob to change the Gain of the selected AEP trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces from each channel are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces from each channel on top of one another.

Smooth All - each time this key is pressed all the traces within the Trace window will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Trace / Trial - defaults to **Trace** mode, in Trace mode the select knobs (Knobs #1 and #3) will function to select individual traces. Press the knob to activate **Trial** mode, in Trial mode the select knobs will function to select a complete trial.

VEP Knob and Fkey Controls

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Gain - this knob can be used to increase or decrease the gain (uV/Div) of the Trace window.

F Keys

Avg / Live - defaults to **Avg** mode, in this mode the Trace window displays the results of the current running average. Press to activate **Live** mode, in Live mode the Trace window displays the un-averaged incoming data. Live mode is useful when troubleshooting artifact problems.

Stim Avg / Stim On - defaults to **Stim Avg** mode, in this mode the averager is synchronized with stimulus delivery and the Run/Stop key is used to start and stop both simultaneously. Press to activate **Stim On** mode, in this mode the stimulator is automatically turned ON and the averager can be turned On or Off independently of the stimulator using the Run/Stop key.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

TabData - opens the TabData Summary window.

Cursor mode

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trace. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trace. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trace - turn this knob to select an VEP trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected VEP trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trace.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trace.

All On / All Off - defaults to **All On** mode. Press to hide all cursors on all traces.

Position mode

Knobs

Sel. Trace / Move - defaults to **Select Trace** mode, turn this knob to select a stored VEP trace. When selected, the trace will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trace up or down within the Trace window.

Move Active - turn this knob to move both of the active (white colored) traces up or down within the Trace window.

Sel. Trace / Delete - turn this knob to select a stored VEP trace. When selected, the trace will be displayed in yellow color. Press the knob to permanently delete the selected trace.

Gain - turn this knob to change the Gain of the selected VEP trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces from each channel are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces from each channel on top of one another.

Smooth All - each time this key is pressed all the traces within the Trace window will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Trace / Trial - defaults to **Trace** mode, in Trace mode the select knobs (Knobs #1 and #3) will function to select individual traces. Press the knob to activate **Trial** mode, in Trial mode the select knobs will function to select a complete trial.

P300 Knobs and Fkeys

The functions assigned to the Sierra Wave base unit's **Knob** and **F Key** controls will vary depending on whether the system is in normal **Acquisition** mode or has been switched to either **Cursor** or **Position** mode.

Cursor mode is entered by pressing the **F5** key on the PC's keyboard.
Position mode is entered by pressing **F6** on the PC's keyboard.

Several Knobs and F Keys have **dual functions**. The currently selected function is displayed in **Bold text**.

Acquisition mode

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Gain - this knob can be used to increase or decrease the gain (uV/Div) of the Trace window.

F Keys

Avg / Live - defaults to **Avg** mode, in this mode the Trace window displays the results of the current running average. Press to activate **Live** mode, in Live mode the Trace window displays the un-averaged incoming data. Live mode is useful when troubleshooting artifact problems.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

TabData - opens the TabData Summary window.

Cursor mode

Knobs

Select Cur / Move Cur - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the selected trace. Press this knob to switch to **Move Cursor** mode which will allow you to move the selected (green triangle) cursor.

Select Cur / On-Off - this knob defaults to the **Select Cursor** mode and can be used to move the focus (yellow triangle) to any cursor on the

selected trace. Press the knob to hide the selected cursor (turn the cursor Off) or bring it back to view (turn the cursor On).

Sel. Trace - turn this knob to select an P300 trace. When selected, the trace will be displayed in yellow.

Gain - turn this knob to change the gain of the selected P300 trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

AutoPlace Cursors - press this function key to re-apply the auto-cursor algorithm to the selected (yellow) trace.

Clear Cursors - press this function key to clear all cursors from the selected (yellow) trace.

All On / All Off - defaults to **All On** mode. Press to hide all cursors on all traces.

Position mode

Knobs

Sel. Trace / Move - defaults to **Select Trace** mode, turn this knob to select a stored P300 trace. When selected, the trace will be displayed in yellow color. Press the knob to switch to **Move** mode, then turn to move the selected trace up or down within the Trace window.

Move Active - turn this knob to move both of the active (white colored) traces up or down within the Trace window.

Sel. Trace / Delete - turn this knob to select a stored P300 trace. When selected, the trace will be displayed in yellow color. Press the knob to permanently delete the selected trace.

Gain - turn this knob to change the Gain of the selected P300 trace. The current gain setting for the trace is displayed on the knob icon.

F Keys

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces from each channel are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces from each channel on top of one another.

Smooth All - each time this key is pressed all the traces within the Trace window will be passed through a digital smoothing algorithm. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Smooth - each time this key is pressed the selected (yellow) traces will be passed through a digital smoothing algorithm. If no traces are selected, then the active (white) traces will be smoothed. Smoothing can be reversed by right-clicking the mouse on the Trace window and selecting Unsmooth All from the pop-up menu.

Trace / Trial - defaults to **Trace** mode, in Trace mode the select knobs (Knobs #1 and #3) will function to select individual traces. Press the knob to activate **Trial** mode, in Trial mode the select knobs will function to select a complete trial.

EP Test Setup

Evoked Potential test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Using Auto Cursors

To place Cursors on the important trace features, follow one of these procedures.

- **Using the Mouse** - simply **left-click on a trial / trace to select it**, the trial will be displayed in yellow. Now, **right-click** the mouse and select **Auto Place Cursors** from the pop-up menu. Cursors will be placed on the selected trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.
- **Using the Mouse and F9 (Auto Cursors) function key** - simply **left-click on a trace/trial to select it**, the trace/trial will be displayed in yellow. Now, press the **F9** key. Cursors will be placed on the selected trace/trial and the values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

- **Using the Knobs** - press the **F5 (Cursor) function key** of the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial / Trace)** to select a trial, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, press the **F2 (AutoPlace Cursors) function key** and cursors will be placed on the selected trial. The values (latency, amplitude, etc.) derived from the cursors will be displayed in the **EP Cursor Table** window.

  After cursors have been placed, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

 In SEP test protocols you select **Trials** for cursor placement. In AEP, VEP, and P300 test protocols you select individual **Traces** for cursor placement.

 For information on configuring the default parameters for the Auto Cursors, see the individual test setup topics. SEP Test Setup, AEP Test Setup, VEP Test Setup. P300 Test Setup.

To adjust the positions of the Cursors, follow one of these procedures.

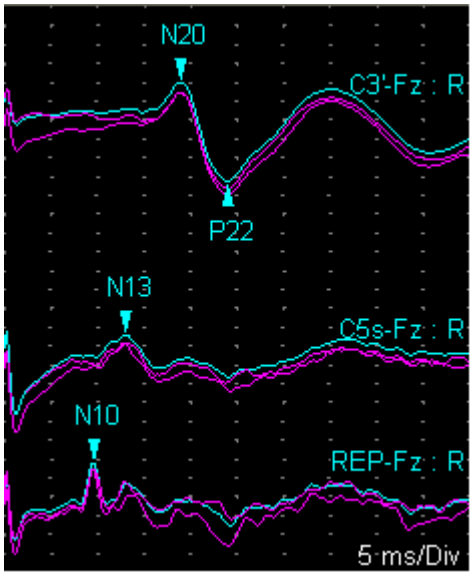
- **Using the Mouse** - simply click on the Cursor you want to move with the left mouse button and drag the cursor along the trace to its new location.
- **Using the Knobs** - press the **F5 (Cursor) function key** on the PC's keyboard. The program's knob and function keys will change to reflect the cursor mode controls. Use **Knob #3 (Sel Trial / Trace)** to select the trial with the cursors you need to adjust, when selected the trial will be displayed in yellow. Once the appropriate trial is selected, use **Knob #1 (Sel Cursor / Move)** to select and move the desired cursor.

  After cursor positions have been adjusted, press the **F5 (Cursor)** function key again or press the **OK** key on the Sierra Wave base unit to exit from Cursor mode.

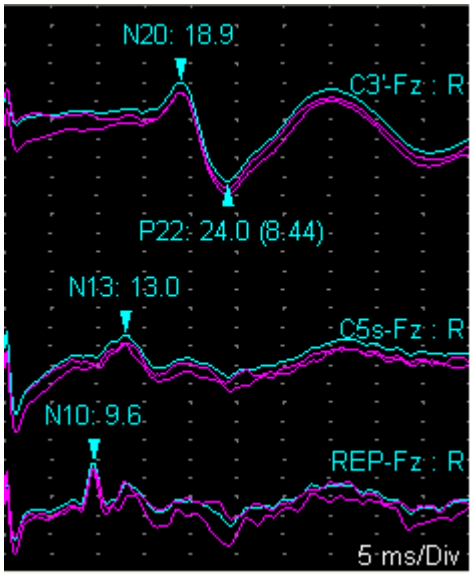
Cursor Display Format

There are three options for how the cursors will appear on the traces. The options are Show Labels, Labels & Values, and Show Values. This setting can be changed at any time by right-clicking over the Trace window and selecting **Cursor Display** from the pop-up window. The factory default selection is **Show Labels**.

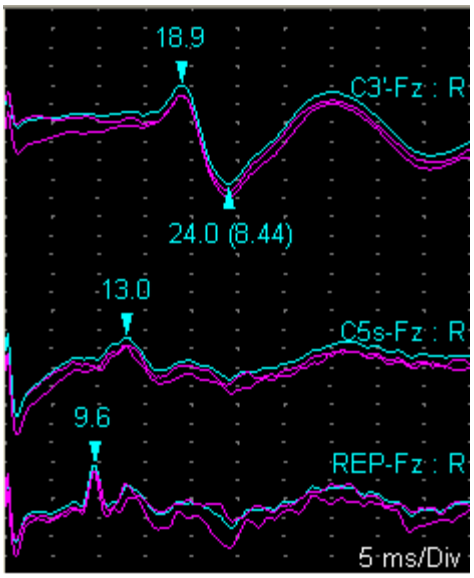
- **Show Labels** - shows the label names as entered in the auto-cursor table.



- **Labels and Values** - shows the label names mentioned above as well as the latency value for the cursor and the amplitude value between two cursors in brackets.



- **Show Values** - shows the latency value for the cursor and the amplitude values between two cursors in brackets.



Example EP Cursor Tables

Defined Measurements

	Trial	N20 (ms)	N13 (ms)	N10 (ms)	N20-N13 (ms)	N13-N10 (ms)	N20-N10 (ms)	N20-P22 (µV)
Normal Values →	Norm	<22	<16.3	<12.0	<6.8	<5.2	<10.9	
Results for Right Side →	Trial1 - R	20.9	15.0	11.6	5.9	3.4	9.3	7.55
Results for Left Side →	Trial3 - L	21.1	15.6	12.9	5.5	2.7	8.2	3.66
L - R Normal Values →	L-R Norm	<1.8	<1.5	<0.7	<1.1	<0.7	<0.8	
Calculated L - R Values →	L-R	0.2	0.6	1.3	0.4	0.7	1.1	3.89

Red color indicates abnormal value.

Example Median SEP Cursor Table.

Defined Measurements

	Trace	I (ms)	II (ms)	III (ms)	IV (ms)	V (ms)	I-III (ms)	III-V (ms)	I-V (ms)	V-Va (µV)	I-Ia (µV)	V-Va/I-Ia
Normal Values →	Norm	<2.0		<4.5		<6.2	<2.4	<2.3	<4.5			
Results for Right Side →	Ch2 : A2-Cz : R	1.64	2.77	3.69	4.92	5.66	2.05	1.97	4.02	0.54	0.49	1.10
Results for Left Side →	Ch1 : A1-Cz : L	1.69	2.75	3.78	4.92	6.05	2.09	2.27	4.36	0.10	0.55	0.18
L - R Normal Values →	L-R Norm						<0.28	<0.32	<0.33			
Calculated L - R Values →	L-R	0.05	0.02	0.09	0.00	0.39	0.04	0.30	**0.34**	0.44	0.06	0.92

Red Color indicates abnormal value

AEP cursor table example.

Defined Measurements

	Trace	N75 (ms)	P100 (ms)	N145 (ms)	N75-P100 (µV)
Results for Right Side →	Ch1 : Oz-Cz : R	72.3	101.2	128.9	11.18
Results for Left Side →	Ch1 : Oz-Cz : L	73.4	101.2	148.0	13.39
Calculated L - R Values →	L-R	1.2	0.0	19.1	2.21

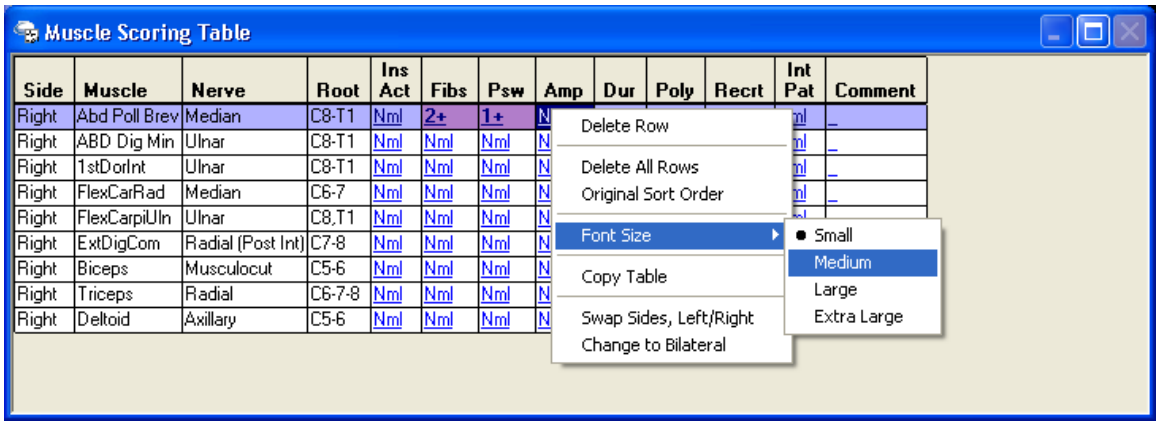
VEP cursor table example.

The program will calculate the left minus right difference values for each defined measurement after cursors have been placed on **one left** and **one right** side trial.

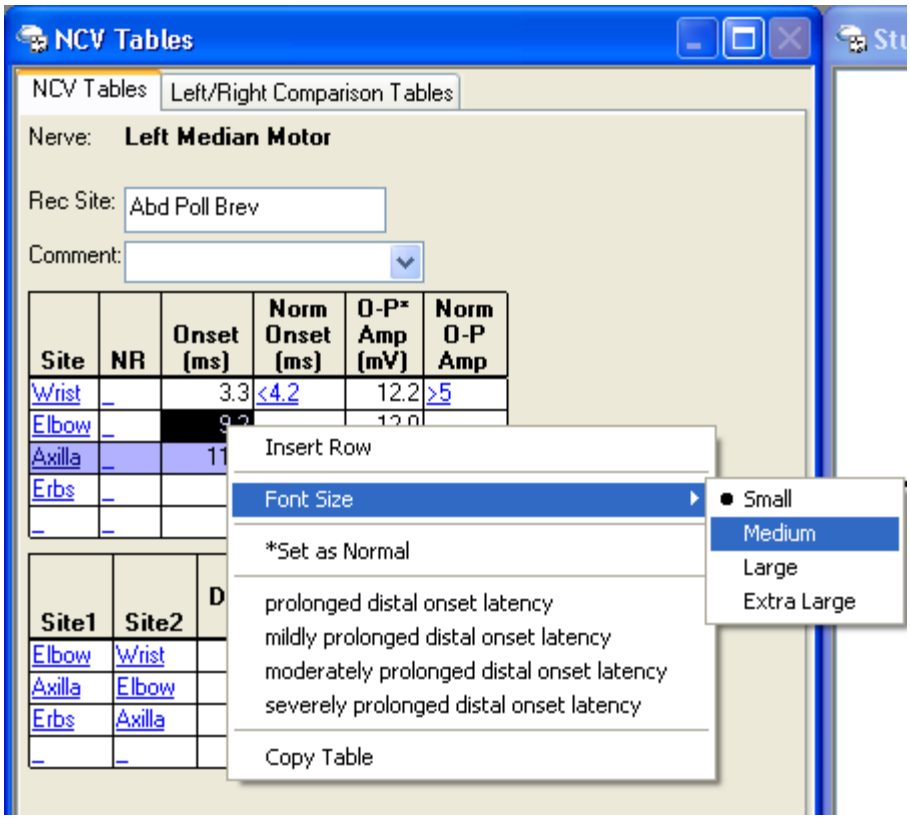
Depending on your preferences in System Setup, abnormal values can be flagged with a red background color, as bold text, as bold text with an asterisk, or as bold text & background color red.

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

Reject

In all evoked potential test protocols a rejection feature can be used to keep large amplitude artifacts from being included in the running average. The controls for the reject feature are found in the EP Controls window.

Reject On / Off - When this feature is turned **On** the program will monitor the **Live** un-averaged data and will not include (i.e., will reject) high amplitude artifacts from the running average. During data acquisition the percentage (%) of stimuli/sweeps that have been rejected from the total delivered will be displayed on the screen.

Level - This is the reject sensitivity level, it is shown as a percentage of full amplifier scale. Choices are 30 to 100 % in increments of 5. 100% equals full scale, smaller numbers will make the reject more sensitive.

Example SEP Averager settings.

How is Reject Determined?

Reject is based on the **Live** un-averaged data and the **Amp Gain** setting. Every channel has 5 divisions above and below its initial baseline. So, if the Amp Gain is set to 10 uV/Div this means that the Live trace has an amplitude window of 100 microvolts (10 vertical divisions times 10 uV/Div) with 50 uV above the baseline and 50 uV below the baseline.

If the reject level is set to 100% (i.e., full scale), then the amplitude of the live data must be below +/- 50 uV to be included in the running average. Should it exceed +/- 50 uV the trace will be rejected from the running average.

If the reject level is set to 50% (i.e., half of full scale), then the amplitude of the Live data can't exceed +/- 25 uV (2.5 divisions above or below the baseline) or it will be rejected from the running average. The lower the reject level setting the more sensitive the program will be in rejecting large artifacts.

What is my Amplifier Gain?

You can check the **Amp Gain** setting by pressing the **F1 (Avg / Live)** function key to switch to the **Live** mode. Press the function key again to return to the **Avg** mode and view the **Display Gain** setting.

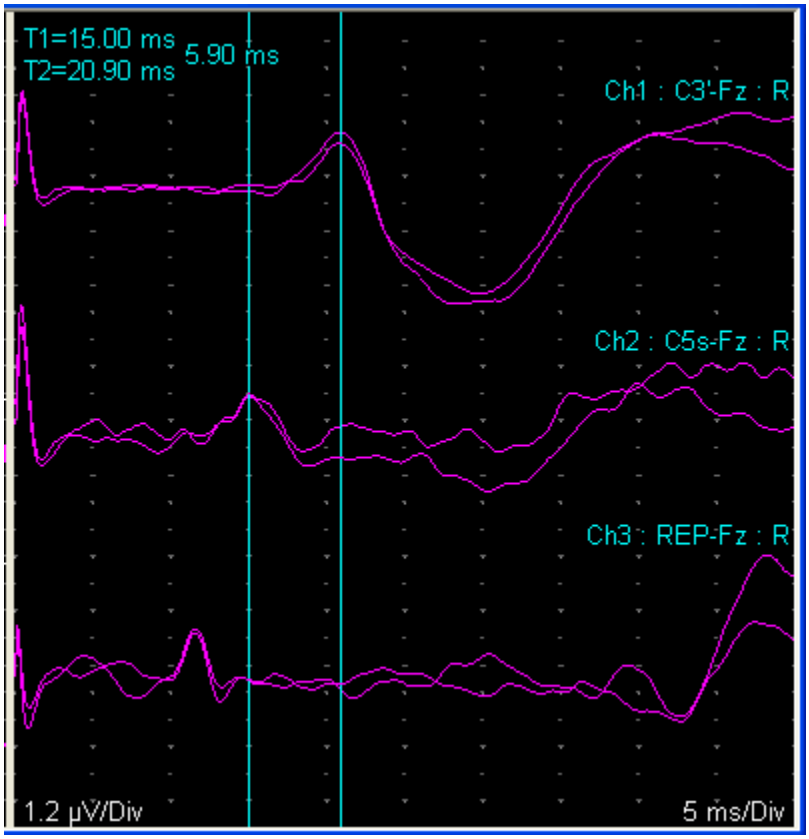
Using Time & Amplitude Markers

To quickly measure the latency or amplitude of a response, use the Time & Amplitude Markers.

Using the Time Markers

- **Right click** over the **EP Trace window** and select **Add Time Marker** from the pop-up menu. One vertical time marker will be displayed.
- **Move** the marker **by clicking** on it with the mouse **and dragging** it across the window.
- Repeat this process until the desired number of time markers are displayed.
- The **latency**, in milliseconds (from the left edge of the Trace window), is displayed for each Time Marker in the **upper left hand** corner of the Trace window. The **difference** between the two time markers is also indicated.

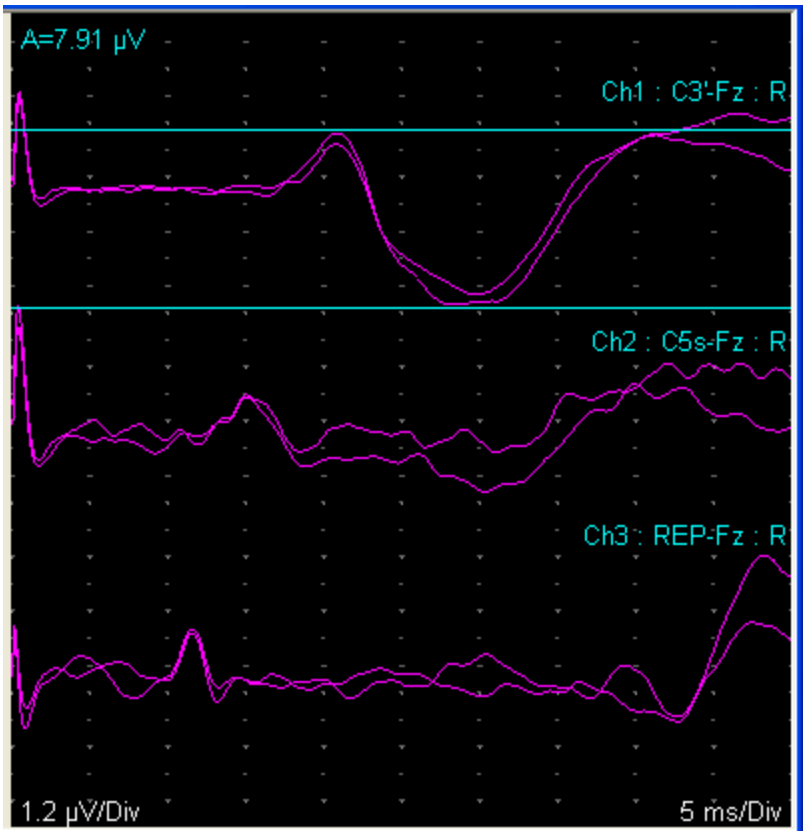
- To **remove** the Time Markers from the window, drag each time marker off the left-hand edge of the trace window.



SEP Trace window with Time Markers on the N13 and N20 peaks.

Using the Amplitude Markers

- **Right click** over the **EP Trace window** and **select Amplitude Markers** from the pop-up menu. Two horizontal amplitude markers will be displayed.
- **Move** the markers **by clicking** on them with the mouse **and dragging** them up or down in the window.
- The **amplitude**, in microvolts, between the two amplitude markers is shown in the **upper left hand** corner.
- To **remove** the Amplitude Markers from the window, **right click** over the **EP Trace window** and **de-select Amplitude Markers** from the pop-up menu.



SEP Trace window with Amplitude Markers measuring the N20-P22 response.

View Avg - View Live

In evoked potential test protocols you can toggle the Trace window between displaying the running average traces or the live un-averaged traces using the **F1 (Avg / Live)** function key.

F1 (Avg / Live) - defaults to **Avg** mode, in this mode the Trace window displays the results of the current running average. Press to activate **Live** mode, in Live mode the Trace window displays the un-averaged incoming data. Live mode is useful when troubleshooting artifact problems.

In **Avg** mode, the traces are displayed using the **Display Gain** setting. In **Live** mode, the traces are displayed using the **Amplifier Gain** setting.

Trace Positioning

Trace Positioning

There are several methods of changing the vertical positions of the evoked potential traces within the Trace window.

Using the Mouse:

Left click on the SEP trial or AEP/VEP/P300 trace you want to move **and drag** the trial or trace to it's new location.

In the SEP protocol, to select and move an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

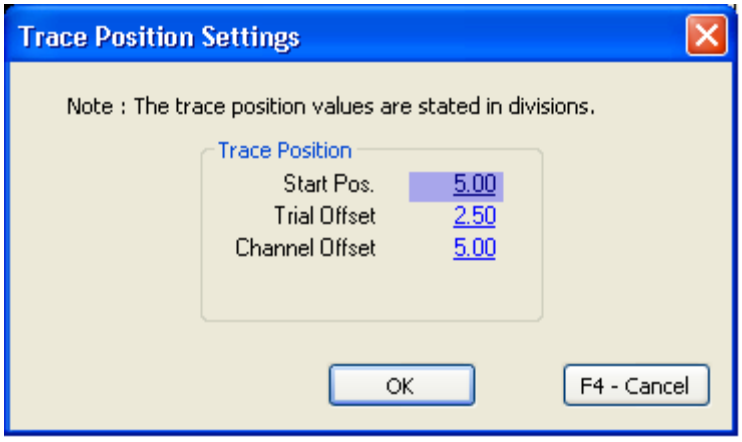
Using the Knobs:

1. Enter the **Position mode** by pressing the **F6** function key on the PC's keyboard.
2. Turn **Knob #1 (Sel Trial or Trace / Move)** until the trial or trace you want to move is selected. A selected trial/trace is displayed in yellow rather than purple.
3. **Press the knob** to activate the **Move** mode, now turn the knob to move the selected trial/trace up or down.
4. Press the knob a second time to return to the **Sel Trial or Trace** mode.

In the SEP protocol, to select and move an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

Using the Trace Position Settings:

1. **Right click** over the **EP Trace** window.
2. From the pop-up menu, select **Trace Position Settings**. The Trace Position Settings window will be displayed.



Trace Position Settings window.

3. Change the listed parameters, then click **OK**.

   Start Position: This is the default trace position for the first trace in the window. It is the number of vertical divisions below the top of the trace window. In this example, the first trace will be positioned 4 divisions below the top of the window.

   Trial Offset: This setting determines how much space will separate each stored evoked potential trace acquired from each channel. In this example the setting is 2.5 divisions, therefore the second evoked potential trace will be displayed 2.5 divisions below the first trace. If a third evoked potential trace is acquired it will be displayed 2.5 divisions below the second evoked potential trace and so on.

   Channel Offset: This setting only applies when more than one channel is turned ON. It is the amount of space, in vertical divisions, that separates the two active channels.

Trace Smoothing

High frequency noise can be removed from the evoked potential traces by applying a digital smoothing filter.

To Smooth All Traces:

- **Using the Mouse** - **right click** over the EP Trace window and select **Smooth All** from the pop-up menu.
- **Using the Knobs** - enter **Position** mode by pressing the **F6** function key on the PC's keyboard. Now press the **F2 (Smooth All)** function key.

To Smooth a Selected Trace:

- **Using the Mouse** - select the trial or trace you want to smooth by **left clicking** the mouse over it. When selected, the trial/trace will be displayed in yellow. Now, **right click** the mouse and select **Smooth** from the pop-up menu.

   In the SEP protocol, to select an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

- **Using the Knobs** - enter **Position** mode by pressing the **F6** function key on the PC's keyboard. Turn **Knob #1 (Sel Trial or Trace)** until the desired trial/trace is selected, when selected the trial/trace will be

displayed in yellow. Now press the F3 (Smooth) function key to smooth the selected trial/trace.

 In the SEP protocol, to select an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

To Remove Smoothing:

Right click the mouse over the EP Trace window. Select **Unsmooth All** from the pop-up menu.

Deleting Traces

To delete evoked potential traces use one of the following methods.

- **Using the Mouse** - **select the trial or trace** you want to delete **by clicking** on it with the **left mouse** button. When selected, the trial/trace color will change from **purple to yellow**. Now you can either **press the Clear key** on the Sierra Wave base unit or you can **right click** the mouse and select **Delete Selected Traces** from the pop-up menu. A confirmation message will be displayed, click **OK** and the selected trial/trace will be deleted.

 In the SEP protocol, to select an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

- **Using the Knobs** - enter the **Position mode** by pressing the **F6** function key. Now **turn Knob #3 (Sel Trial or Trace / Delete)** until the trial/trace you want to delete is selected, a selected trial/trace is displayed in yellow. **Press the knob to delete** the selected trial/trace. Exit Position mode by pressing the F6 function key a second time or by pressing the OK key on the Sierra Wave base unit.

 In the SEP protocol, to select and delete an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

Change Gain of a Stored Trace

To change the gain of a stored EP trial or trace, perform the following.

1. **Select the Trial or Trace** you want to change.

- **Using the Mouse** - simply left click the mouse over the trial or trace, when selected the trial/trace will be displayed in yellow rather than purple.

  In the SEP protocol, to select an individual trace, rather than the entire trial, first right click the mouse and disable the "Trial Selection Mode" setting in the pop-up menu by clicking on it to remove the checkmark.

- **Using the Knobs** - enter **Position mode** by pressing the **F6** function key on the PC's keyboard. Turn **Knob #1 (Sel Trial or Trace / Move)** until the desired trial/trace is selected.

  In the SEP protocol, to select an individual trace, rather than the entire trial, first press the **F4 (Trace / Trial)** function key to toggle the function to **Trace** mode.

2. Now, **turn Knob #4 (Gain)**, the selected trial/trace will be changed and it's current gain value will be displayed on the knob's icon.

Trace Labels

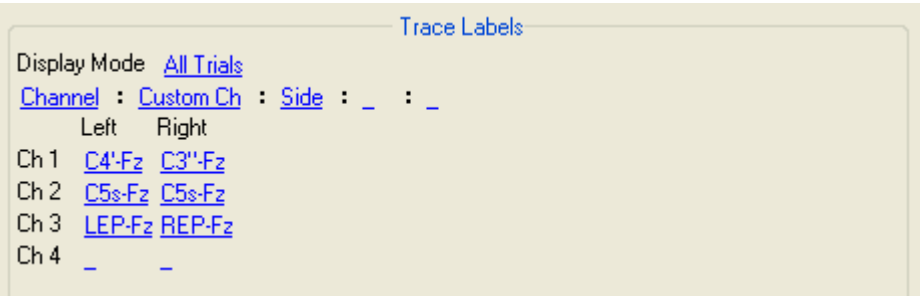
The labels that appear at the right end of each trace are programmed in the evoked potential's Test Setup window.

To open the Test Setup window:

- Select **Test Setup** from the **File** menu. Now click on the individual test protocol name in the Test Lists column. The default trace label settings are displayed in the Trace Labels section.

Trace Labels

This section is used to configure how the trace labels are displayed and allows you to choose the type of information that is included in the trace labels. The trace label can consist of up to five parameters. The parameters can be separated by a colon (:), a hyphen (–), or a line return (↵).



Example SEP test protocol trace label setup.

Display Mode: Click here to specify how the trace labels will be displayed during data acquisition. The choices are;

- **All Trials** - trace labels are shown on all traces.
- **No Trials** - trace labels are not shown on any traces.
- **First Trial** - only the first trace/trial acquired on each side has a trace label.
- **Active Trial** - only the active (white traces) have trace labels.

Trace Label Selections: (up to 5 can be selected)

- **Trial** - shows the trial number or the display mode of active traces (Avg or Live).
- **Channel** - shows the amplifier channel number.
- **Side** - shows the side being tested.
- **Gain** - shows the display gain setting.
- **Sweep** - shows the sweep speed setting.
- **Intensity** - shows the stimulus intensity setting.
- **Rep Rate** - shows the stimulus repetition rate.
- **Time** - shows the time of day.
- **Custom Ch** - allows you to include notations that only appear for a specific channel or side (i.e., C4'-Fz or A1-Cz montage designations).

Left / Right Custom Labels:

When **Custom Ch** is selected for one of the five parameters the Left/Right Channel area becomes activated. This allows you to enter a text label of your choice for each channel on a left/right basis. This is most commonly used to display the amplifier montage on the channel's trace label.

Separators:

The parameters can be separated by a colon (:), a hyphen (-), or a line return (↵). Simply click the mouse on the separator and select the type that you want from the pop-up list. The line return can be used to put parameters that follow it on a second line.

To change the Trace Labels after data acquisition:

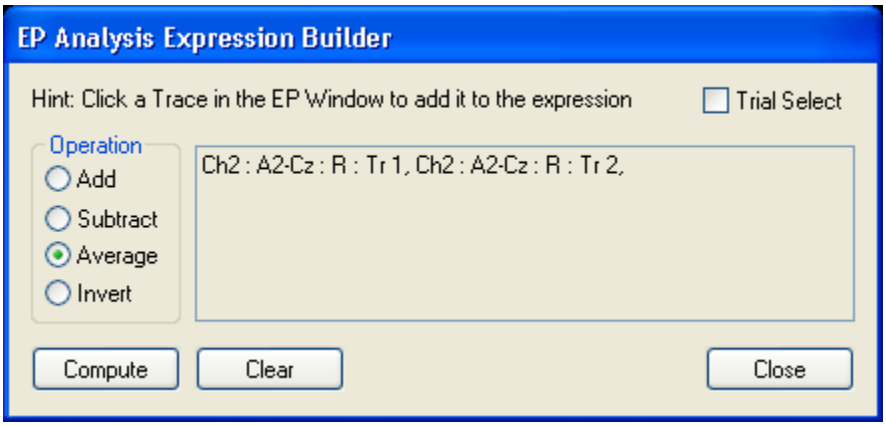
- Select **Edit Current Test** from the **Edit** menu. Make the necessary changes to the Trace Label setup and click **OK**.

EP Analysis

The Sierra Wave program contains an evoked potential analysis module that can be used to **Add**, **Average**, **Subtract**, or **Invert** selected traces.

To open the Analyze module:

- **Right click** the mouse over the **EP Trace** window.
- From the pop-up menu, select **Analyze**.
- The **EP Analysis Expression Builder** window is displayed.



Example analyze window using AEP test data.

To perform EP analysis, follow these steps.

1. Open the Analyze window as described above.
2. Select the **type of operation** that will be performed. Choices are **Add, Subtract**, **Average**, or **Invert**.
3. **Build** the **analysis expression** by **selecting traces** and adding them to the expression. Simply left click the mouse on the traces you want to include in the operation. Each trace's label will be added to the expression. In the above example, the trial #1 (A2-Cz) trace from channel 2 is being averaged with the trial #2 (A2-Cz) trace also from channel 2.

   Use the **Clear** button to erase the expression and start a new one.
4. Once the analysis expression has been built, click the **Compute** button. The results of the analysis are displayed within the Trace window in a **blue** color. In addition, the resulting trace label will contain the text "Avg", "Sub", or "Add". The result of the Invert operation does not result in additional traces, the original traces are simply inverted.

5. Click the **Close** button when all EP Analysis operations are complete.

Grand Average

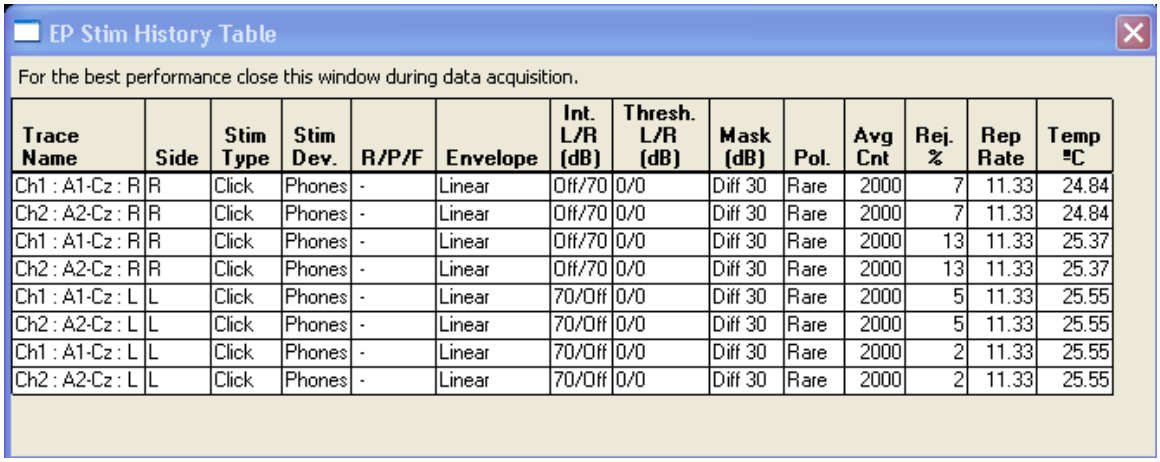
To perform a grand average on an evoked potential, follow these steps.

1. **Right click** the mouse over the **EP Trace** window.
2. Select **Grand Average** from the pop-up menu.
3. The grand averages are computed and the resulting traces are displayed within the Trace window in **blue** color and have the text "GAvg" as part of their trace label.

Grand Averages are computed separately for each channel and for each side of stimulation.

Stim History window

Press the **F11-Stim Hist.** function key to open a window listing the stimulation parameters for each trial that has been run.



Trace Name	Side	Stim Type	Stim Dev.	R/P/F	Envelope	Int. L/R (dB)	Thresh. L/R (dB)	Mask (dB)	Pol.	Avg Cnt	Rej. %	Rep Rate	Temp °C
Ch1 : A1-Cz : R	R	Click	Phones	-	Linear	Off/70	0/0	Diff 30	Rare	2000	7	11.33	24.84
Ch2 : A2-Cz : R	R	Click	Phones	-	Linear	Off/70	0/0	Diff 30	Rare	2000	7	11.33	24.84
Ch1 : A1-Cz : R	R	Click	Phones	-	Linear	Off/70	0/0	Diff 30	Rare	2000	13	11.33	25.37
Ch2 : A2-Cz : R	R	Click	Phones	-	Linear	Off/70	0/0	Diff 30	Rare	2000	13	11.33	25.37
Ch1 : A1-Cz : L	L	Click	Phones	-	Linear	70/Off	0/0	Diff 30	Rare	2000	5	11.33	25.55
Ch2 : A2-Cz : L	L	Click	Phones	-	Linear	70/Off	0/0	Diff 30	Rare	2000	5	11.33	25.55
Ch1 : A1-Cz : L	L	Click	Phones	-	Linear	70/Off	0/0	Diff 30	Rare	2000	2	11.33	25.55
Ch2 : A2-Cz : L	L	Click	Phones	-	Linear	70/Off	0/0	Diff 30	Rare	2000	2	11.33	25.55

Start New Run

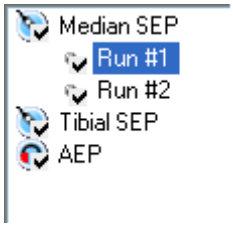
If you decide to repeat an evoked potential you have a choice of clearing the previously acquired data for the evoked potential or of keeping the previously acquired data.

To Clear the Previous Data & Repeat:

1. **Right click** the mouse **in the EP Trace window** over the previously acquired traces. From the pop-up menu select **Delete All Stored Trials.**
2. A confirmation message will be displayed. Click **OK** and all previous data for the evoked potential is cleared.
3. **Acquire new data** in the normal fashion.

To Keep the Previous Data & Repeat:

1. **Right click** the mouse over the **evoked potential's name** in the **Study window**. From the pop-up menu select **Start New Run**.
2. A second run node will be displayed under the evoked potential test's name.
3. Acquire new data in the normal fashion.
4. To view the first run select **Run #1** from the Study window. To view the second run select **Run #2**.



Two separate runs have been acquired for the Median SEP.

5. If you want **to delete one of the runs** for the evoked potential test, simply **right click** over the run you want to delete and select **Delete** from the pop-up menu. A confirmation message will be displayed, click **OK** to delete the run.

Split Screen Controls

To Change the Split Screen Controls during data acquisition:

- **Right click** the mouse over the **EP Trace** window. From the pop-up menu select either **Full Screen**, **Vertical Split**, or **Horizontal Split**.

The default layout of the EP Trace window is programmed in the evoked potential's Test Setup window.

To open the Test Setup window and change the default layout:

- Select **Test Setup** from the **File** menu. Now click on the individual test protocol name in the Test Lists column. The default layout for the Trace window is specified in the **Display Settings** section.
- Make the appropriate changes and click **OK**.

Display Settings

Side: Click here to set the default setting for the **side of stimulation**. The choices are **Left**, **Right**, and **Bilateral**. For example, selecting Right will always set the initial side of stimulation to "Right" when the test protocol is selected. This setting can be changed on the acquisition screen if you want to begin stimulation on the opposite side.

Split Screen: Click here to set the default setting for how the trace window is displayed. The choices are **Full**, **Vertical** and **Horizontal**.

- **Full** - sets the trace area to full, all data from all sides are displayed in the same trace area.
- **Vertical** - splits the trace area into two equal halves with a vertical divider. Left sided traces are displayed on the left half of the trace window. Right sided traces are displayed on the right half of the trace window.
- **Horizontal** - splits the trace area into two equal halves with a horizontal divider. Left sided traces are displayed in the top half of the trace window. Right sided traces are displayed in the lower half of the trace window.

Stim Avg - Stim On

In some circumstances you may want to run the averager independent of the stimulator. This is useful during AEP testing on infants when starting and stopping the stimulator could awaken the sleeping infant.

The F2 function key can be used for this purpose.

F2 (Stim Avg / Stim On) - defaults to **Stim Avg** mode, in this mode the averager is synchronized with stimulus delivery and the Run/Stop key is used to start and stop both simultaneously. Press to activate **Stim On** mode, in this mode the stimulator is automatically turned ON and the averager can be turned On or Off independently of the stimulator using the Run/Stop key.

Saving Changes to EP Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the EP test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

RR Interval

RR Interval Basic Steps

Select the RR Interval Test:

- **If a Study has already been selected**, simply click on the RR Interval test protocol within the Study window or turn **Knob #1 (Study Item / Site)** to highlight the test.
- **If a Study has not been selected, or you don't want to use a Study.** Select the RR Interval test protocol from the Study/Test menu.

Follow these steps for performing the RR Interval test:

1. **Apply electrodes to the patient and connect to amplifier**

   Surface electrodes are used to record the ECG signal. Connect the electrodes to Act1-Ref1 inputs so that the ECG peak is shown as an upward deflection in the trace window. The Live ECG signal is displayed as soon as the test protocol is loaded.

2. **Verify Amplifier Settings**

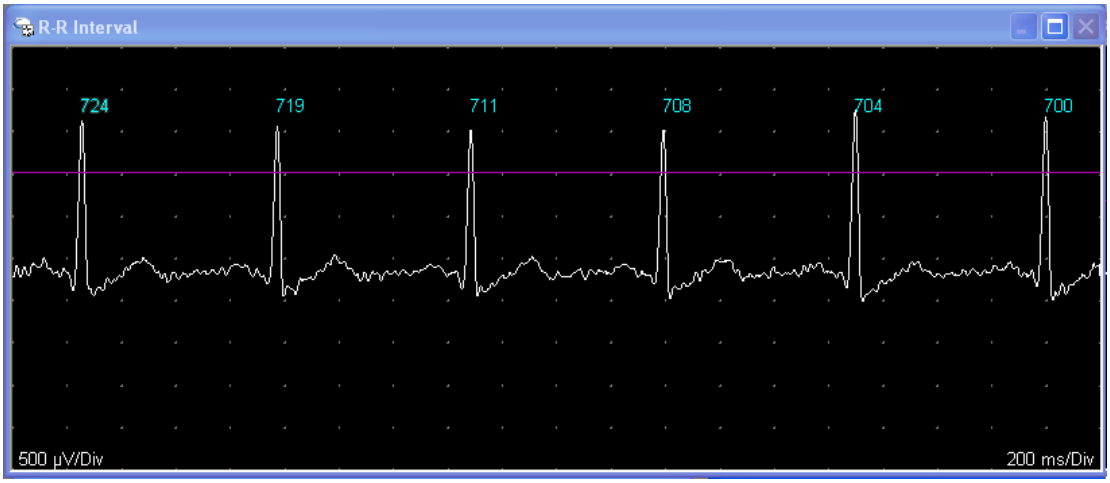
   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate. You want to visualize 3 or more ECG peaks across the sweep.

Typical Settings

	Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
RR Interval	200-500	50	1	200

3. **Adjust the Peak Detection Threshold**

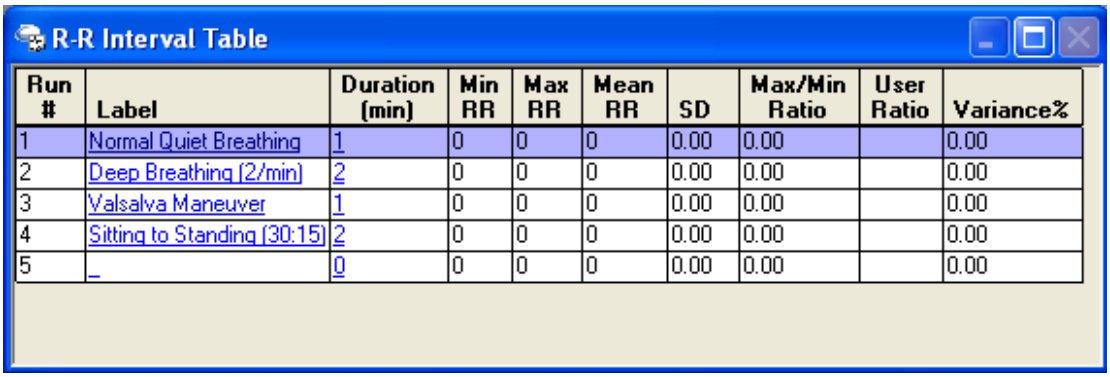
The peak detection threshold line should be positioned about halfway up the ECG peak. Use **Knob #3 (Trigger Level)** to move the detection line up or down. The RR Interval (ms) or Heart Rate (bmp) will be shown in blue text next to the ECG peak.



RR Interval Trace window.

4. Select a Run in the RR Interval Table

The RR Interval test protocol supports up to 5 preprogrammed data acquisition runs. This table labels the run and controls the amount of time (duration) that the Sierra Wave will acquire data. Click on a row in the table to select it and give instructions to the patient that are appropriate for the run selected (e.g., begin deep breathing).



Run #	Label	Duration (min)	Min RR	Max RR	Mean RR	SD	Max/Min Ratio	User Ratio	Variance%
1	Normal Quiet Breathing	1	0	0	0	0.00	0.00		0.00
2	Deep Breathing (2/min)	2	0	0	0	0.00	0.00		0.00
3	Valsalva Maneuver	1	0	0	0	0.00	0.00		0.00
4	Sitting to Standing (30:15)	2	0	0	0	0.00	0.00		0.00
5	_	0	0	0	0	0.00	0.00		0.00

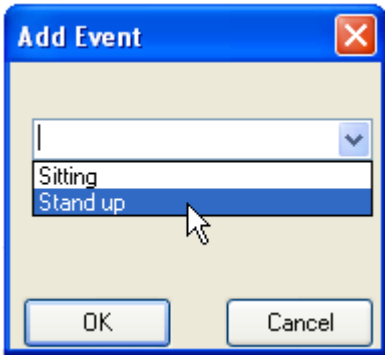
RR Interval Run Table.

5. Begin Data Acquisition

Press the **Run/Stop key** on the Sierra Wave base unit to begin data acquisition. The text **Recording Run #*n*** will be displayed in the trace window to indicate that the Sierra Wave is acquiring RR Interval data for the selected run. RR Datapoints will begin to be plotted within the RR Datapoint Graph.

6. Enter Events (optional)

Events can be entered during data collection by pressing the **F1 (Events)** function key.

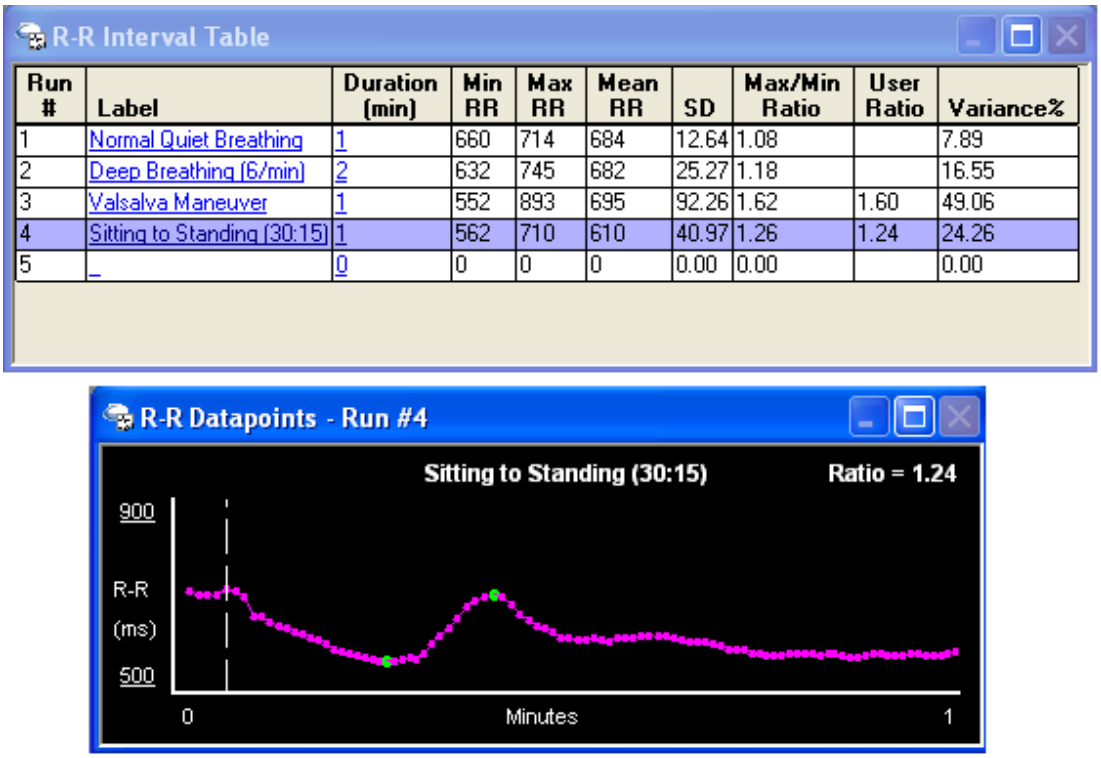


Type in the text for the event or select a preprogrammed event from the drop-down list and then click the **OK** button. A dashed vertical line will appear in the RR Datapoint Graph to indicate the event.

7. Stop Data Acquisition

The program will automatically stop data acquisition when the Duration setting specified for the run has been reached. You can also manually stop data acquisition at any time by pressing the **Run/Stop key**. As soon as data acquisition is stopped the program will calculate and display the results for the run in the **RR Interval Table**.

The Live ECG trace will continue to be displayed even though data collection has stopped.



Completed RR Interval Table and corresponding Datapoint Graph for Run #4.

The program displays the following measurements for each run:

- **Min RR** - minimum RR interval recorded during the run.
- **Max RR** - maximum RR interval recorded during the run.
- **Mean RR** - the mean RR interval for the run.
- **Min/Max Ratio** - the ratio of the minimum to maximum RR interval for the run.
- **SD** - the standard deviation of the RR interval for the run.
- **Variance %** - the percentage of variance for the run. *(Max – Min) / Mean x 100*

The program can be configured to display the results in Heart Rate (bpm) values rather than RR Intervals (ms). Please refer to the RR Interval Setup topic for details.

8. Make Adjustments to RR Datapoint Graph (optional)

The following functions can be performed within the RR Datapoint Graph.

- **Change Y-Axis** - click on the upper or lower limit of the Y-axis and then enter the desired value. The graph will automatically be re-drawn.

- **Calculate Ratio** - the program automatically calculates the Min/Max Ratio for the lowest and highest values recorded within the run. You can also manually calculate a ratio between any two selected data points. The manually calculated ratio is displayed in the upper right corner of the datapoint graph and in the **User Ratio** column of the RR Interval table.

  To calculate a manual ratio:

  a. Right click within the datapoint graph.

  b. Select **Calculate Ratio** from the pop-up menu.

  c. Click on the first data point, the data point will be displayed in green.

  d. Click on the second data point, the data point will be displayed in green.

  e. The ratio is calculated and displayed in the upper right corner.

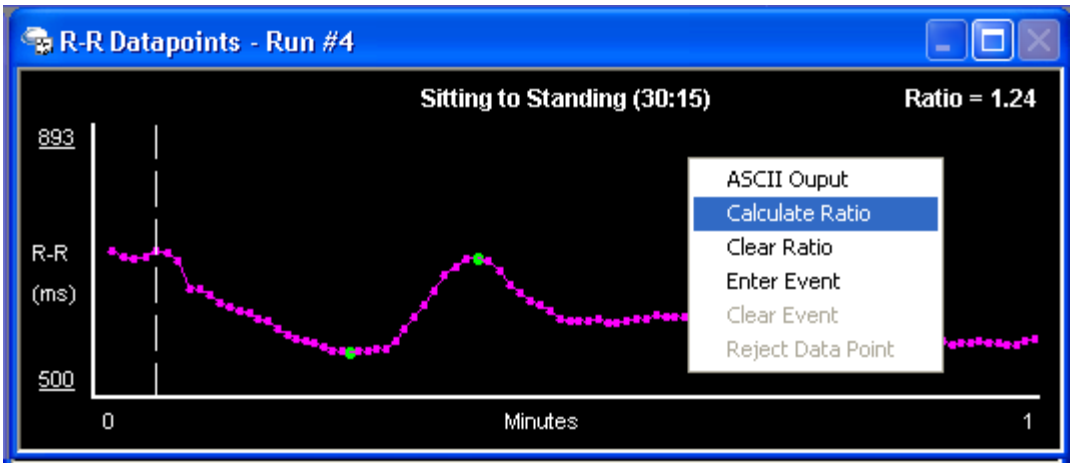
- **Clear Ratio** - select this option in the pop-up menu to clear a manual ratio.

- **Enter Event** - right click on the data point corresponding to where you would like to enter an event, then select **Enter Event** from the pop-up menu. Type in the text for the event, or select a preprogrammed event from the list, then click **OK**. A dashed vertical line will be displayed in the graph.

   Position the mouse over the vertical dashed line to view a pop-up box of the event text.

- **Clear Event** - to remove an event, right click over the vertical dashed line and select **Clear Event** from the pop-up menu.

- **Reject Data Point** - to remove a data point, right click over the point and select **Reject Data Point** from the pop-up menu. The deleted point will be shown in gray color.



RR Datapoint Graph and right-click menu.

9. Repeat Steps 4-9 for other Runs

To record additional runs, repeat steps 4 through 9.

10. TabData (optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the **Sierra Wave base unit**.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the **Sierra Wave base unit** or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the **report buttons** at the bottom of the TabData window, or press the corresponding function key on the **Sierra Wave base unit**.

11. Next Test (optional)

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (RR Interval)

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Trigger Lvl - turn this knob to change the vertical position of the ECG trigger level indicator.

Gain / Sweep - turn the knob to change the gain of the ECG trace. Press the knob, then turn to change the sweep speed of the ECG trace.

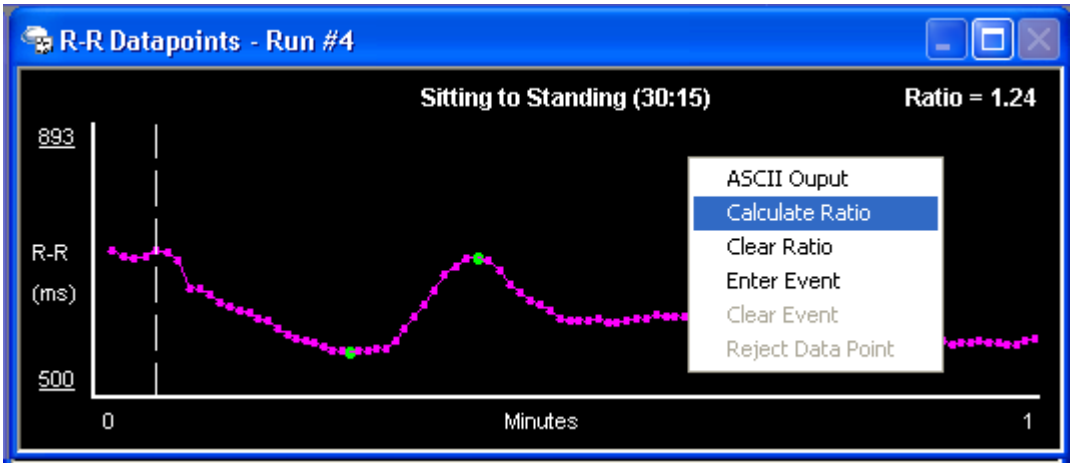
Function Keys

Event - opens the Add Event window which allows you enter an event during a recording.

TabData - opens the TabData Summary window.

RR Datapoint Graph

The following functions can be performed within the RR Datapoint Graph.



RR Datapoint Graph and right-click menu.

- **Change Y-Axis** - simply click on the upper or lower limit of the Y-axis and then enter the desired value. The graph will automatically be re-drawn.
- **Calculate Ratio** - the program automatically calculates the Min/Max Ratio for the lowest and highest values recorded within the run. You can also manually calculate a ratio between any two selected data points. The manually calculated ratio is displayed in the upper right corner of the datapoint graph and in the User Ratio column of the run table.

  To calculate a manual ratio:

  a. Right click within the datapoint graph.

  b. Select **Calculate Ratio** from the pop-up menu.

  c. Click on the first data point, the data point will be displayed in green.

  d. Click on the second data point, the data point will be displayed in green.

  e. The ratio is calculated and displayed in the upper right corner.

- **Clear Ratio** - select this option in the pop-up menu to clear a manual ratio.
- **Enter Event** - right click on the data point corresponding to where you would like to enter an event, then select **Enter Event** from the pop-up

menu. Type in the text for the event, or select a preprogrammed event from the list, then click **OK**. A dashed vertical line will be displayed in the graph.

 Position the mouse over the vertical dashed line to view a pop-up box of the event text.

- **Clear Event** - to remove an event, right click over the vertical dashed line and select **Clear Event** from the pop-up menu.
- **Reject Data Point** - to remove a data point, right click over the point and select **Reject Data Point** from the pop-up menu. The deleted point will be shown in gray color.
- **Ascii Output** - allows the RR interval data points to be output to an ASCII file. The ASCII file is saved as a 'comma separated values' file; this means it can be opened easily with a spreadsheet or analysis program.

Reviewing a Run

To review the Datapoint Graph for a Run, perform one of the following:

- Click on **Run #** in **Study window**.
- Click on the Run's corresponding **row** in the **RR Interval Table**

In both cases, the Datapoint Graph for the selected run will be displayed.

 If no data was acquired for the selected run, the Datapoint Graph will be empty.

Deleting/Clearing a Run

To Delete or Clear the data for a Run, perform one of the following:

- **Right click** on the **Run #** in the **Study window**, select **Delete** from the pop-up menu.
- **Right click** over the Run's corresponding **row** in the **RR Interval Table**, select **Clear Row** from the pop-up menu.

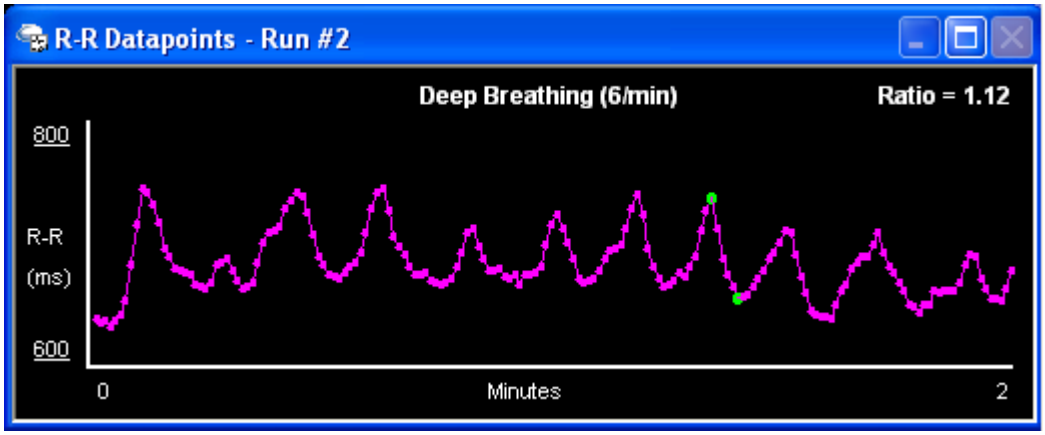
In both cases, the tabulated results for the run will be erased and the Datapoint Graph will be cleared.

Normative Data

Deep Breathing:

6 breaths per minute for 1 or 2 minutes (5 seconds inhale, 5 seconds exhale).

AGE (yrs)	Norm Max/Min Ratio
16-20	>1.23
21-25	>1.20
26-30	>1.18
31-35	>1.16
36-40	>1.14
41-45	>1.12
46-50	>1.11
51-55	>1.09
56-60	>1.08
61-65	>1.07
66-70	>1.06
71-75	>1.06
75-80	>1.05



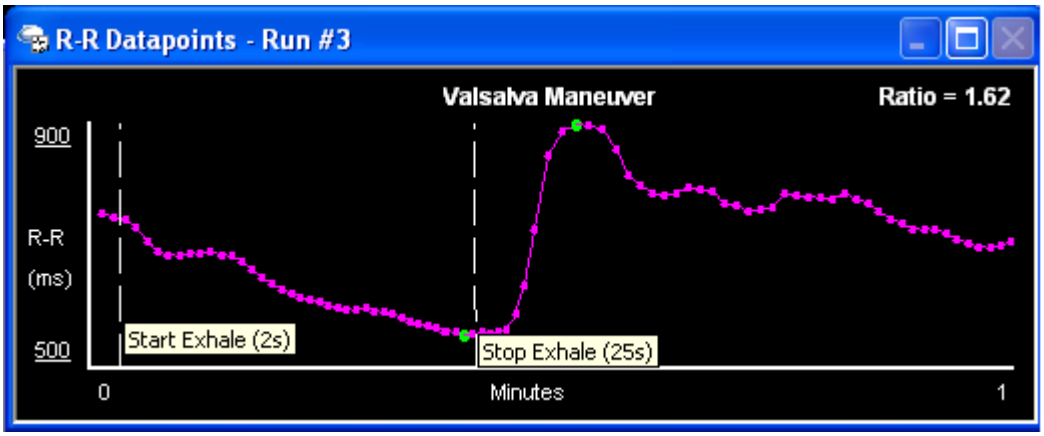
Example Deep Breathing (42 year old)

Valsalva Maneuver:

Patient inhales deeply and then forcibly exhales into a leaky mouthpiece and maintains a constant pressure for 15-20 seconds before releasing and completely exhaling.

Ratio is calculated using the Max RR after cessation of forced exhale divided by the Min RR during the 15-20 seconds of forced exhale.

AGE (yrs)	Norm Max/Min Ratio
10-40	>1.5
41-50	>1.45
51-60	>1.45
61-70	>1.35

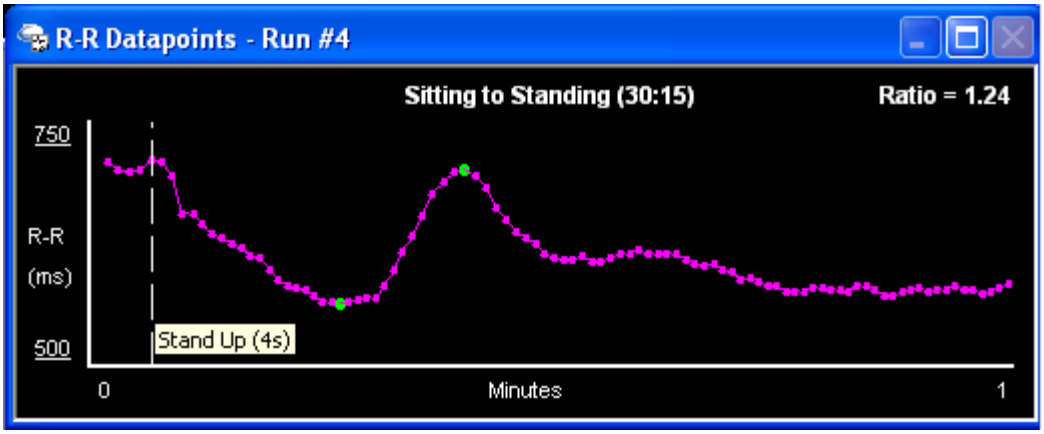


Example Valsalva Maneuver (42 year old)

Sitting To Standing:

Patient goes from sitting position to standing up. The 30:15 ratio is typically calculated, this is the RR interval at beat 30 after standing divided by the RR Interval at beat 15 after standing.

AGE (yrs)	Norm 30:15 Ratio
10-29	>1.17
30-49	>1.09
50-65	>1.03



Example Sitting-To-Standing (42 year old)

Reference:

AAEM Minimonograph #48

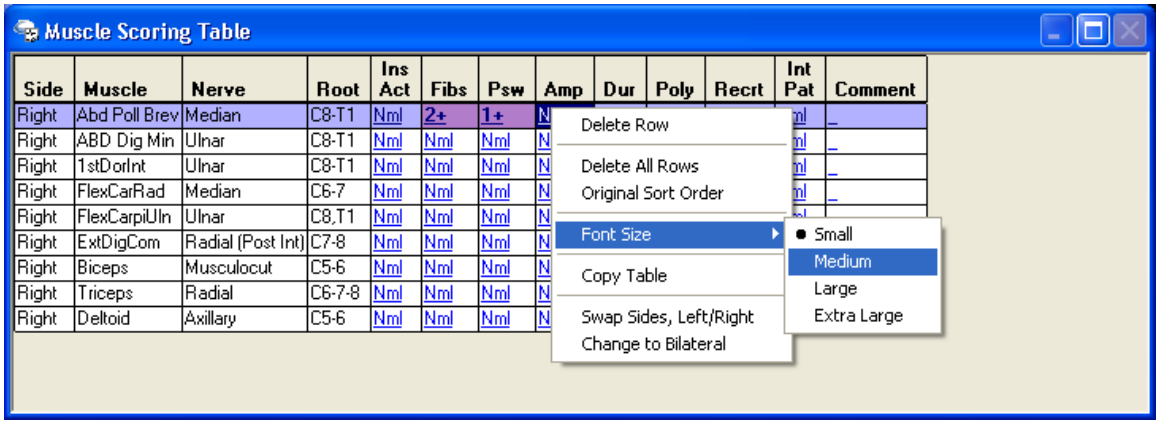
Autonomic Nervous System Testing

John M. Ravits, MD

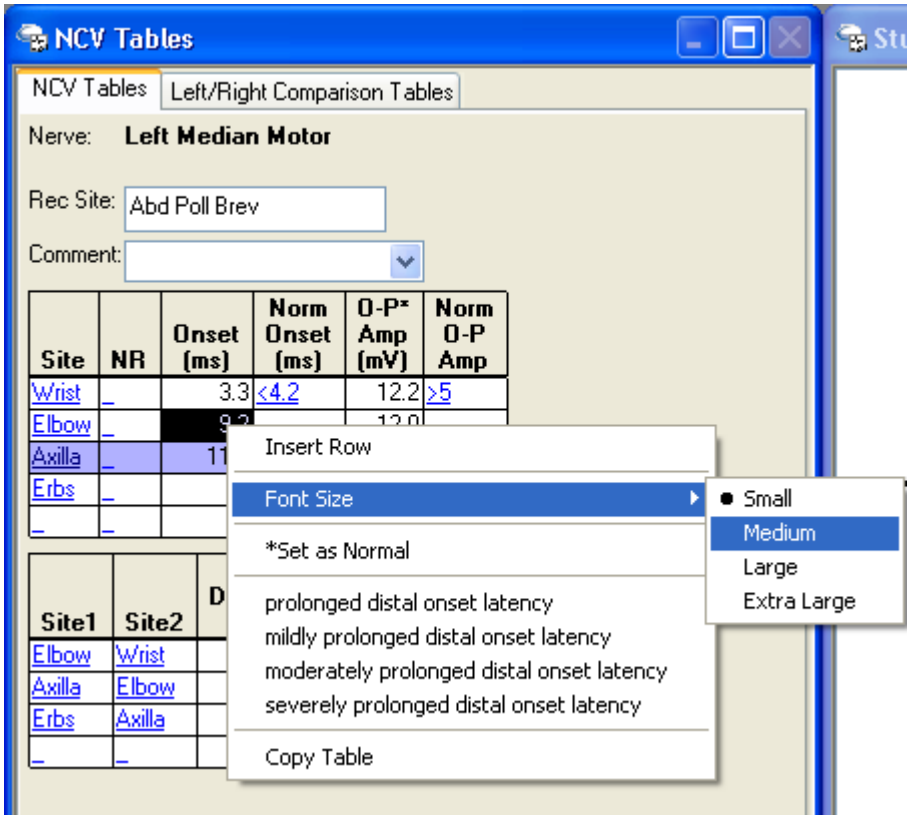
Muscle & Nerve, August 1997

Table Font Size

In all test protocols the font size of the Table window can be increased or decreased. Simply **right click** on the table and select **Font Size** from the pop-up menu. The choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.



Changing the font size of the Muscle Scoring Table.



Changing the font size of the NCV Tables.

To save your selection as part of the test protocol's default settings, select **Save Test Parameters** from the **Edit** menu.

The selected font size is also applied to that table in the TabData window.

Saving Changes to RR Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the RR Interval test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

MUNE - Incremental

MUNE-Incremental Basics

What is MUNE?

Motor unit number estimation (MUNE) refers to a group of electrophysiologic techniques that estimate the number of lower motor neurons (i.e. motor units) innervating a muscle. The motor unit number must be estimated, because there is no method to count the actual number of functioning lower motor neurons innervating a given muscle.

MUNE is obtained by dividing the size of the maximal CMAP by the size of the mean surface-recorded single motor unit potential (SMUP).

MUNE = Max CMAP (Area or Amplitude) / Mean SMUP (Area or Amplitude)

MUNE techniques differ in the ways in which they obtain samples of SMUPs from which the mean SMUP size is determined. All methods are quite reproducible, and the reliability improves as the number of motor units reduces.

Overview of Incremental MUNE

This protocol has two features that assist the user in determining if an increment is valid and is not due to alternation (see description below). First, the program performs on-line subtraction of successive incremental responses and displays the resulting difference traces, thereby showing the contribution of each recruited single motor unit potential. Second, a post data collection alternation detection function can be run which analyzes the incremental responses and notifies the user when cases of alternation exist in the data set.

 **Alternation** refers to the problems that occur when two or more motor units are capable of being activated at the same stimulus intensity. One or the other (or both) motor units may be recruited at any given time. Alternation results in a larger number of perceived increments, which in turn

results in a smaller mean SMUP value, and hence a larger or overestimated MUNE value. The alternation detection function sorts the incremental responses by increasing negative peak amplitude and then subtracts each incremental response from all subsequent ones; any identical solutions are considered to be examples of alternation.

The area/amplitude of each difference trace is tabulated and the mean SMUP value is calculated. The mean SMUP value is then divided into the Max CMAP value to provide the motor unit estimate.

The ability to record and store a sub-threshold response and automatically subtract this from each incremental response is also available. This can help to reduce stimulus artifact and improve the detection of the negative peak onset.

Select the MUNE-Incr Test:

- **If a Study has already been selected**, simply click on a MUNE-Incr muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual MUNE-Incr test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that as soon as any muscle is selected, it is displayed within the Study window.

The MUNE-Incr protocol defaults to the **Max CMAP** acquisition mode, note that the **F1** function key defaults to this setting.

Once the muscle has been selected. Follow these steps for performing MUNE-Incr data acquisition:

1. Verify Amplifier Settings

Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the muscle being tested.

Typical Settings

Max Gain (uV/Div)	Incr Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
5k	100	10k	10	3.0

2. Verify Side Setting

Make sure the appropriate side, **Right** or **Left**, is selected.

3. Electrode Placement

Attach the electrodes to the patient.

4. Check Stimulator Polarity

For MUNE Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

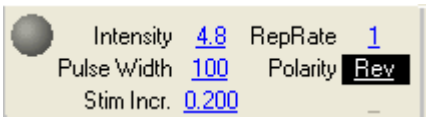
The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode.

In the **Normal mode**, the polarity field on the screen will indicate **Nml**.

Normal Polarity

In the **Reversed mode**, the polarity field on the screen will indicate **Rev**.

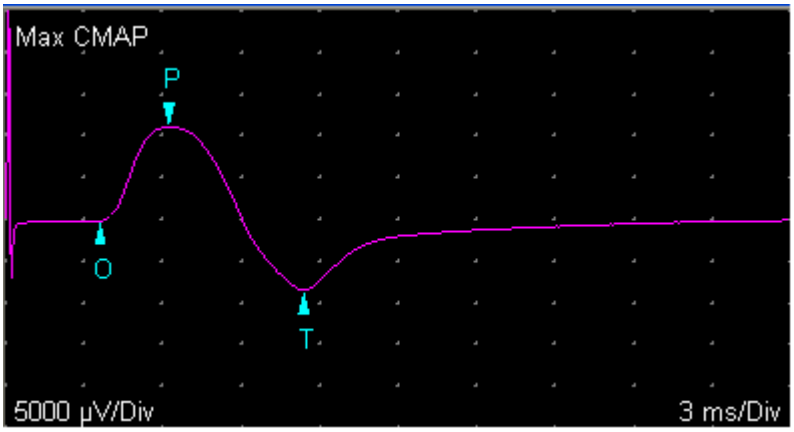


Reversed Polarity

5. Acquire the Max CMAP Response

Begin by acquiring the supra-maximal CMAP response in the upper left trace window. This window is labeled **Max CMAP**. Cursors are automatically

placed on the response and the area/amplitude of the response is shown in the MUNE Tables window.



Max CMAP

6. Enable Increments Acquisition Mode

Once the supra-maximal CMAP response has been acquired press the **F1 (Max CMAP/Increments)** function key to enable the **Increments** mode. This activates the trace window in the lower left section of the screen labeled **Increments** and automatically stores the Max CMAP response.

7. Acquire Sub-Threshold Response (Optional)

Press the **F8 (Sub Thr.)** function key to enable the sub-threshold feature. Turn down the stimulus intensity and acquire a sub-threshold response (i.e., the response prior to the first all-or-nothing single motor unit). Press the **Store** key to save the response. The sub-threshold response is colored **light-blue** on the screen and is labeled **sThr**. This response will be automatically subtracted from all subsequent incremental responses to help reduce stimulus artifact and improve the detection of the negative peak onset.

8. Acquire first All-or-Nothing Response

Slowly increase the stimulus intensity and acquire the first all-or-nothing response. The response should not fractionate or show changes in shape or size when stimulated repetitively at this intensity. Press the **Store** key to save the response. This trace is automatically copied to the **Difference** trace area as it is assumed to be the lowest threshold single motor unit potential (SMUP).

9. Acquire Response for Second Unit

Continue stimulation and slowly increase the stimulus intensity until a larger response appears, likely due to activation of a second motor unit. As soon as this response is acquired the program will compute the difference between this trace and the previously stored trace. The result is shown in the **Differences** trace area and the trace is labeled **2-1**.. The difference trace

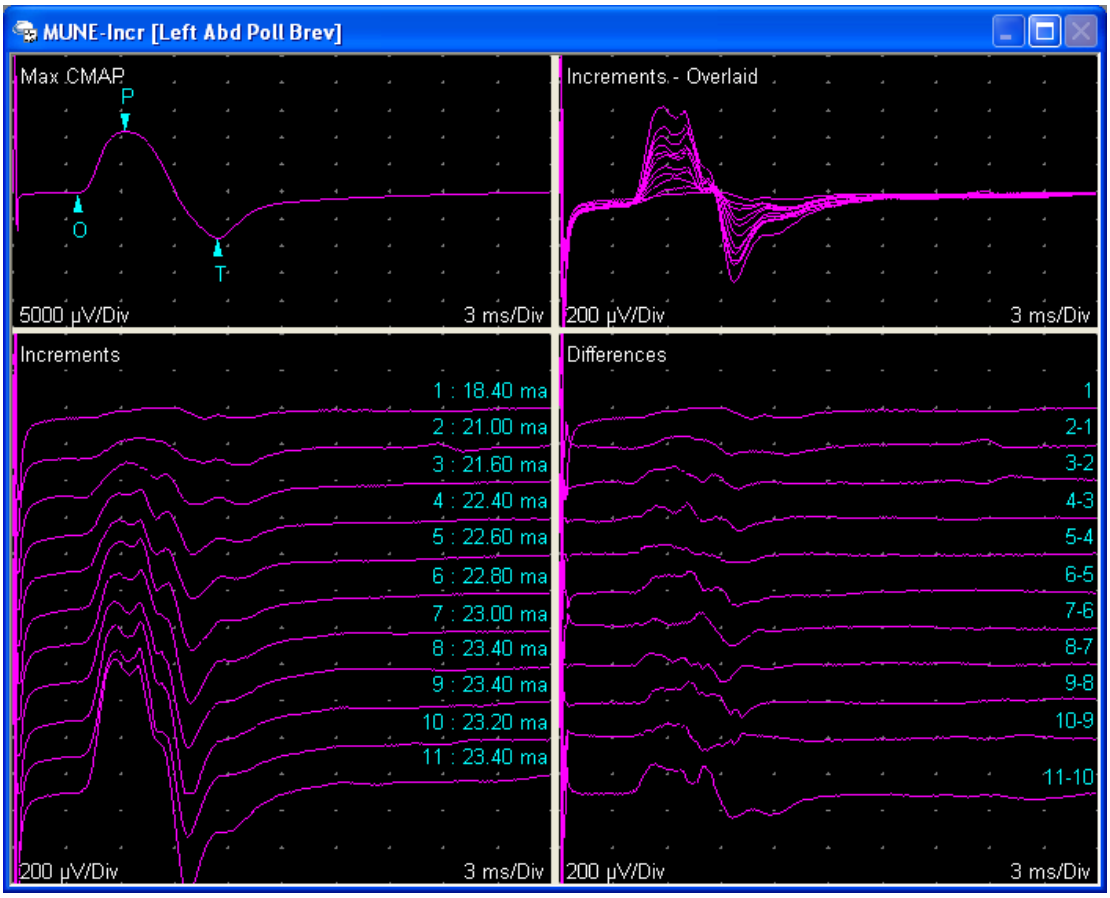
shows the contribution of the newly recruited motor unit. Press the **Store** key to save the increment and difference traces.

As increments are acquired and stored the area/amplitude of each difference trace is recorded in the MUNE Tables window. The mean SMUP area/amplitude is calculated and the MUNE value for the muscle is updated.

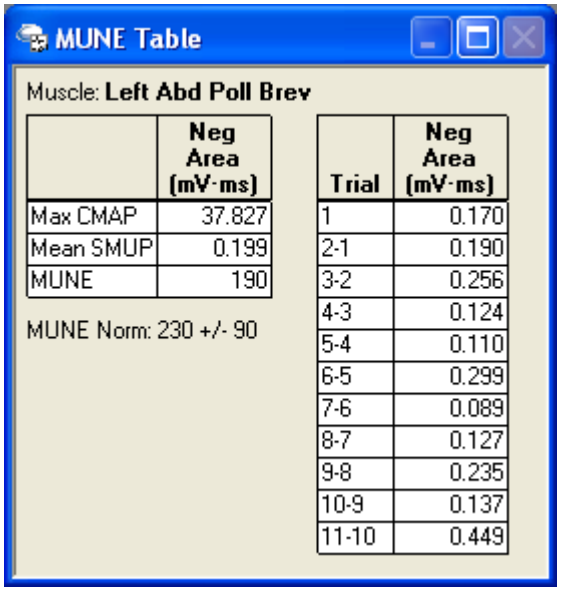
10. Acquire additional Incremental Responses

Continue to acquire and store additional increments. Typically 11 increments (10 difference traces) need to be acquired for an accurate estimate. The Gain can be adjusted in both the Increments and Difference trace areas. Use the Gain knob or Gain setting in the amplifier toolbar to change the gain of the incremental traces. Right-click over the Differences trace area to change the gain of the difference traces.

The trace area located above the difference traces will default to show the incremental traces in an overlayed fashion. You can right-click over this area and choose to display the difference traces in overlayed fashion.



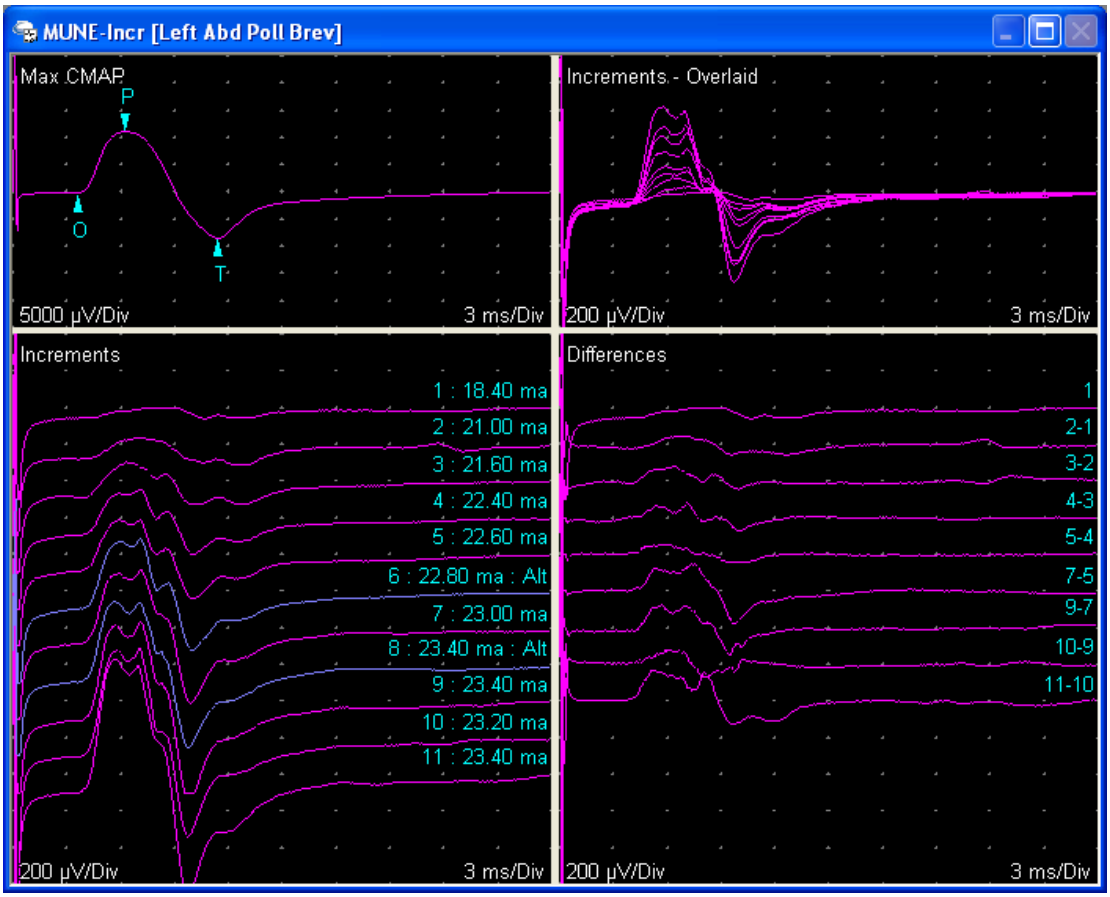
MUNE Incr - Trace window showing Max CMAP, Increments, and Differences



MUNE Table for traces shown above.

11. Check for Alternation (Optional)

After acquiring an appropriate number of increments, press the **F7 (Auto ALT)** function key to automatically detect for possible instances of alternation in the data set. The incremental responses are first sorted by increasing negative peak amplitude and then each incremental response is subtracted from all subsequent ones; any identical solutions (determined by cross-correlation) are considered to be examples of alternation. Cases of alternation are indicated by coloring the incremental trace **dark blue** and these traces are automatically removed from the estimate. The difference traces are updated to reflect the new order of the incremental traces and the motor unit estimate is re-calculated.



Increment traces 6 and 8 have been marked as alternation (blue color) and as a result the Difference traces have been updated. The MUNE value for the muscle went from 190 down to 150.

Because the first step in the alternation detection is to sort the incremental traces by increasing peak amplitude it is a good idea to check the **Onset** and **Peak** cursor positions on the incremental traces prior to running the detection. If the cursors are not displayed on the incremental traces, **right-click** over the increments trace area and select **Show Cursors**.

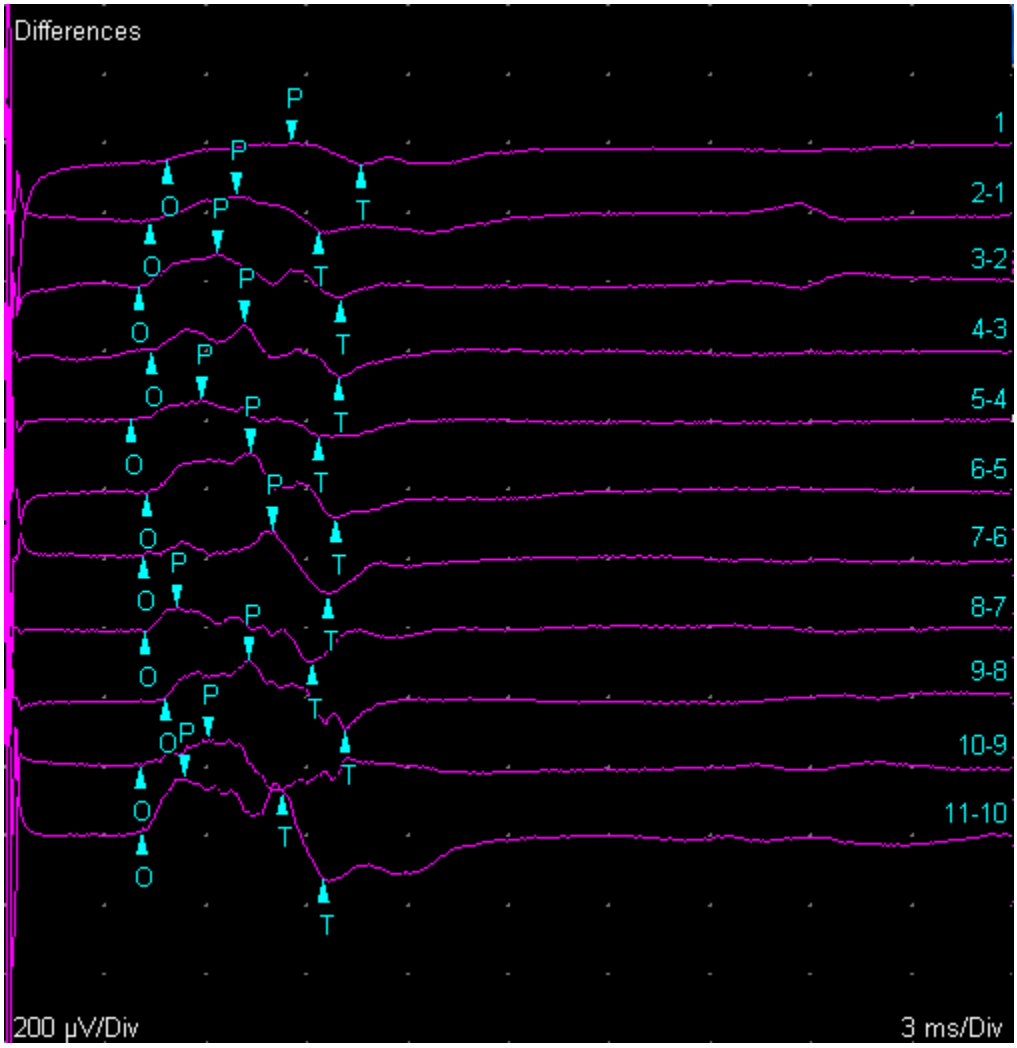
To Undo Alternation detection:

Alternation detection can be over-ruled in two ways:

- You can left click on a blue alternation trace to select it, the trace will be displayed in yellow when selected, then right-click to remove the alternation status in the pop-up menu.
- You can undo the alternation detection completely by pressing the **F7 (Undo Alt)** function key.

12. Verify Cursor Positions on the Difference Traces (Very Important)

Right-click within the Difference trace area and select **Show Cursors**. Verify the positions of the **Onset**, **Peak**, and **Trough** cursors on each trace as these positions will effect the SMUP area/amplitude measurements and therefore the calculated MUNE value for the muscle. You can return the setting to **Show Onset Cursors** or **Hide Cursors** after verifying the positions.



Difference traces with cursors positioned correctly.

13. TabData (Optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the Sierra Wave base unit.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the Sierra Wave base unit or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the Sierra Wave base unit or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the Sierra Wave base unit.

14. Next Muscle or Test

To advance to the Next Muscle:

- Use **Knob #1 (Study Item / Site)** to highlight another muscle in the **Study** window.
- **Click** on another muscle in the **Study** window using the **mouse**.
- **Press** the **F3 (Muscle List)** function key on the **Sierra Wave base unit** and select another muscle from the muscle list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (MUNE-Incr)

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current

intensity value (in milliamps) is displayed on the knob icon. Press this knob to switch to the **Pulse Width** mode and turn to change the value of the electrical stimulus pulse width, the current pulse width value (in microseconds) will be displayed on the knob icon.

Gain / Sweep - turn the knob to change the gain of the Max CMAP or Increments trace area. Press the knob, then turn to change the sweep speed of all traces.

Function Keys

Max CMAP / Increments - defaults to **Max CMAP** mode which allows the recording of the supra-maximal response. Pressing this key switches to **Increments** mode which automatically stores the Max CMAP and configures the program for recording of incremental single motor unit potentials.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Muscle List - opens the MUNE-Incr Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

MUNE Incremental Test Setup

MUNE Incremental test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Alternation Detection (MUNE-Incr)

Alternation refers to the problems that occur when two or more motor units are capable of being activated at the same stimulus intensity. One or the other (or both) motor units may be recruited at any given time. Alternation results in a larger number of perceived increments, which in turn results in a smaller mean SMUP value, and hence a larger or overestimated MUNE value.

In the MUNE-Incr test protocol incremental traces can be manually marked as instances of alternation or an automatic alternation detection function can be utilized.

Manual Marking of Alternation

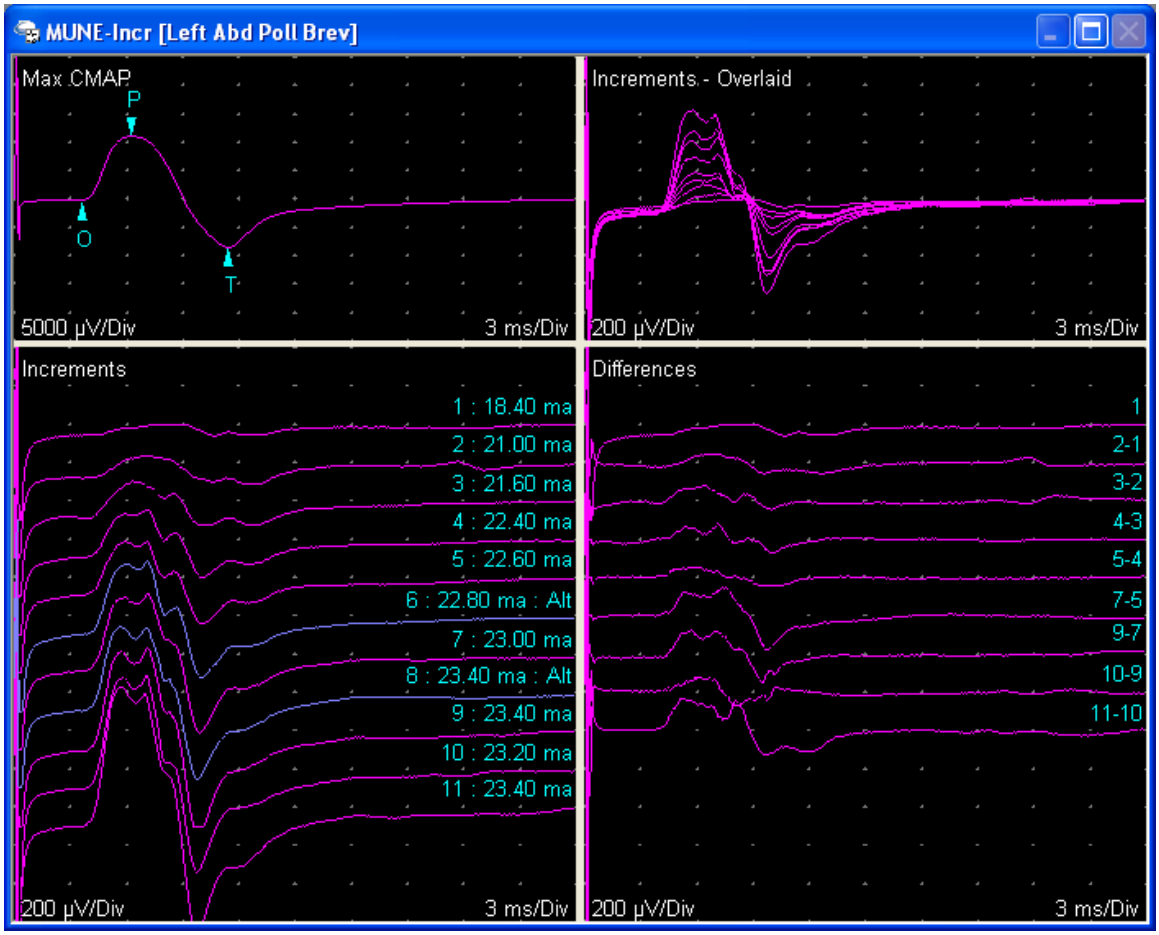
To manually mark an incremental trace as alternation:

1. Left-click on the trace to select it, the trace will be displayed in yellow.
2. Now, right-click and select **Mark Selected Traces for Alternation** from the pop-up menu.
3. The trace will be displayed in **dark blue**, indicating it has been marked as alternation. The difference traces will automatically be updated to reflect the new order of the incremental traces and the motor unit estimate will be re-calculated

Automatic Alternation Detection

To run the automatic alternation function:

1. Verify the positions of the **Onset** and **Peak** cursors on the incremental traces. This is important because the alternation detection function first sorts the incremental traces by increasing negative peak amplitude.
2. Press the **F7 (Auto Alt)** function key. Each incremental trace is subtracted from all subsequent ones; any identical solutions are considered to be examples of alternation. Cases of alternation are indicated by coloring the incremental trace **dark blue** and these traces are automatically removed from the estimate. The difference traces are updated to reflect the new order of the incremental traces and the motor unit estimate is re-calculated.



Increment traces 6 and 8 have been marked as alternation (blue color) and as a result the Difference traces have been updated.

Reversing Alternation

Alternation detection can be over-ruled in two ways:

- You can left click on a blue alternation trace to select it, the trace will be displayed in yellow when selected, then right-click to remove the alternation status in the pop-up menu.
- You can undo the alternation detection completely by pressing the **F7 (Undo Alt)** function key.

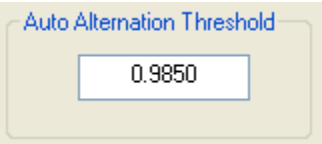
Adjusting Automatic Alternation Detection Threshold

The automatic alternation detection function subtracts each incremental trace from all subsequent incremental traces and compares all the resulting solutions using **cross-correlation**. The cross-correlation is normalized to the largest amplitude incremental trace. Solutions that are found to be matches

indicate alternation in the incremental traces, and those traces are displayed in dark blue.

The cross-correlation threshold defaults to **0.9850** but can be changed in the test setup window.

1. From the **Edit** menu, select **Current Test.**
2. Change the value shown in the **Auto Alternation Threshold** field.



3. Click **OK.**
4. Press the **F7 (Auto Alt)** function key to run the alternation detection function using the new threshold value.

Adjusting Cursors

Max CMAP, Increment, and Difference Traces

Right-click over the trace area and select **Show Cursors** from the pop-up menu. Now, simply click and drag the cursors to position them on the traces.

Trace Positions

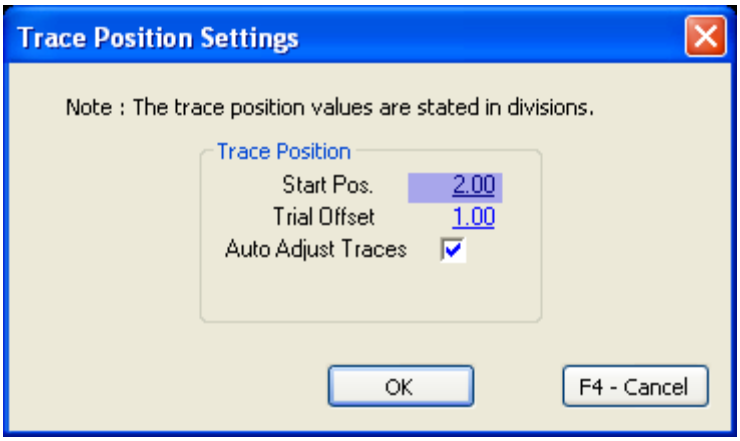
There are two ways to change the vertical positions of the Incremental traces.

Using the Mouse:

Left click on the trace you want to move **and drag** the trace to it's new location.

Using the Trace Position Settings:

1. **Right click** over the **Incremental Trace** window.
2. From the pop-up menu, select **Trace Position Settings**. The Trace Position Settings window will be displayed.



Trace Position Settings window.

3. Change the listed parameters, then click **OK**.

   Start Position: This is the default trace within the incremental SMUP trace window. It specifies the number of vertical divisions below the top of the trace window. In this example, the first incremental trace will be positioned 2 divisions below the top of the window.

   Trial Offset: This setting determines how much space will separate each stored incremental trace. In this example the setting is 1.0 divisions, therefore the second incremental trace will be displayed 1.0 divisions below the first trace. The third incremental trace will be displayed 1.0 divisions below the second trace and so on.

   Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the incremental trace window.

Deleting Traces

To Delete an Incremental Trace

Left-click on the incremental trace **to select** it, the trace will be displayed in yellow. Now, **right-click** and select **Delete Selected Traces** from the pop-up menu.

The Difference traces are automatically updated to reflect the new order of the Incremental traces.

Start New Run

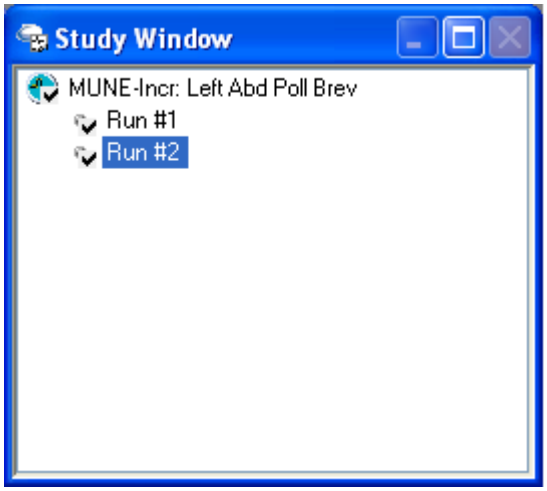
If you decide to repeat a muscle you have a choice of clearing the previously acquired data for the muscle or of keeping the previously acquired data.

To Clear the Previous Data & Repeat:

1. **Right click** the mouse in the **Increments trace area**. From the pop-up menu select **Delete All Stored Trials**.
2. A confirmation message will be displayed. Click **OK** and all the incremental traces are cleared.
3. **Acquire new data** for the muscle in the normal fashion.

To Keep the Previous Data & Repeat:

1. **Right click** the mouse over the **muscle's name** in the **Study window**. From the pop-up menu select **Start New Run**.
2. A second run node will be displayed under the muscle's name.
3. Acquire new data for the muscle in the normal fashion.
4. To view the first run done on the muscle select **Run #1** from the Study window. To view the second run done on the muscle select **Run #2**.



Two separate runs have been acquired for the Left Abd Poll Brev muscle.

5. If you want **to delete one of the runs** for the muscle, simply **right click** over the run you want to delete and select **Delete** from the pop-up menu. A confirmation message will be displayed, click **OK** to delete the run.

Saving Changes to MUNE-Incr Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the MUNE-Incr test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

MUNE References

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MUNE - MPS

MUNE-MPS Basics

What is MUNE?

Motor unit number estimation (MUNE) refers to a group of electrophysiologic techniques that estimate the number of lower motor neurons (i.e. motor units) innervating a muscle. The motor unit number must be estimated, because there is no method to count the actual number of functioning lower motor neurons innervating a given muscle.

MUNE is obtained by dividing the size of the maximal CMAP by the size of the mean surface-recorded single motor unit potential (SMUP).

MUNE = Max CMAP (Area or Amplitude) / Mean SMUP (Area or Amplitude)

MUNE techniques differ in the ways in which they obtain samples of SMUPs from which the mean SMUP size is determined. All methods are quite reproducible, and the reliability improves as the number of motor units reduces.

Overview of Multiple Point Stimulation (MPS) MUNE

This protocol supports both the **Standard** and **Adapted** methods of multiple point stimulation.

For both methods the program automatically aligns the onset latencies of the individual SMUP responses from different stimulus sites and then averages these responses 'data-point-by-data point' and displays the resulting averaged SMUP response (upper right section of trace window). The area/amplitude of the averaged SMUP response is then used to calculate the motor unit estimate.

The **Standard** method records and stores **only the first** all-or-nothing SMUP from each stimulus site along the nerve.

The **Adapted** method supports the recording of **multiple** SMUPs from each stimulus site along the nerve. When more than one incremental response is acquired for a stimulus site, the program automatically computes the difference trace between the newest and previous response and places the resulting difference trace in the **onset aligned** window.

The ability to record and store a sub-threshold response for each stimulus site and automatically subtract this from each incremental response is also available. This can help to reduce stimulus artifact and improve the detection of the negative peak onset.

Select the MUNE-MPS Test:

- **If a Study has already been selected**, simply click on a MUNE-MPS muscle name (i.e., Right Deltoid) within the Study window or turn **Knob #1 (Study Item)** to highlight the muscle name.
- **If a Study has not been selected, or you don't want to use a Study.** Select the individual MUNE-MPS test protocol from the **Study/Test** menu, a muscle list will be displayed allowing you to pick the muscle or muscles that you will be testing on the patient. Notice that as soon as any muscle is selected, it is displayed within the Study window.

The MUNE-MPS protocol defaults to the **Max CMAP** acquisition mode, note that the **F1** function key defaults to this setting.

Once the muscle has been selected. Follow these steps for performing MUNE-MPS data acquisition:

1. **Verify Amplifier Settings**

   Check the **Gain**, **Hicut**, **Locut**, and **Sweep Speed** settings and make sure they are appropriate for the muscle being tested.

Typical Settings

Max CMAP Gain (uV/Div)	SMUP Gain (uV/Div)	Hicut (Hz)	Locut (Hz)	Sweep Speed (ms/Div)
5k	100	10k	10	3.0

2. **Verify Side Setting**

   Make sure the appropriate side, **Right** or **Left**, is selected.

3. **Electrode Placement**

   Attach the electrodes to the patient.

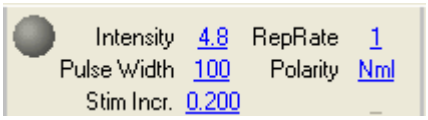
4. **Check Stimulator Polarity**

   For MUNE Studies, the **Cathode (-)** should be oriented **closest to the recording electrodes**.

The Cathode (i.e., the negative stimulus probe) can be selected by pressing the **Reverse Polarity (+/-)** button on the electrical stimulator handle. A **green LED** indicates the probe that is the Cathode.

Clicking on the **Polarity field** in the **Controls Toolbar** can also reverse the stimulator polarity. The default (i.e., normal) mode has the right-side probe as the Cathode (if holding the stimulator with the Stim button facing you and the probes up); the reversed state will make the left-side probe the Cathode.

In the **Normal mode**, the polarity field on the screen will indicate **Nml**.



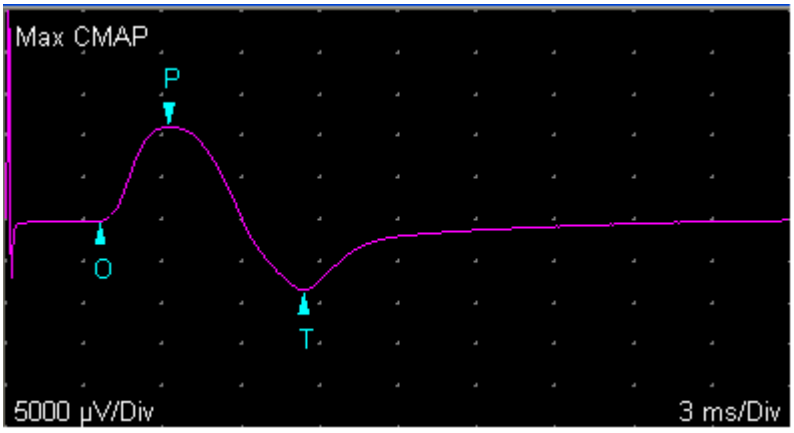
Normal Polarity

In the **Reversed mode**, the polarity field on the screen will indicate **Rev**.

Reversed Polarity

5. Acquire the Max CMAP Response

Begin by acquiring the supra-maximal CMAP response in the upper left trace window. This window is labeled **Max CMAP**. Cursors are automatically placed on the response and the area/amplitude of the response is shown in the MUNE Tables window.



Max CMAP

6. Enable SMUPs Acquisition Mode

Once the supra-maximal CMAP response has been acquired press the **F1 (Max CMAP/SMUPs)** function key to enable the **SMUPs** mode. This

activates the trace window in the lower left section of the screen labeled **SMUPs** and automatically stores the Max CMAP response.

7. Acquire Sub-Threshold Response (Optional)

Press the **F8 (Sub Thr.)** function key to enable the sub-threshold feature. Turn down the stimulus intensity and acquire a sub-threshold response (i.e., the response prior to the first all-or-nothing single motor unit) from the first stimulus site. Press the **Store** key to save the response. The sub-threshold response is colored **light-blue** on the screen and is labeled **S1:sThr**. This response will be automatically subtracted from all subsequent incremental responses recorded from this stimulus site, this will help reduce stimulus artifact and improve the detection of the negative peak onset.

8. Acquire first All-or-Nothing Response

Slowly increase the stimulus intensity and acquire the first all-or-nothing response. The response should not fractionate or show changes in shape or size when stimulated repetitively at this intensity. Press the **Store** key to save the response. This trace is automatically copied to the **Difference-Onset Aligned** trace area (labeled **S1:1**) as it is assumed to be the lowest threshold single motor unit potential (SMUP) from this stimulus site.

9. Acquire another response from the same stimulus site (Optional - Adapted Method)

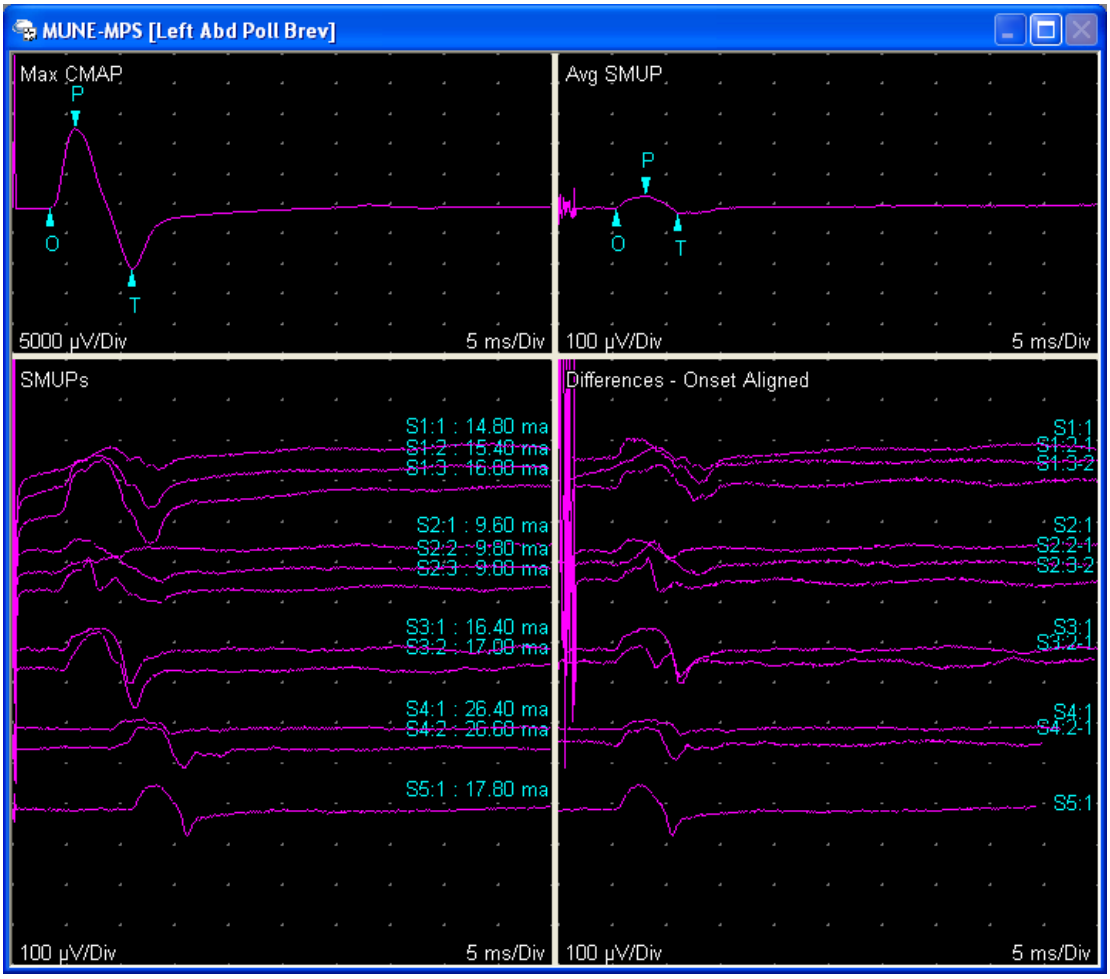
Continue stimulation at the first stimulus site and slowly increase the stimulus intensity until a larger response appears, likely due to activation of a second motor unit. As soon as this response is acquired the program will compute the difference between this trace and the previous trace. The result is labeled **S1:2-1** and is shown in the **Differences-Onset Aligned** trace area. The difference trace shows the contribution of the newly recruited motor unit. Press the **Store** key to save the incremental trace (labeled **S1:2**). This step can be repeated to acquire additional incremental traces from this stimulus site, but typically only 2 or 3 are easily obtained.

10. Advance to the Next Stimulus Site

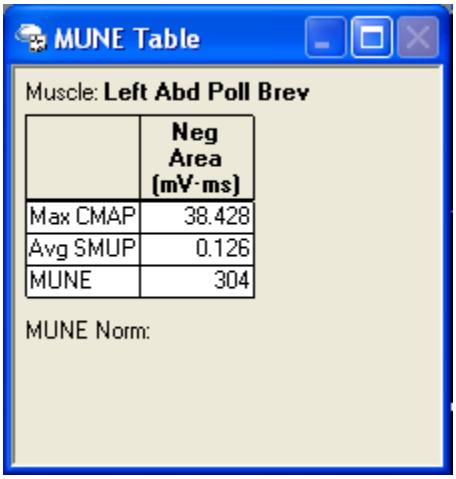
Press the **F9 (Next Site)** function key and then move the stimulator to a new stimulus site along the nerve. Repeat steps **7-9** above. Typically 10 SMUPs need to be acquired for an accurate estimate.

The Gain can be adjusted in both the Increments and Difference-Onset Aligned trace areas. Use the Gain knob or Gain setting in the amplifier toolbar to change the gain of the SMUP traces, right-click over the Differences-Onset Aligned area to change the gain of these traces.

The **Avg SMUP** trace area (upper right) shows the averaged SMUP trace and is automatically updated as new traces are added to the Difference-Onset Aligned area.



MUNE MPS - Trace window showing Max CMAP, SMUPs, Difference-Onset Aligned, and Avg SMUP traces.



MUNE-MPS Table for traces shown above.

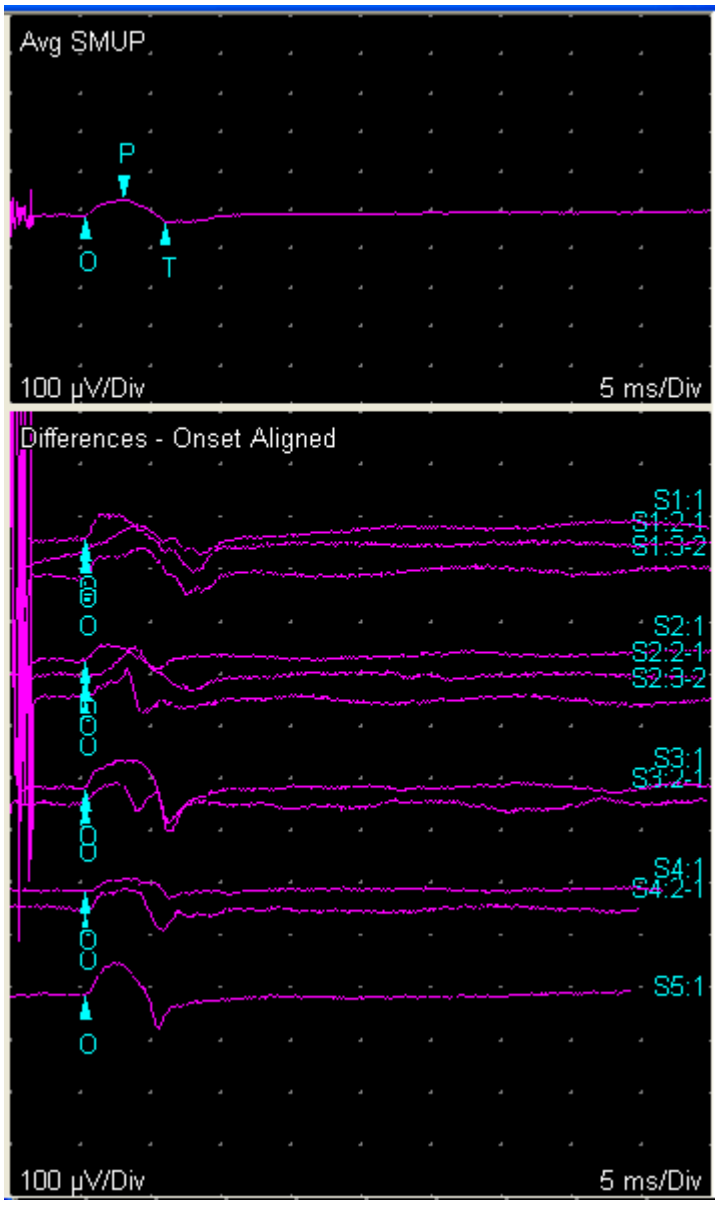
11. Verify Onset Cursor Positions (Very Important)

Right-click within the **Difference-Onset Aligned** trace area and select **Show Cursors**. Verify that the placement of the **Onset** cursor is correct on all the Difference-Onset Aligned traces and that the **Onset**, **Peak**, & **Trough** cursors are appropriately placed on the **Avg SMUP** trace.

These cursor positions will effect the computation of the average SMUP trace and therefore the calculated MUNE value for the muscle. You can return the setting to **Show Onset Cursors** or **Hide Cursors** after verifying the positions.

When the Onset cursor is moved on a Difference-Onset Aligned trace:

- The program automatically moves the trace horizontally to align the onset position with the other traces in this area.
- Recomputes the Avg SMUP and updates the MUNE calculation.



Onset cursors in correct positions.

12. TabData (Optional)

To view a Summary window of all the tests done on the patient, press the **F4 (TabData)** function key on the Sierra Wave base unit.

The left hand side of the **TabData** window shows all the tests that were performed on the patient. It also has entries for Summary Tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1 (Select / Open)** on the Sierra Wave base unit or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a Summary Table:

Highlight the table by turning **Knob #1 (Select / Open)** on the Sierra Wave base unit or by clicking on the Summary Table with the mouse. The selected table will be displayed on the right hand side of the window.

To print a Report:

Click on one of the report buttons at the bottom of the TabData window, or press the corresponding function key on the Sierra Wave base unit.

13. Next Muscle or Test

To advance to the Next Muscle:

- Use **Knob #1 (Study Item / Site)** to highlight another muscle in the **Study** window.
- **Click** on another muscle in the **Study** window using the **mouse**.
- **Press** the **F3 (Muscle List)** function key on the **Sierra Wave base unit** and select another muscle from the muscle list.

To change Test Protocols:

- Use **Knob #1 (Study Item / Site)** to highlight another Test Protocol in the **Study** window.
- **Click** on another Test Protocol in the **Study** window using the **mouse**.
- **Press** the **Select** key on the **Sierra Wave base unit** and select a Test Protocol from the **Study/Test** menu.

Knob & Fkey Controls (MUNE-MPS)

Knobs

Study Item - turn this knob to highlight and load a different Test Protocol in the Study window.

Intensity / Pulse Width - this knob defaults to the **Intensity** mode and can be used to increase or decrease the stimulus intensity, the current intensity value (in milliamps) is displayed on the knob icon. Press this knob to switch to the **Pulse Width** mode and turn to change the value of the electrical stimulus pulse width, the current pulse width value (in microseconds) will be displayed on the knob icon.

Gain / Sweep - turn the knob to change the gain of the Max CMAP or Increments trace area. Press the knob, then turn to change the sweep speed of all traces.

Function Keys

Max CMAP / SMUPs - defaults to **Max CMAP** mode which allows the recording of the supra-maximal response. Pressing this key switches to **SMUPs** mode which automatically stores the Max CMAP and configures the program for recording of single motor unit potentials.

Raster / Overlay - defaults to **Raster** mode, in Raster mode the traces are separated according to the Trace Position Settings. Pressing this key switches to **Overlay** mode which will superimpose all traces on top of one another.

Muscle List - opens the MUNE-MPS Muscle List window which allows you to select and add muscles to your Study window.

TabData - opens the TabData summary window.

MUNE MPS Test Setup

MUNE-MPS test setup options are discussed in detail in the **Test Protocol Setup** chapter of the Help system.

Click here to go to this topic.

Alternation Detection (MUNE-MPS)

Alternation refers to the problems that occur when two or more motor units are capable of being activated at the same stimulus intensity. One or the other (or both) motor units may be recruited at any given time. Alternation results in a larger number of perceived increments, which in turn results in a smaller mean SMUP value, and hence a larger or overestimated MUNE value.

In the MUNE-MPS test protocol SMUP traces can be manually marked as instances of alternation.

Manual Marking of Alternation

To manually mark an SMUP trace as alternation:

1. Left-click on the trace to select it, the trace will be displayed in yellow.
2. Now, right-click and select **Mark Selected Traces for Alternation** from the pop-up menu.
3. The trace will be displayed in **dark blue**, indicating it has been marked as alternation. The Difference-Onset Aligned traces for that stimulus site will automatically be updated to reflect the new order of the SMUP traces and the Avg SMUP trace and motor unit estimate will be re-calculated.

Reversing Alternation

Left click on a blue alternation trace to select it, the trace will be displayed in yellow when selected, then right-click to remove the alternation status in the pop-up menu.

Adjusting Cursors

Max CMAP, SMUP, Difference-Onset Aligned, and Avg SMUP Traces

Right-click over the trace area and select **Show Cursors** from the pop-up menu. Now, simply click and drag the cursors to position them on the traces.

When the Onset cursor is moved on a Difference-Onset Aligned trace:

- The program automatically moves the trace horizontally to align the onset position with the other traces in this area.
- Recomputes the Avg SMUP and updates the MUNE calculation.

Trace Positions

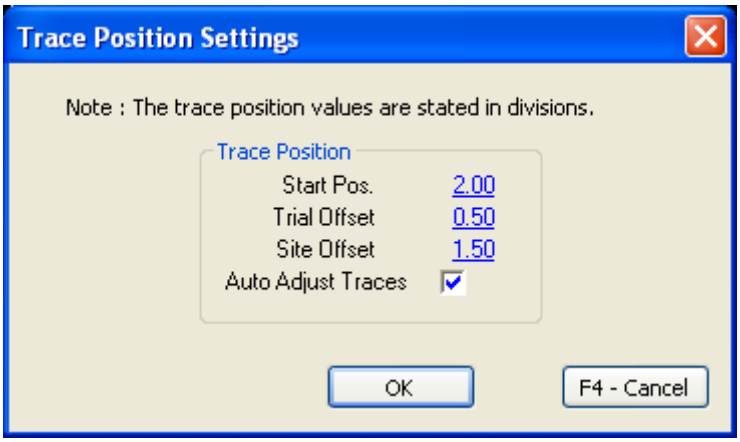
There are two ways to change the vertical positions of the SMUP traces.

Using the Mouse:

Left click on the trace you want to move **and drag** the trace to it's new location.

Using the Trace Position Settings:

1. **Right click** over the **SMUP Trace** window.
2. From the pop-up menu, select **Trace Position Settings**. The Trace Position Settings window will be displayed.



Trace Position Settings window.

3. Change the listed parameters, then click **OK**.

Start Position: This is the default trace within the SMUP trace window. It specifies the number of vertical divisions below the top of the trace window. In this example, the first SMUP trace will be positioned 2 divisions below the top of the window.

Trial Offset: This setting determines how much space will separate each stored SMUP trace acquired from the same stimulus site. In this example the setting is 0.5 divisions, therefore the second SMUP trace will be displayed 0.5 divisions below the first trace. The third SMUP trace will be displayed 0.5 divisions below the second trace and so on.

Site Offset: This setting determines how much space will separate the SMUP traces from different stimulus sites.

Auto Adjust Traces: When checked, this parameter will automatically adjust the Start Position and Trial Offset to keep all acquired traces displayed within the SMUP trace window.

Deleting Traces

To Delete an SMUP Trace

Left-click on the SMUP trace **to select** it, the trace will be displayed in yellow. Now, **right-click** and select **Delete Selected Traces** from the pop-up menu.

 The Difference-Onset Aligned traces are automatically updated to reflect the new order of the SMUP traces.

Start New Run

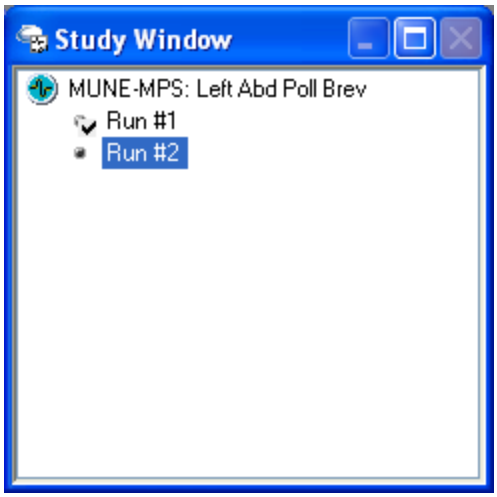
If you decide to repeat a muscle you have a choice of clearing the previously acquired data for the muscle or of keeping the previously acquired data.

To Clear the Previous Data & Repeat:

1. **Right click** the mouse in the **SMUP trace area**. From the pop-up menu select **Delete All Stored Trials**.
2. A confirmation message will be displayed. Click **OK** and all the SMUP traces are cleared.
3. **Acquire new data** for the muscle in the normal fashion.

To Keep the Previous Data & Repeat:

1. **Right click** the mouse over the **muscle's name** in the **Study window**. From the pop-up menu select **Start New Run**.
2. A second run node will be displayed under the muscle's name.
3. Acquire new data for the muscle in the normal fashion.
4. To view the first run done on the muscle select **Run #1** from the Study window. To view the second run done on the muscle select **Run #2**.



Two separate runs have been acquired for the Left Abd Poll Brev muscle.

5. If you want **to delete one of the runs** for the muscle, simply **right click** over the run you want to delete and select **Delete** from the pop-up menu. A confirmation message will be displayed, click **OK** to delete the run.

Saving Changes to MUNE-MPS Settings

During an exam you may make changes to various parameters or window layouts.

To save these changes as the new **default** settings for the MUNE-MPS test protocol.

- Select **Save Test Parameters** from the **Edit** menu.

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18:1412-1416, 1995

Study Window

Study Window Overview

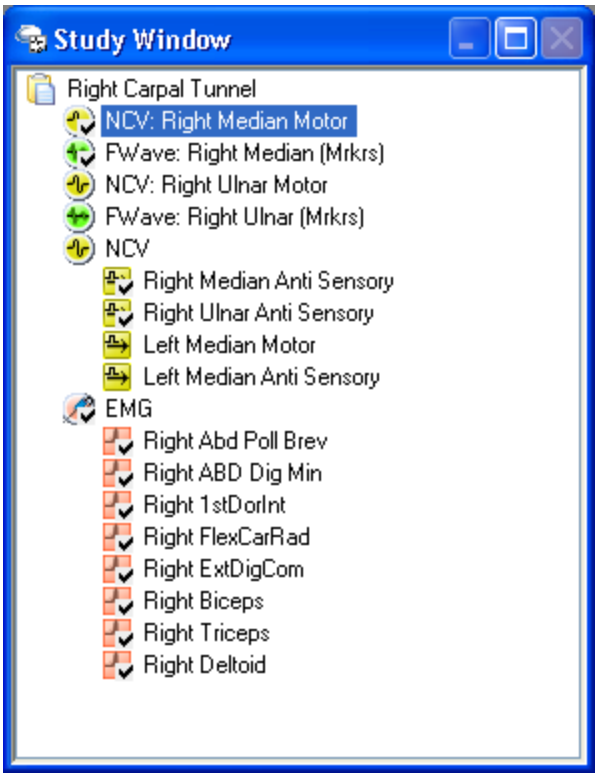
The **Study** window has several functions:

- Lists the test protocols that have been pre-selected and grouped into the selected Study List (e.g., lists the tests for the Right Carpal Tunnel Study).
- Automatically adds to the list other test protocols, not originally part of the Study list, as they are selected from the Study/Test menu or nerve and muscle lists.
- Provides an easy way to change from one test protocol to another or go back and review a previous test.
- Shows which test protocols have been completed by placing a **checkmark** on the test protocol's icon.

To Select a Test Protocol in the Study window

Use **Knob #1 (Study Item)**, on the Sierra Wave base unit, to move the highlight up and down through the Study window. If you stop the highlight on a test protocol for more than **1.5 seconds**, that protocol will be loaded.

Alternatively, click on a test protocol with the **left mouse button** to load it.



Study window.

Context Menu Options

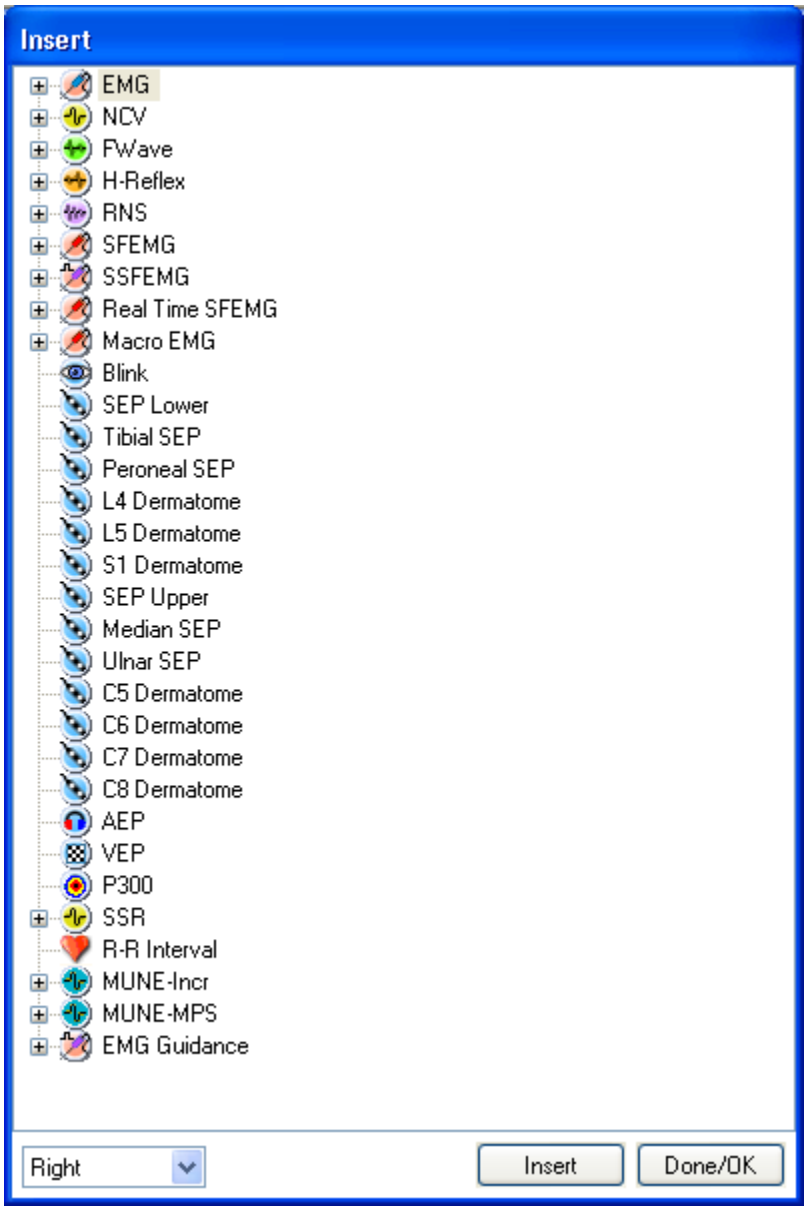
Study Window Context Menu

The Study window has a Context menu, also known as the **right click menu.** It is accessed by right clicking the mouse over a blank area, or over a test protocol name, within the Study window. The functions that are available in the context menu will vary depending on where you right clicked.

When right clicking over a blank area in the Study window:

The following context menu appears. The **Delete** & **Start New Run** functions are disabled.

Insert - this function opens the **Insert window**. The Insert window shows all the available test protocols on the system and allows you to easily add test protocols to those already listed in your Study window.



Insert window.

To Insert a Test Protocol:

- **Using the mouse.**
  - **Highlight** a test protocol by clicking on it. *Expand nodes by clicking on the (+) sign.*
  - Choose the appropriate **Side** (Left, Right, or Left & Right) by clicking on the drop down arrow. *The Side Setting does not*

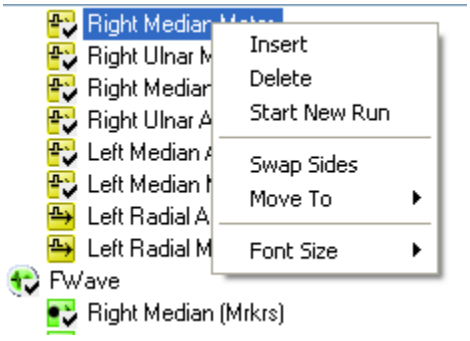
apply to SEP, AEP, VEP, P300, RR Interval, or Blink test protocols.

- Click the **Insert** button. The test protocol is inserted into the Study window below the currently selected test.
- Repeat these steps until you have inserted all the test protocols that you need, then click the **Done/OK** button.

- **Using the Knobs.**
  - **Turn Knob #1 (Select / Insert)** to move the highlight up/down within the Insert window and highlight the test protocol you want to insert. *You can press the knob to expand any nodes that have a (+) sign, like NCV.*
  - **Turn Knob #2 (Side)** to change the **Side** (Left, Right, Left & Right). *The Side Setting does not apply to SEP, AEP, VEP, P300, RR Interval, or Blink test protocols.*
  - **Press Knob #1 (Select / Insert)**. The highlighted test is inserted into the Study window below the currently selected test.
  - Repeat these steps until you have inserted all the test protocols that you need, then press the **OK** key on the Sierra Wave base unit.

When right clicking on an NCV, F, H, RNS, Blink, SFEMG, or Evoked Potential test protocol name in the Study window:

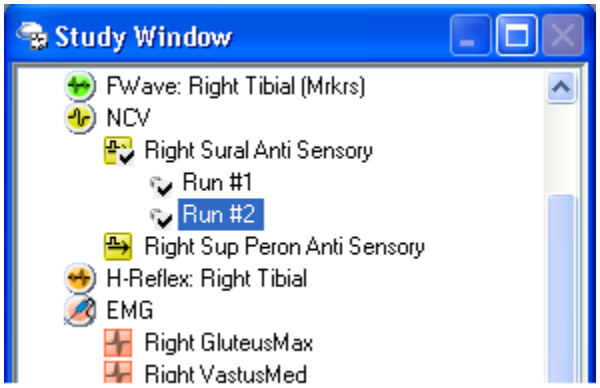
The following context menu appears.



Insert - this function opens the Insert window. This is the same window as described above.

Delete - this function will delete the selected test protocol from the Study window and all data associated with the test.

Start New Run - use this function to repeat a test protocol while keeping the results of the first test. For example, you may want to run the Right Sural Anti Sensory nerve twice on the same patient. After selecting this function you will see **Run Nodes** appear underneath the test protocol's name in the Study window. The first run node, **Run #1**, contains the original test results, **Run #2** is for the second set of results. Selecting Start New Run again would place additional run nodes in the Study window (e.g., Run #3, Run #4).



Study window showing Run Nodes for Right Sural Anti Sensory nerve.

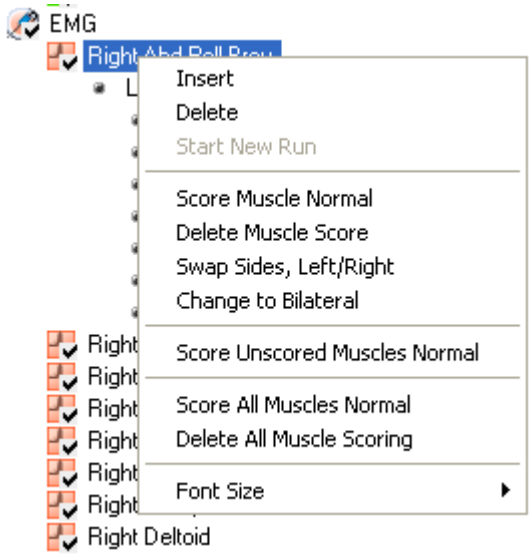
Swap Sides - selecting this function will **switch the Side Setting**, from **Right to Left** or **Left to Right**, for the selected test protocol. If the test protocol that results from the swap does not already exist in the Study window, it will be created automatically. If the test protocol that results from the swap does already exist in the Study window, then the data is simply moved from the selected test to the resulting test.

Move To - this feature allows the NCV, F Wave, H Reflex, or RNS traces to be moved to a different nerve. For example, motor nerve traces can be moved to any other motor nerve of the same 'nerve type' in your nerve list.

Font Size - use this function to change the font size displayed within the Study window. Choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

When right clicking on an EMG muscle name in the Study window:

The following context menu appears. The **Start New Run** function is disabled.



Insert - this function opens the Insert window. This is the same window as described above.

Delete - this function will delete the selected test protocol from the Study window and all data associated with the test.

Score Muscle Normal - this function will add the selected muscle to the scoring table with all choices set to normal.

Delete Muscle Score - this function will remove the selected muscle from the scoring table. It also removes the check mark next to the muscle name, this indicates the muscle is no longer scored.

Swap Sides, Left/Right - changes the side label of the muscle to the opposite setting.

Change to Bilateral - changes the side label of the muscle to "Bilateral".

Score Unscored Muscles Normal - this function will add all unscored muscles within the EMG test protocol to the scoring table with all choices set to normal.

Score All Muscles Normal - this function will add all the muscles within the EMG test protocol to the scoring table with all choices set to normal.

Delete All Muscle Scoring - this function will remove all the muscles within the EMG test protocol from the scoring table. It also remove the check marks next to the muscle names, indicating that these muscle are no longer scored.

Font Size - use this function to change the font size displayed within the Study window. Choices are **Small** (default), **Medium**, **Large**, and **Extra Large**.

TabData Window

TabData Window Overview

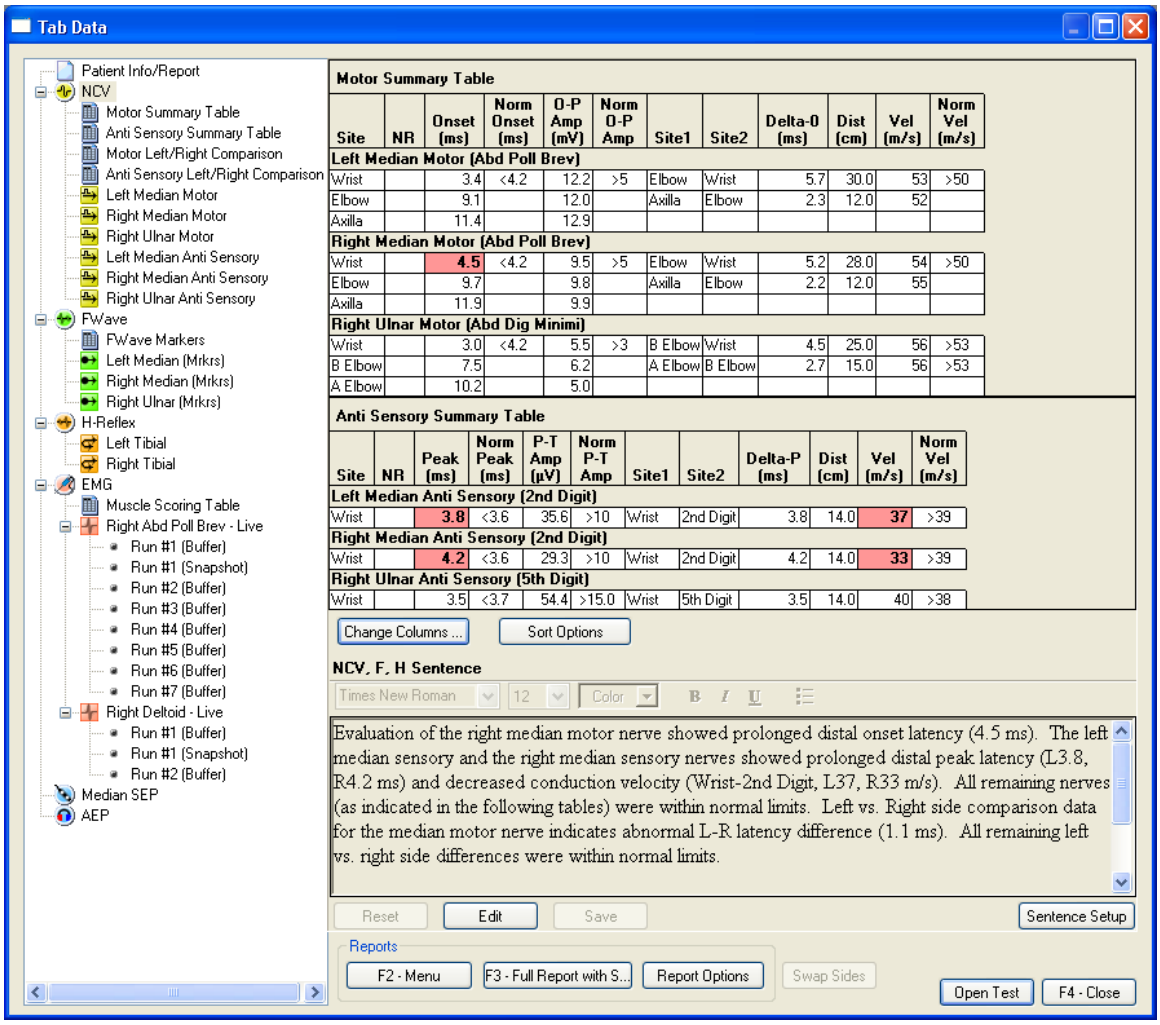
The **TabData** window provides an overview of all tests completed on the patient as well as summary tables for test protocols such as NCV, F/H, and EMG. An optional Sentence Generator is available to create sentences describing the results.

To open the TabData window press the **F4 (TabData)** function key from within any test protocol or select TabData from the **View** menu.

Completed test protocols are listed down the left-hand side of the window. To select a test protocol or summary table perform one of the following actions.

- Turn **Knob #1 (Select / Open)** to move the blue highlight to the desired test protocol or table.
- **Click the left mouse** button on the test protocol or table.

The highlighted entry's results are displayed on the right-hand side of the TabData window.



TabData window with All NCV summary tables selected.

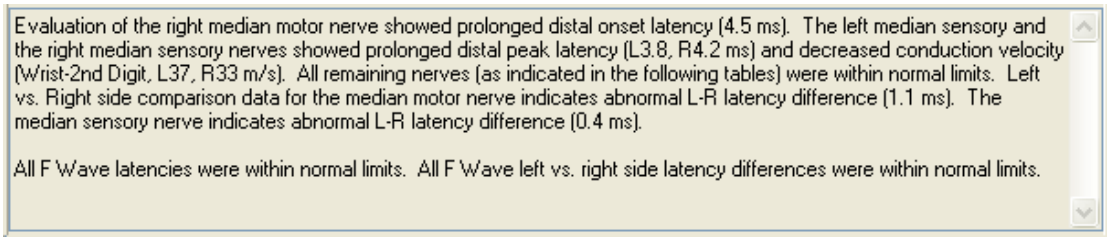
Integrated Sentence Generator for Findings:

The TabData window features an optional Sentence Generator which can build findings sentences to describe NCV, F Wave, H-Reflex, EMG, and EP data.

To Enable the Sentence Generator:

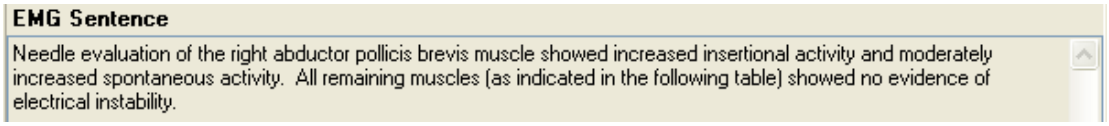
- Start the Sierra Wave program.
- Select **System Setup** from the **Edit** menu.
- Place a check mark in the box labeled **"Show Sentence Generator in TabData"**.
- Click **OK**.

When an NCV, F Wave, or H-Reflex table node is highlighted in the TabData window, the findings sentences for those test protocols will be displayed below the summary tables.



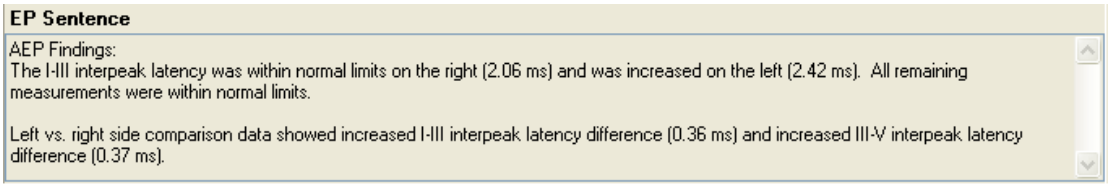
NCV, F, H findings sentences.

When the EMG Scoring Table is highlighted in the TabData window, the findings sentences for the muscle scoring will be displayed below the scoring table.



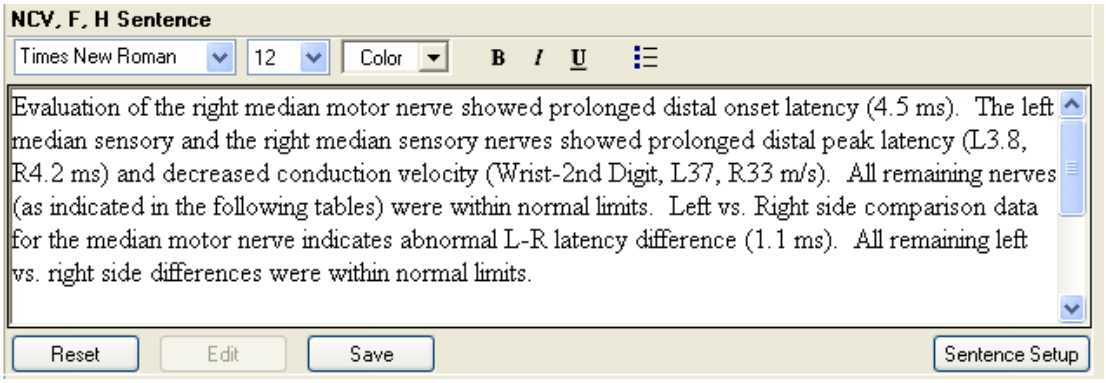
EMG findings sentences.

When an EP table is highlighted in the TabData window, the findings sentences for the EP test will be displayed below the table.



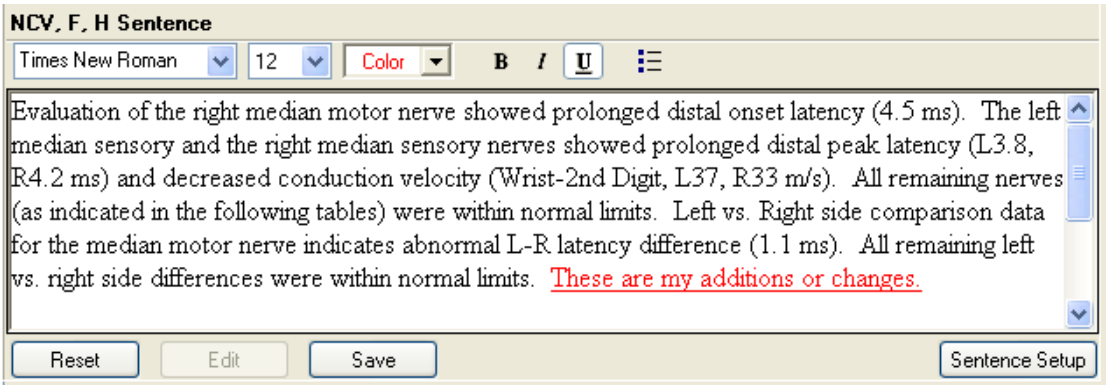
Editing the Findings Sentences:

Below each sentence is a **Reset**, **Edit**, and **Save** button. Click the **Edit button** if you want to make changes or additions to the generated sentences. The background of the sentence area will change to white color, signifying that you are in the Edit mode. The formatting controls above the sentence area will also be activated.



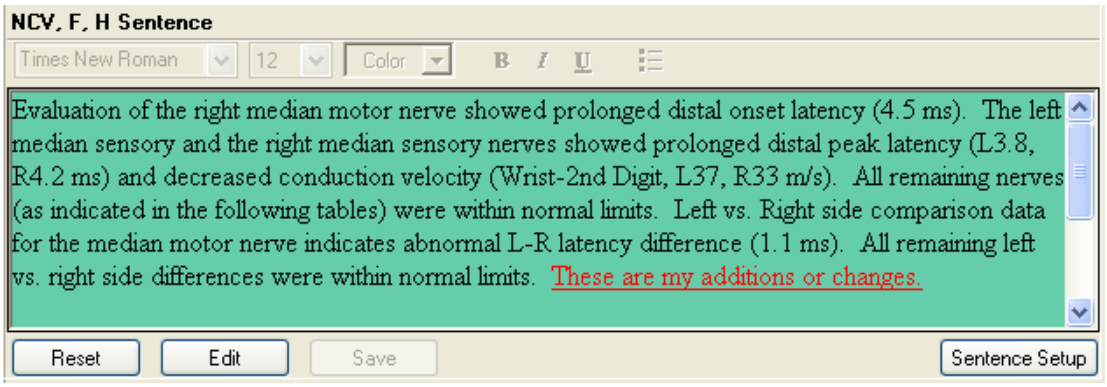
Edit mode.

Click within the sentence area and make your changes/additions.



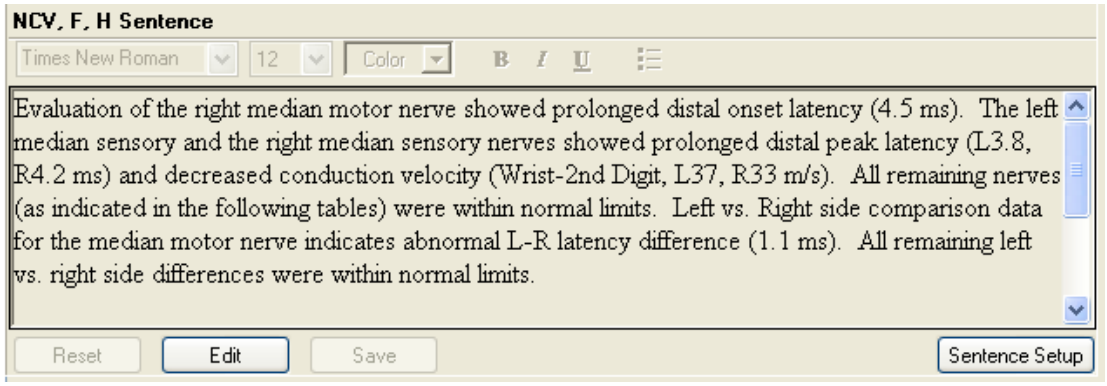
Edit mode with changes.

To save your changes, click the **Save button**. The background will turn green, this signifies that editing has been performed and those changes/additions have been saved.



Changes to the sentences have been saved.

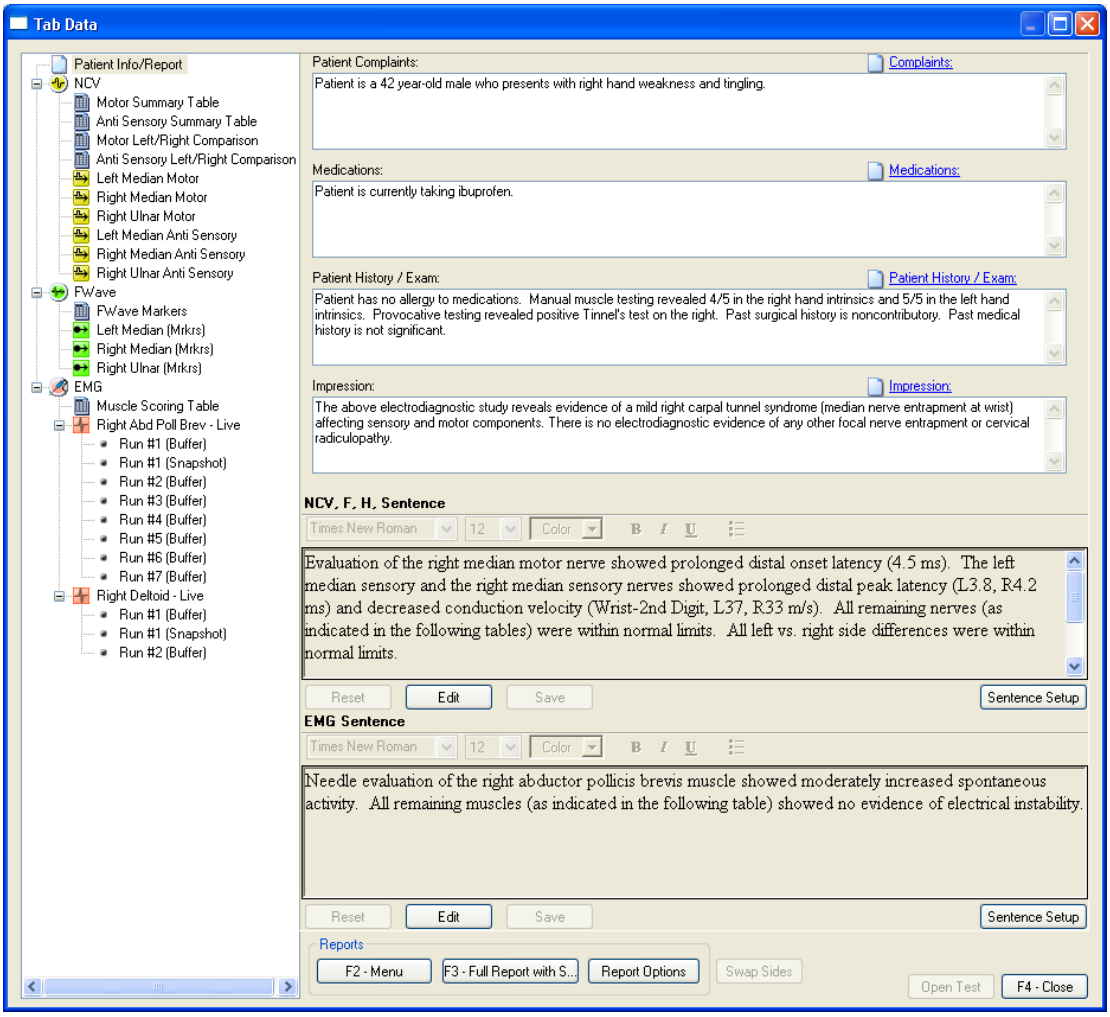
To cancel your changes or additions, click the **Reset button**. The sentence is returned to its default state and the background color changes back to the non-edit mode color.



Sentence has been reset to default state.

View the Custom Fields from the Patient Information window

Clicking on the **Patient Info / Report** node will display the custom fields from the patient information window as well as the findings sentences (if enabled). If a QuickReport Item has been assigned to a custom field, it can be processed in this view. For more information on using custom fields, click here.



TabData window with Patient Info/Report node selected.

Changing NCV Column Setup

NCV Column Setup

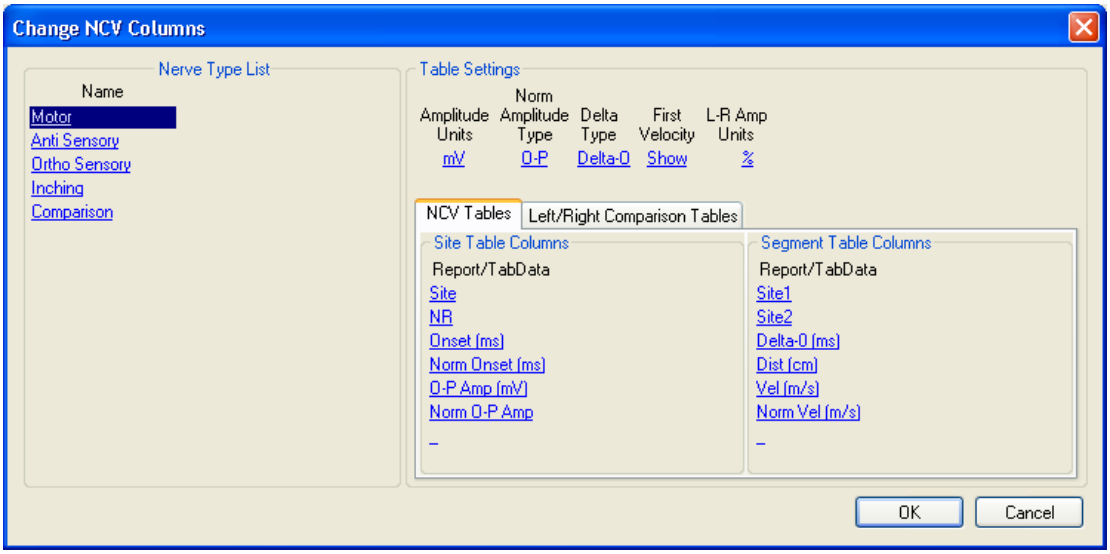
When a NCV Summary table or individual nerve test protocol is selected the **Change Columns** button is available.

Clicking on **Change Columns** allows you to specify how the NCV results will be shown in your reports. *This does not change how the results are displayed during data acquisition.*

Selections can be made for both the **NCV Tables** and the **Left/Right Comparison Tables**.

Click on the **nerve type** you want to change. To include information in reports, click at the bottom of the displayed column, or within the column, and

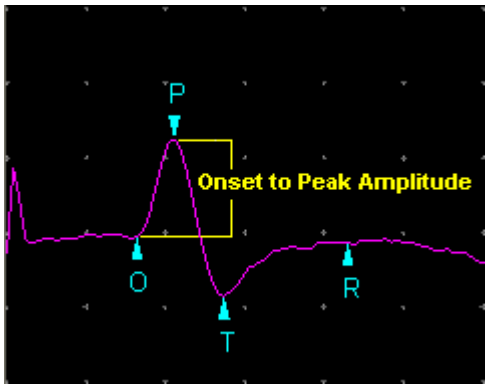
then select **Insert** from the pop-up menu. Select the value you want to include in the report from the displayed list of choices. To remove information in reports, click on the value displayed in the column, then select **Delete** from the pop-up menu.

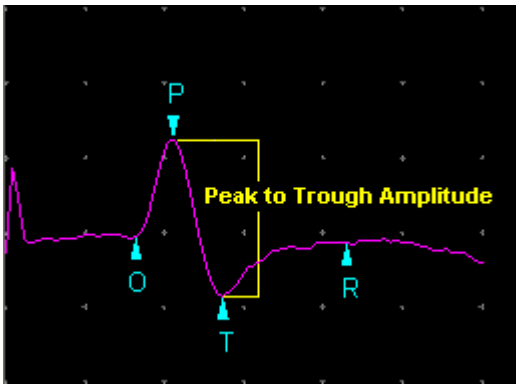


NCV - Change Columns window.

Amplitude Units: Click here to select the amplitude measurement units, either millivolts **(mV)** or microvolts **(uV)**. Motor nerves are generally displayed in millivolts, sensory nerves in microvolts.

Amplitude Type: Click here to select how the normal amplitude value is displayed, either **Onset to Peak** or **Peak to Trough**.





Delta Type: Click here to select how the nerve conduction velocity calculations are determined.

- **Delta-O**, velocity is calculated based on the difference between the onset latencies of the two responses, and when distal onset latency is used for the terminal conduction velocity.

- **Delta-P**, velocity is calculated based on the difference between the peak latencies of the two responses, and when distal peak latency is used for the terminal conduction velocity.

First Velocity: Click here to select whether the first velocity segment should have it's velocity displayed or hidden. Generally this setting is always set to Show, but in some instances users like to put in a distal segment for motor nerves, such as Wrist to APB. This allows them to record the distal distance but hide the conduction velocity.

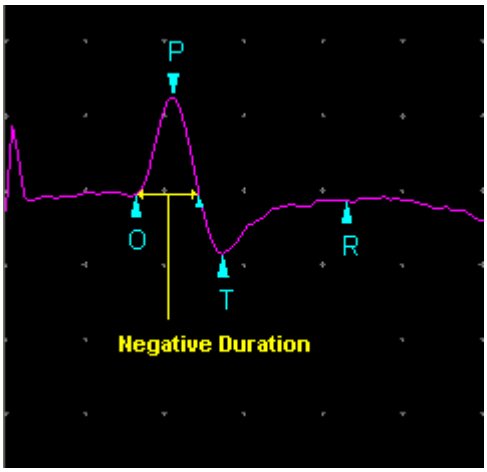
L-R Amp Units: Click here to specify whether the left minus right side amplitude differences are displayed as percentages (%) or absolute amplitude values (uV or mV).

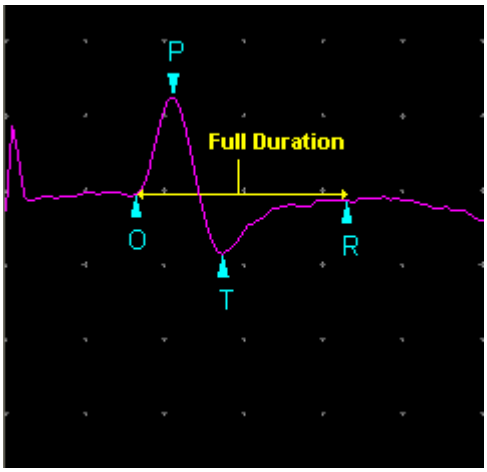
Site Table Columns: Select the site measurement columns that you would like to display in the report (Report/TabData). To include a measurement, click at the bottom of the displayed column list, or within the column list, and then select **Insert** from the pop-up menu. Select the measurement you want to include from displayed list of choices. To remove a measurement, click on the measurement column in the column list, then select **Delete** from the pop-up menu.

Site Table measurement choices.

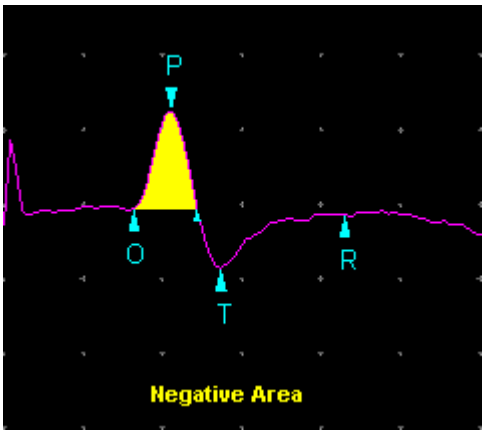
- **Site** - this column displays the stimulus site names, (e.g., Wrist, Elbow, Axilla).
- **NR** - this column is used to indicate a "no response".
- **Onset (ms)** - this column reports the onset latency of the response in milliseconds.
- **Norm Onset (ms)** - this column displays the normal value for the site if one has been entered for the nerve being tested.
- **Peak (ms)** - this column displays the peak latency of the response in milliseconds.
- **Norm Peak (ms)** - this column displays the normal value for the site if one has been entered for the nerve being tested.

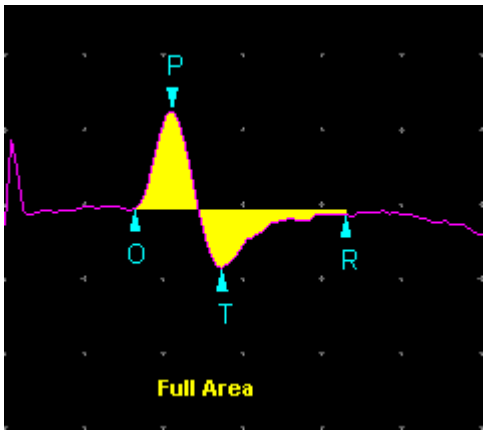
- **O-P or P-T Amp** - this column displays the amplitude of the response as either onset to peak or peak to trough. The type of measurement, **mV** or **uV**, is determined by selecting the **Amplitude Units**.
- **Norm Amp** - this column displays the normal amplitude for the site if one has been entered for the nerve being tested.
- **Neg Dur (ms)** - this column displays the negative duration of the response in milliseconds.
- **Full Dur (ms)** - this column displays the full duration of the response in milliseconds.





- **Neg Area** - this column displays the negative area of the response in either **mV-ms** or **uV-ms** depending on the setting of the **Amplitude Units**.
- **Full Area** - this column displays the full area of the response in either **mV-ms** or **uV-ms** depending on the setting of the **Amplitude Units**.





- **Amp% (1st)** - this column shows a site's percent change in amplitude compared to the amplitude of site #1. (Site #1 compared to itself is always 100%)
- **Amp% (Prev)** - this column shows a site's percent change in amplitude compared to the amplitude of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Neg Area% (1st)** - this column shows a site's percent change in negative area compared to the negative area of site #1. (Site#1 compared to itself is always 100%).
- **Neg Area% (Prev)** - this column shows a site's percent change in negative area compared to the negative area of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Full Area% (1st)** - this column shows a site's percent change in full area compared to the full area of site #1. (Site#1 compared to itself is always 100%).
- **Full Area% (Prev)** - this column shows a site's percent change in full area compared to the full area of the previous site. (e.g., Site 2 compared to Site 1, Site 3 compared to Site 2)
- **Contra Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the contralateral side.
- **L Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the left side of the nerve.
- **R Lat (ms)** - this column shows the corresponding latency values (if Delta-O they are onset latencies, if Delta-P they are peak latencies) for the right side of the nerve.
- **L-R Lat (ms)** - this column shows the Left minus Right side difference in the latency values.
- **Norm L-R Lat (ms)** - this column displays the L-R normal latency difference value for the site if one has been entered for the nerve being tested.
- **Contra Amp (uV or mV)** - this column displays the corresponding amplitude values (as either onset to peak or peak to trough) for the contralateral side. The type of measurement, mV or uV, is determined by selecting the Amplitude Units.
- **L Amp (uV or mV)** - this column shows the correspond amplitude values (as either onset to peak or peak to trough) for the left side.

The type of measurement, mV or uV, is determined by selecting the Amplitude Units.

- **R Amp (uV or mV)** - this column shows the correspond amplitude values (as either onset to peak or peak to trough) for the right side. The type of measurement, mV or uV, is determined by selecting the Amplitude Units.
- **L-R Amp (%, uV, or mV)** - this column displays the Left minus Right side difference in amplitude values. The values can be shown as a percentage or as an absolute value.
- **Norm L-R Amp** - this column displays the L-R normal amplitude difference value for the site if one has been entered for the nerve being tested.

Segment Table Columns: Select the segment measurement columns that you would like to display in the report (Report/TabData). To include a measurement, click at the bottom of the displayed column list, or within the column list, and then select **Insert** from the pop-up menu. Select the measurement you want to include from the displayed list of choices. To remove a measurement, click on the measurement column in the column list, then select **Delete** from the pop-up menu.

Segment Table measurement choices.

- **Site 1 and Site 2** - this column shows the names of the stimulus sites that make up the segment.

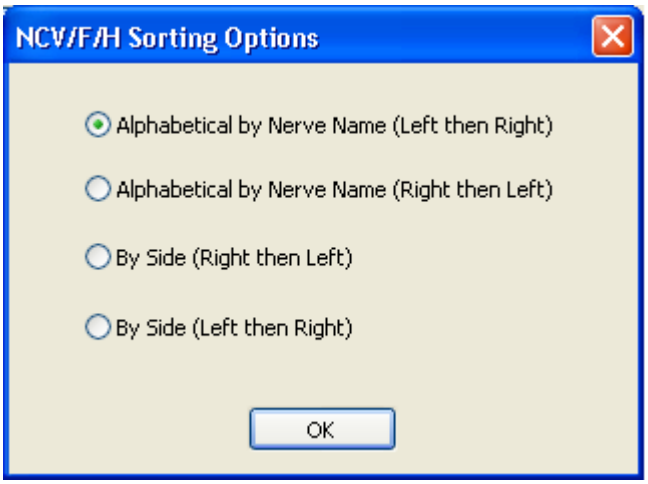
- **Delta-O or Delta-P** - this column shows the difference (in milliseconds) between the response latencies of the two sites composing the segment. The type of measurement is determined by selecting the **Delta Type** (onset or peak).
- **Norm Delta (ms)** - this column displays the segment's normal value for the Delta measurement if one has been entered for the nerve being tested.
- **Distance (cm)** - this column provides a place to enter the distance (in centimeters) between the two stimulus sites, or in some cases the distance between the distal stimulation site and the recording site.
- **Vel (m/s)** - this column displays the calculated conduction velocity in meters per second.
- **Norm Vel (m/s)** - this column displays the normal velocity for the segment if one has been entered for the nerve being tested.
- **Contra Dist (cm)** - the column displays the corresponding distance values for the contralateral side.
- **L Dist (cm)** - this column displays the distance values for segments on the left side.
- **R Dist (cm)** - this column displays the distance values for segments on the right side
- **Contra Vel (m/s)** - this column displays the corresponding velocity values for the contralateral side.
- **L Vel (m/s)** - this column displays the velocity values for segments on the left side.
- **R Vel (m/s)** - this column displays the velocity values for segments on the right side.
- **L-R Vel (m/s)** - this column displays the Left minus Right side difference in velocity values.
- **Norm L-R Vel (m/s)** - this column displays the L-R normal velocity difference value for the segment if one has been entered for the nerve being tested.
- **DVel (m/s 1st)** - this column shows a segment's change in velocity compared to the velocity of the 1st segment. (e.g., Segment 2 compared to Segment 1, Segment 3 compared to Segment 1).
- **DVel (m/s prev)** - this column shows a segment's change in velocity compared to the velocity of the previous segment. (e.g.,

Segment 2 compared to Segment 1, Segment 3 compared to Segment 2).

Sort Options

When a NCV Summary table or individual nerve test protocol is selected the **Sort Options button** is available.

Clicking on this button allows you to specify how the NCV, F Wave, and H Reflex results will be sorted within the summary tables.



NCV/F/H Sorting Options

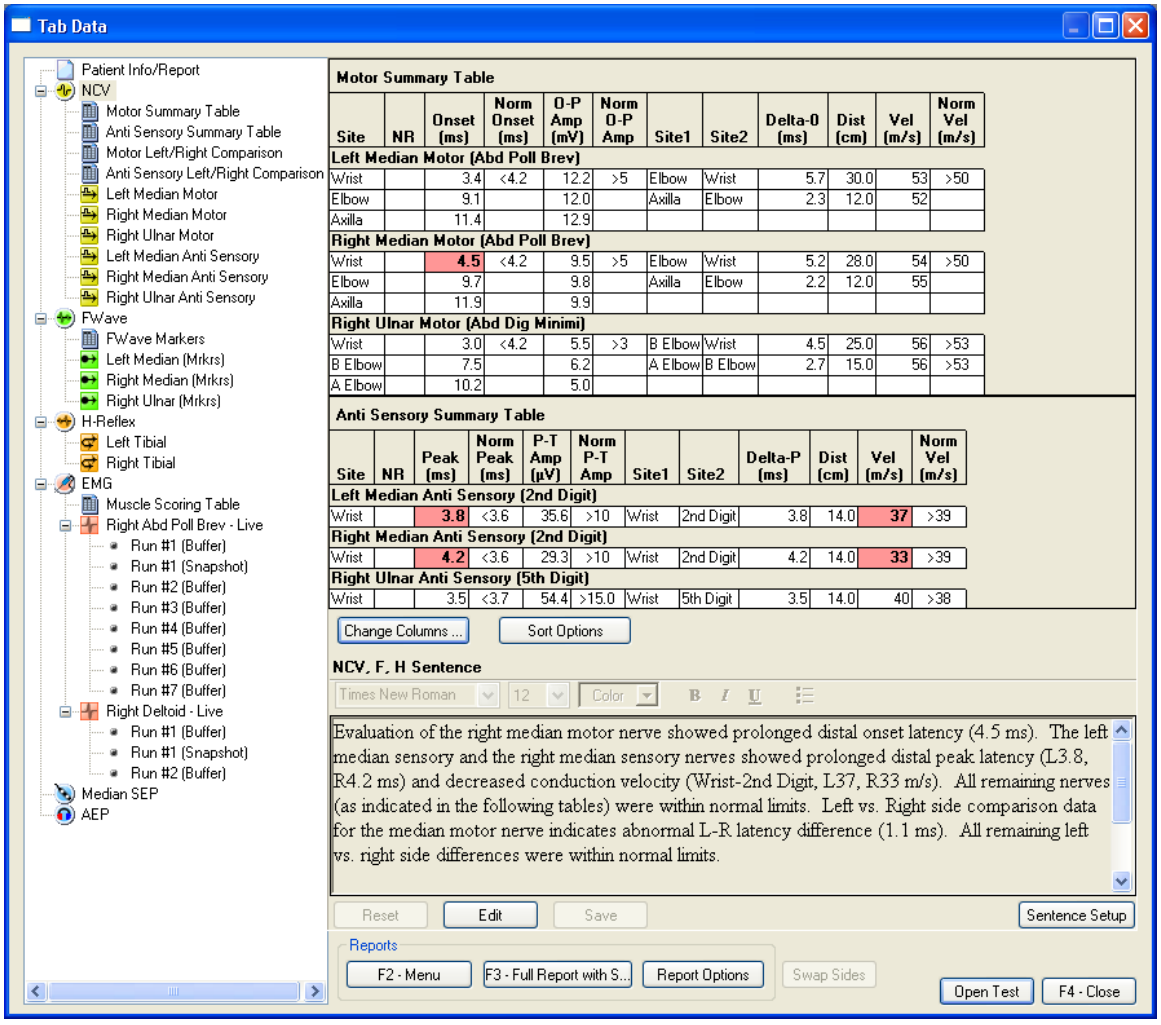
- **Alphbetical by Nerve Name (Left then Right)** - when this option is selected the nerves are sorted alphabetically by nerve name, Left side first and then Right side.
- **Alphbetical by Nerve Name (Right then Left)** - when this option is selected the nerves are sorted alphabetically by nerve name, Right side first and then Left side.
- **By Side (Right then Left)** - when this option is selected the nerves are sorted with Right side before Left side (all right-sided nerves and then all left-sided nerves).
- **By Side (Left then Right)** - when this option is selected the nerves are sorted with Left side before Right side (all left-sided nerves and then all right-sided nerves).

EMG/NCV Sentence Generator

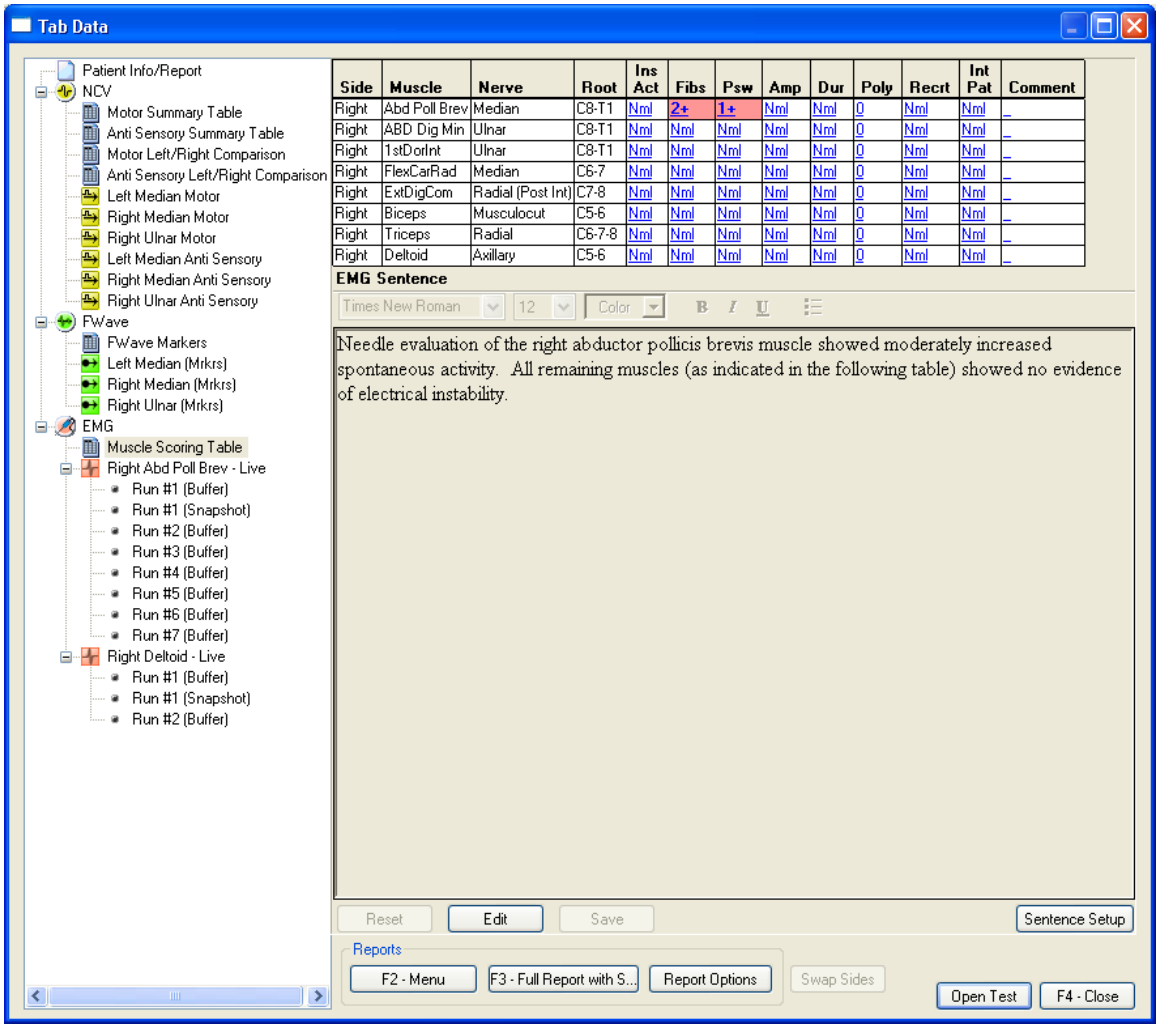
The Sentence Generator feature, which is used to automatically create findings sentences, is integrated into the Sierra Wave's TabData window. This gives the user the ability to simultaneously view the patient's tabulated test results and the findings sentences. This is an optional feature which can be turned On or Off in the System Setup window.

The findings sentences also include Left vs. Right side comparison data for NCV, F Wave, and H-Reflex test protocols.

When an **NCV, F Wave, or H-Reflex table node** is highlighted in the TabData window, the findings sentences for those test protocols will be displayed at the bottom of the window. When an **EMG table node** is highlighted, the EMG findings sentences will be displayed.



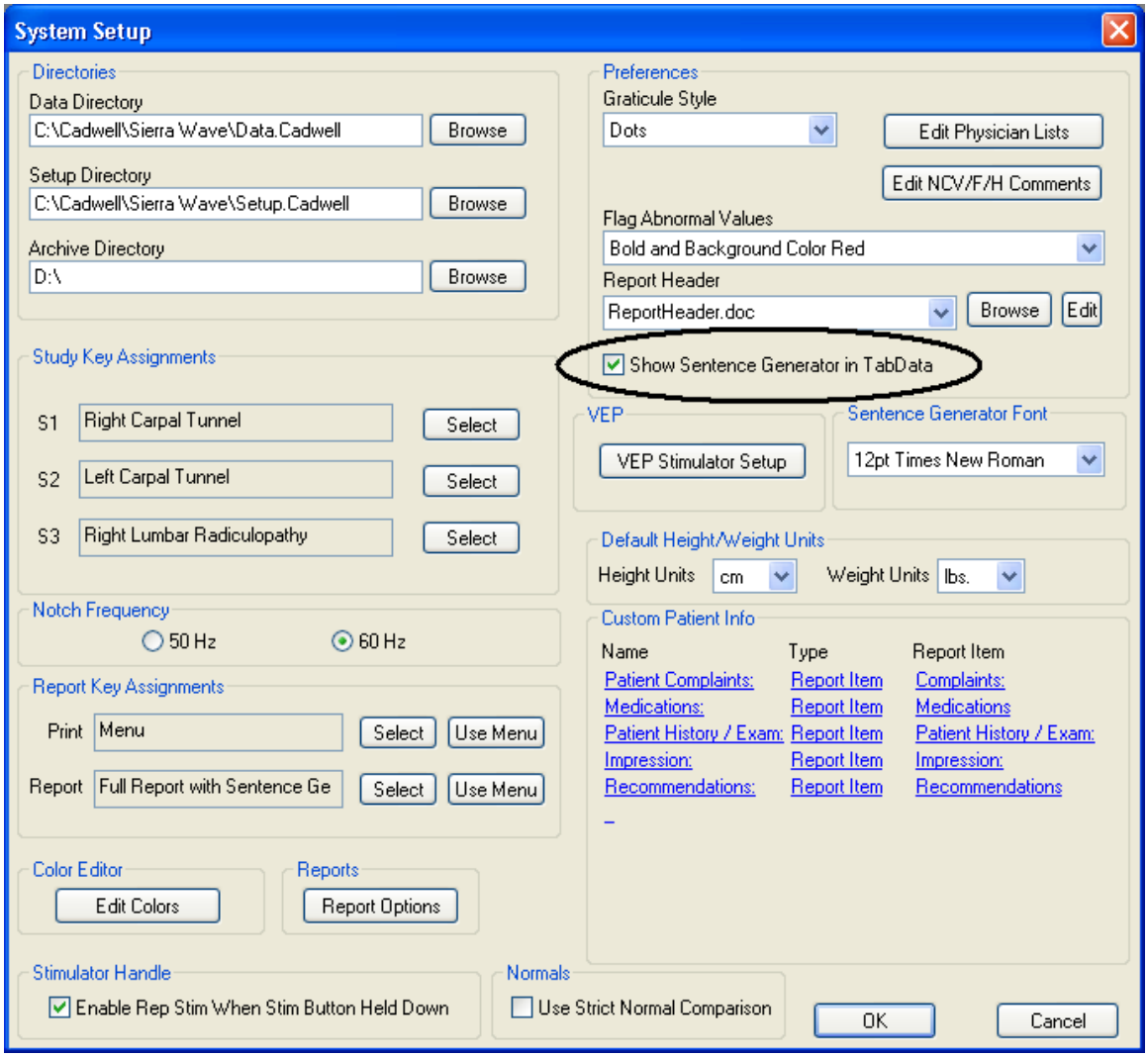
NCV node highlighted and the NCV, F Wave, and H-Reflex sentences shown at the bottom of the TabData window.



Muscle Scoring Table node highlighted and EMG sentences shown below the scoring table.

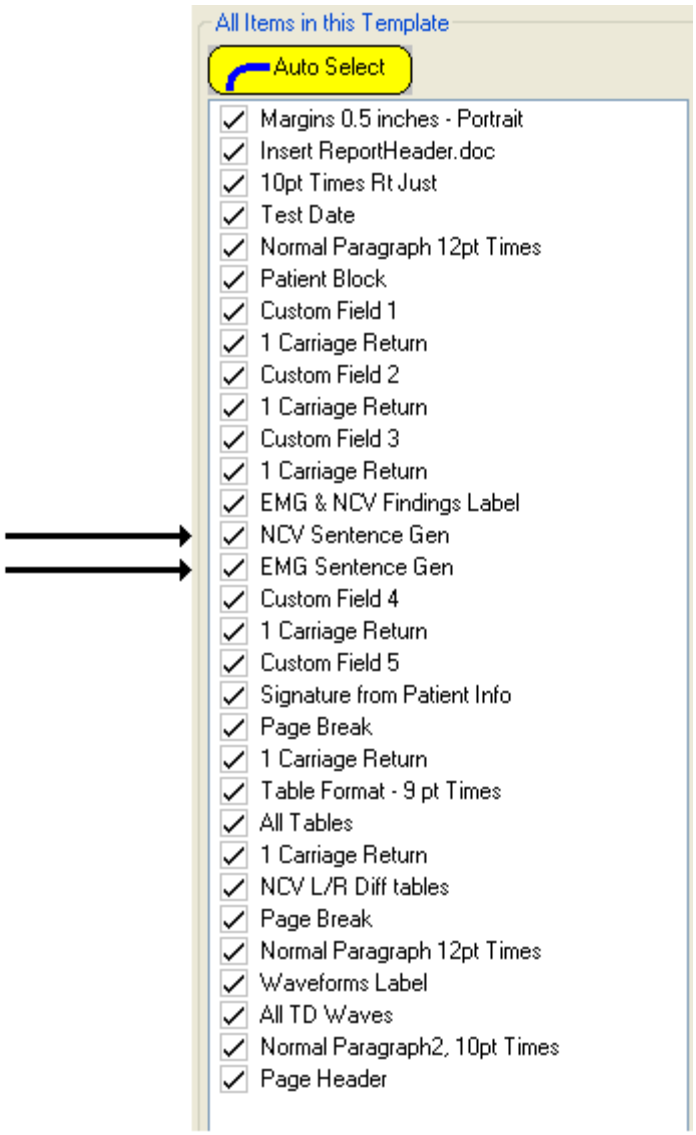
How to enable the Sentence Generator feature:

The integrated sentence generator is enabled in the System Setup window (shown below). From the **Edit** menu, select **System Setup**. Check the Sentence Generator box and then click **OK**.



How to include the Sentence Generator findings in a Report:

In order to include the Sentence Generator findings in your report, your QuickReport template must contain the sentence generator items. The factory default template, named “Full Report with Sentence Gen”, already includes these items.

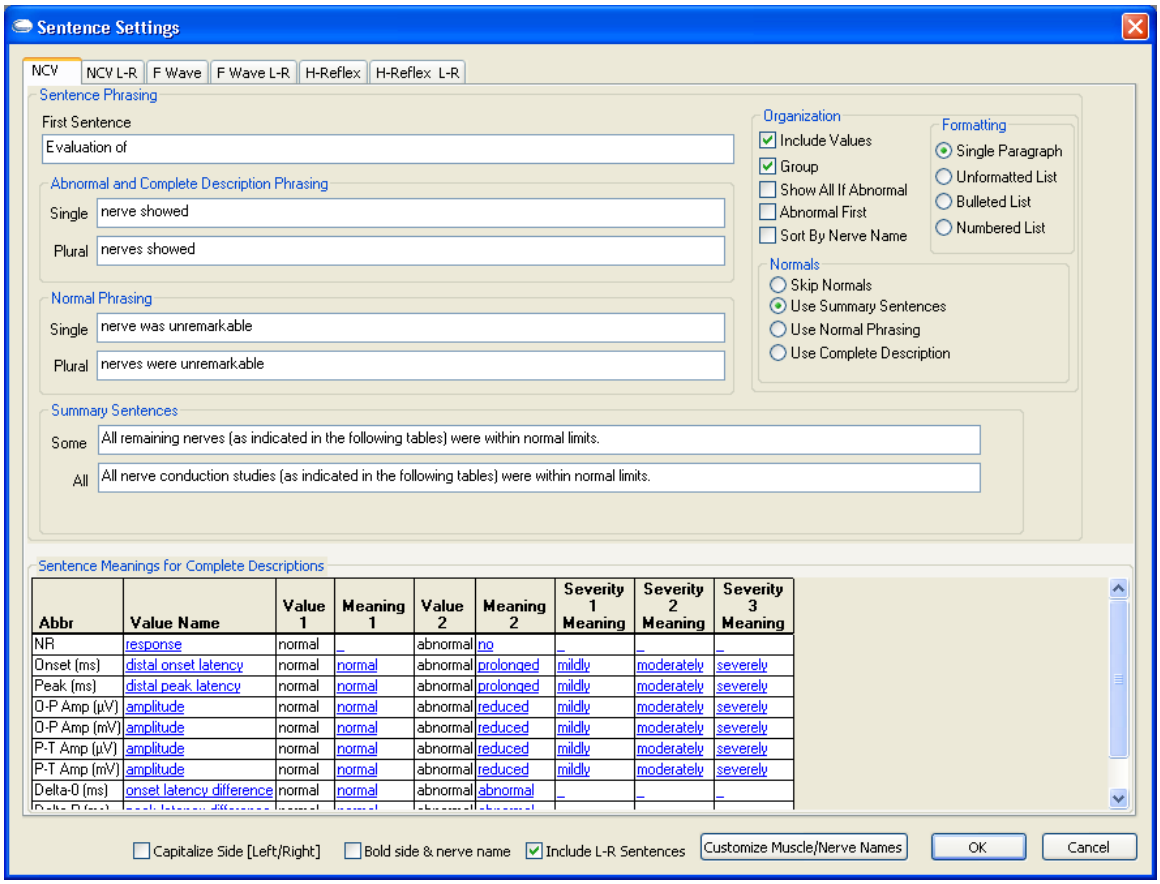


Item list for the template named “Full Report with Sentence Gen”.

Note the arrow pointing to the NCV and EMG Sentence Gen items.

Sentence Generator Setup for NCV, F Wave, and H-Reflex

When the NCV, F, H findings sentences are displayed a **Sentence Setup** button will be shown in the lower right hand corner of the TabData window. Click on this button to make changes to the wording used by the NCV/F/H sentence generator.



NCV, F Wave, and H-Reflex sentence generator setup window.

Sentence Phrasing for NCV/F/H:

Click on the tab at the top of the window corresponding to the part of the sentence you want to modify. You can simply type into the First Sentence, Abnormal Single & Plural, Normal Single & Plural, and Summary Sentences boxes.

First Sentence – the words used to begin the findings paragraph.

Abnormal and Complete Description Phrasing – the words used to begin a sentence when a result is abnormal.

Normal Phrasing – the words used to begin a sentence when a result is normal.

Summary Sentences – the sentence that is used to describe any remaining normal nerves (after the abnormal nerves have been individually described first), or when all nerves tested are found to be normal.

Sentence Meanings for Complete Descriptions:

Value Name, Meaning 1 & Meaning 2

Click on the underlined words in the Complete Descriptions table to change the words used to describe the abbreviated measurement name and value meaning (normal or abnormal meaning) for that measurement. The defined meaning is used in front of the value name in the sentence. For example, “The median motor nerve showed normal distal onset latency”.

Severity Meanings 1-3 (Optional)

These fields allow you to specify additional wording to use in the findings sentence when a value is abnormal. For example, "the distal latency was mildly prolonged" rather then simply "the distal latency was prolonged". These additional words can be manually selected for each abnormal value or the program can apply them automatically if the normal values for a nerve are configured appropriately. For more information on using the Abnormal Severity feature, click here.

Organization Options:

Include Values – when enabled the sentence will contain the latency, amplitude, and/or velocity value of the nerve in brackets. *Evaluation of the Right Median Motor nerve showed prolonged distal onset latency (4.3 ms).*

Group – combines multiple nerves into one sentence when they have the same abnormality. Evaluation of the Left Median Motor and the Right Median Motor nerves showed prolonged distal onset latency.

Show All if Abnormal – when a nerve has an abnormal value the sentence will also comment on the nerve’s normal values. *Evaluation of the Right Median Motor nerve showed prolonged distal onset latency (4.3 ms), normal amplitude (14.9 mV), and normal conduction velocity (Elbow-Wrist, 51.8 m/s).*

Abnormal First – use in combination with the **Use Normal Phrasing** parameter to force abnormal nerves to be described before normal nerves.

Sort by Nerve Name - sorts the sentences alphabetically by nerve name. For example, all the sentences regarding the median nerve, then the sentences regarding radial nerve, and finally all the sentences pertaining to the ulnar nerve.

Normals Options:

These settings determine how normal nerves are described in the findings sentences.

Skip Normals – does not include any sentences for normal nerves.

Use Summary Sentences – when there is at least one abnormal nerve, or when all nerves are normal, the sentence will include the summary sentence text. *All remaining nerves (as indicated in the following tables) were within normal limits*.

Use Normal Phrasing – when a nerve is normal, the normal phrasing will be used to describe it. *The Right Ulnar Motor nerve was unremarkable*.

Use Complete Description – uses the value name and meanings from the Complete Description table to describe normal nerves. *The Right Ulnar Motor nerve showed normal distal onset latency (3.0 ms), normal amplitude (5.9 mV), normal conduction velocity (B Elbow-Wrist, 54.0 m/s), and normal conduction velocity (A Elbow-B Elbow, 56.0 m/s)*.

Formatting Options:

These settings determine how the sentences are formatted in the report.

Single Paragraph - the findings sentences will be grouped into a single paragraph.

Evaluation of the right median motor nerve showed prolonged distal onset latency (4.5 ms). The left median sensory and the right median sensory nerves showed prolonged distal peak latency (L3.8, R4.3 ms) and decreased conduction velocity (Wrist-2nd Digit, L37, R33 m/s). All remaining nerves (as indicated in the following tables) were within normal limits. Left vs. Right side comparison data for the median motor nerve indicates abnormal L-R latency difference (1.2 ms). The median sensory nerve indicates abnormal L-R latency difference (0.5 ms).

All F Wave latencies were within normal limits. All F Wave left vs. right side latency differences were within normal limits.

Unformatted List - the findings sentences will appear in list format but without bullets or numbers.

Evaluation of the right median motor nerve showed prolonged distal onset latency (4.5 ms).

The left median sensory and the right median sensory nerves showed prolonged distal peak latency (L3.8, R4.3 ms) and decreased conduction velocity (Wrist-2nd Digit, L37, R33 m/s).

All remaining nerves (as indicated in the following tables) were within normal limits.

Left vs. Right side comparison data for the median motor nerve indicates abnormal L-R latency difference (1.2 ms).

The median sensory nerve indicates abnormal L-R latency difference (0.5 ms).

All F Wave latencies were within normal limits.

All F Wave left vs. right side latency differences were within normal limits.

Bulleted List - the findings sentences will be formatted into a bulleted list. Microsoft Word's default bullets will be used.

- Evaluation of the right median motor nerve showed prolonged distal onset latency (4.5 ms).
- The left median sensory and the right median sensory nerves showed prolonged distal peak latency (L3.8, R4.3 ms) and decreased conduction velocity (Wrist-2nd Digit, L37, R33 m/s).
- All remaining nerves (as indicated in the following tables) were within normal limits.
- Left vs. Right side comparison data for the median motor nerve indicates abnormal L-R latency difference (1.2 ms).
- The median sensory nerve indicates abnormal L-R latency difference (0.5 ms).
- All F Wave latencies were within normal limits.
- All F Wave left vs. right side latency differences were within normal limits.

Numbered List - the findings sentences will be formatted into a numbered list. Microsoft Word's default numbering format will be used.

1. Evaluation of the right median motor nerve showed prolonged distal onset latency (4.5 ms).
2. The left median sensory and the right median sensory nerves showed prolonged distal peak latency (L3.8, R4.3 ms) and decreased conduction velocity (Wrist-2nd Digit, L37, R33 m/s).
3. All remaining nerves (as indicated in the following tables) were within normal limits.
4. Left vs. Right side comparison data for the median motor nerve indicates abnormal L-R latency difference (1.2 ms).
5. The median sensory nerve indicates abnormal L-R latency difference (0.5 ms).
6. All F Wave latencies were within normal limits.
7. All F Wave left vs. right side latency differences were within normal limits.

Capitalize Side [Left/Right]

Check this box to have the side (Left or Right) automatically capitalized within the generated sentences.

Bold Side & Nerve Names

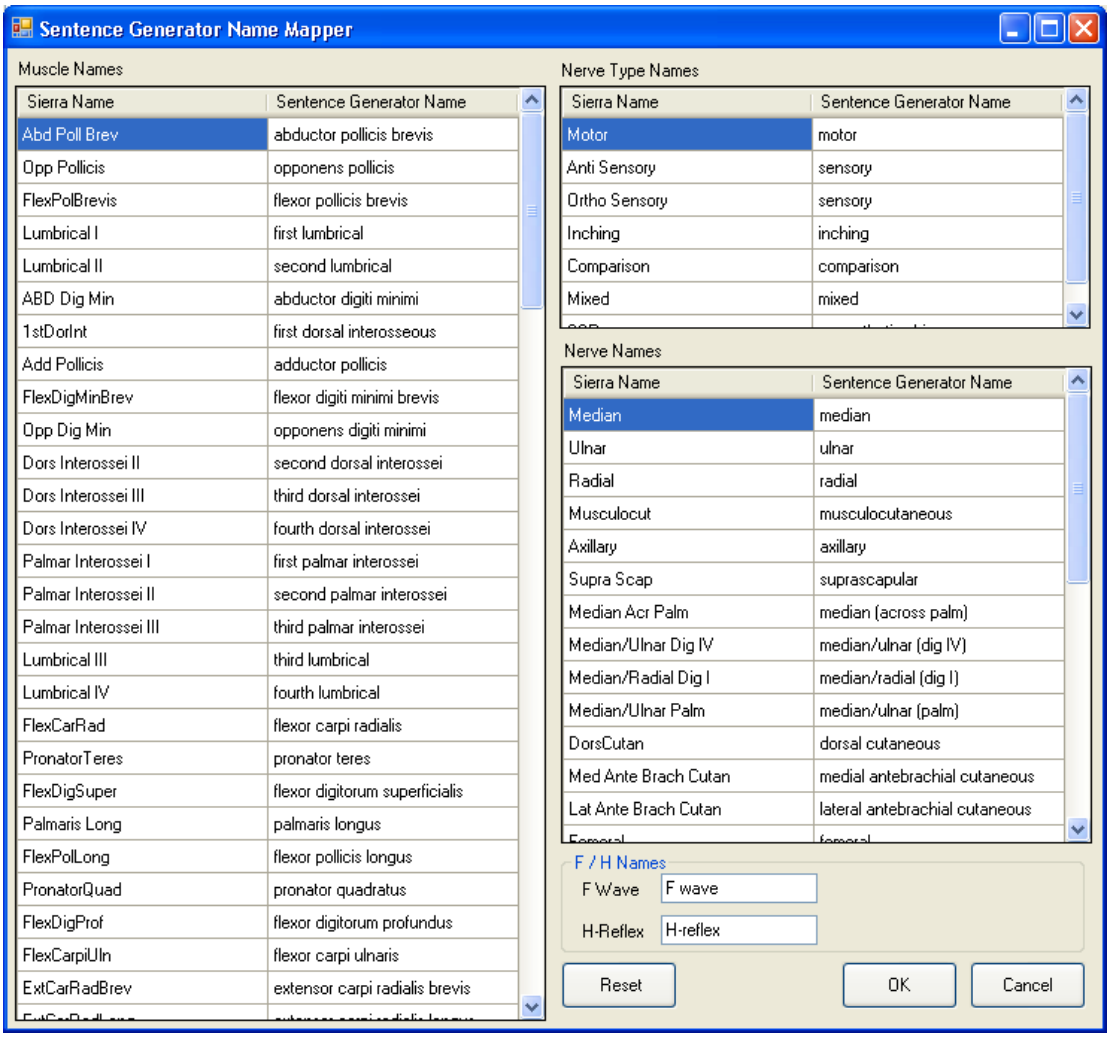
Check this box to have the side and nerve name displayed in **bold text** within the generated sentences.

Include L-R Sentences

Check this box to include the Left vs. Right side differences within the generated sentences.

Customize Muscle/Nerve Names

Clicking on this button opens a window where you can specify alternate wording that can used for each EMG muscle, NCV Nerve Type, and NCV Nerve. This feature allows for complete names to be used within the sentences while keeping the abbreviated names for use in results tables.

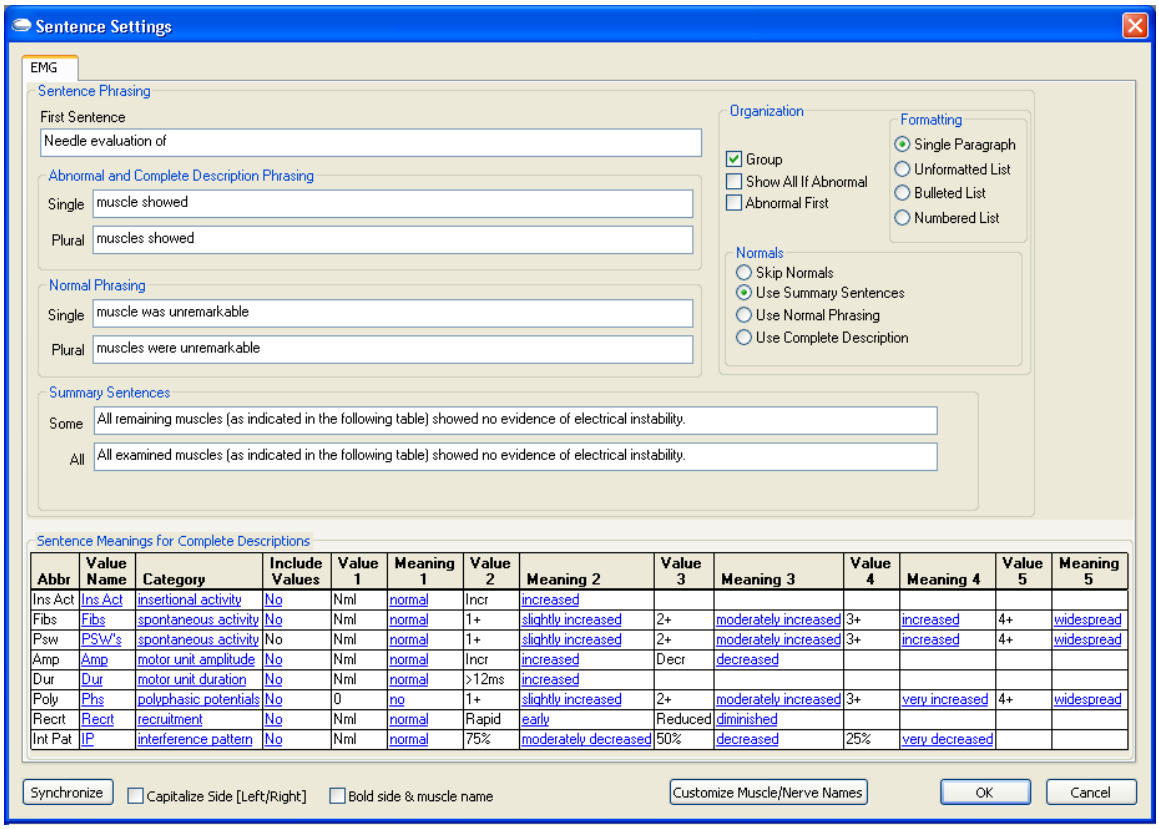


The columns on the left (Sierra Name) are the abbreviated names from the user's setup file. Enter the complete names for each muscle or nerve in the right hand column (Sentence Generator Name), these names will be used in the sentence generator. If a Sentence Generator Name is left blank, then the system will continue to use the name from the Sierra Name column.

Clicking **OK** saves this information to a file in the user's setup folder. This file is named "SentenceGenMap.xml" and is automatically included in the Preserve & Restore functions.

Sentence Generator Setup for EMG

When the EMG findings sentences are displayed, a **Sentence Setup** button will be displayed in the lower right hand corner of the TabData window. Click on this button to make changes to the wording used by the EMG sentence generator.



EMG sentence generator setup window.

Synchronize Button:

If you have modified the original factory default muscle scoring options you will need to click this button the first time you enter the EMG Sentence Setup. This will import the new or modified scoring options from your EMG test protocol so that you can assign categories and meanings to those options.

Sentence Phrasing for EMG:

First Sentence – the words used to begin the EMG findings paragraph.

Abnormal and Complete Description Phrasing – the words used to begin a sentence when a muscle is abnormal.

Normal Phrasing – the words used to begin a sentence when a muscle is normal.

Summary Sentences – the sentence that is used to describe any remaining normal muscles (after the abnormal muscles have been individually described first), or when all muscles tested are found to be normal.

Sentence Meanings for Complete Descriptions:

Click on the underlined words in the Complete Descriptions table to change the words used to describe the abbreviated value name, category name, and

value meaning for the muscle scoring column. The defined meaning is used in combination with the category name in the sentence. For example, if the APB muscle had 2+ Fibs the sentence would be, “The Right Abd Poll Brev showed moderately increased spontaneous activity. Fibs has been assigned to a category called “spontaneous activity” and the value of 2+ has been assigned a meaning of “moderately increased”.

Include Values – when enabled the sentence will contain the actual scoring values in brackets. *Needle evaluation of the Right Abd Poll Brev showed increased insertional activity (Incr Ins Act) and moderately increased spontaneous activity (2+ Fibs, 1+ PSW's).*

Organization Options:

Group – combines multiple muscles into one sentence when they have the same abnormality. *Needle evaluation of the Right Abd Poll Brev and the Right ABD Dig Min showed moderately increased spontaneous activity.*

Show All if Abnormal – when a muscle has an abnormal value the sentence will also comment on the muscle’s normal values. *Needle evaluation of the Right Abd Poll Brev showed increased insertional activity, moderately increased spontaneous activity, normal motor unit amplitude, normal motor unit duration, no polyphasic potentials, normal recruitment, and normal interference pattern.*

Abnormal First – use in combination with the **Use Normal Phrasing** parameter to force abnormal muscles to be described before normal muscles.

Normals Options:

These settings determine how normal muscles are described in the findings sentences.

Skip Normals – does not include any sentences for normal muscles.

Use Summary Sentences – when there is at least one abnormal muscle, or when all muscles are normal, the sentence will include the summary sentence text. *All remaining muscles (as indicated in the following table) showed no evidence of electrical instability.*

Use Normal Phrasing – when a muscle is normal, the normal phrasing will be used to describe it. *The Right Deltoid was unremarkable.*

Use Complete Description – uses the category name and meanings from the Complete Description table to describe normal muscles. *The Right Deltoid showed normal insertional activity, normal spontaneous activity, normal motor unit amplitude, normal motor unit duration, no polyphasic potentials, normal recruitment, and normal interference pattern.*

Formatting Options:

These settings determine how the sentences are formatted in the report. See examples shown above for the NCV sentences.

Single Paragraph - the findings sentences will be grouped into a single paragraph.

Unformatted List - the findings sentences will appear in list format but without bullets or numbers.

Bulleted List - the findings sentences will be formatted into a bulleted list. Microsoft Word's default bullets will be used.

Numbered List - the findings sentences will be formatted into a numbered list. Microsoft Word's default numbering format will be used.

Capitalize Side [Left/Right]

Check this box to have the side (Left or Right) automatically capitalized within the generated sentences.

Customize Muscle/Nerve Names

Clicking on this button opens a window where you can specify alternate wording that can used for each EMG muscle, NCV Nerve Type, and NCV Nerve. This feature allows for complete names to be used within the sentences while keeping the abbreviated names for use in results tables. See the complete description above in the **Setup for NCV Sentences**.

Making Changes to Test Results

While viewing the TabData window, the Sentence Generator will automatically update the findings sentences as soon as changes are made to the EMG muscle scoring or to the cursor positions on NCV, F Wave, or H-Reflex traces.

Using Abnormal Severity Meanings

This feature gives a user the ability to specify an abnormal value's degree of abnormality (e.g., mildly increased, moderately increased, or severely increased) for a latency value rather than simply having the findings sentence indicate that a latency is only 'increased'.

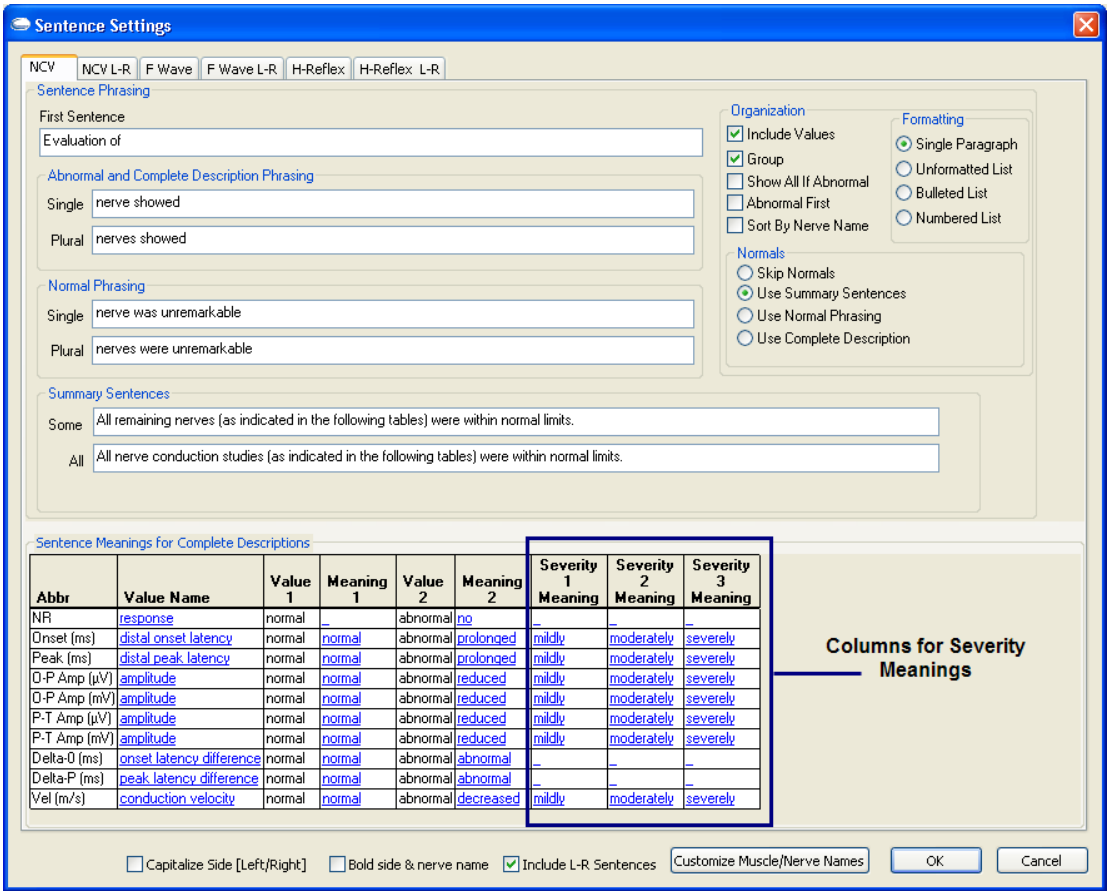
You can define the wording used for up to 3 severity ranges in the **NCV Sentence Setup** window and this feature can be automated by using a range of values for the normal value of a nerve.

Abnormal Severity Setup

In the **NCV Sentence Setup** window there are three columns for specifying the degree of abnormality. The columns are titled **Severity Meaning 1**, **Severity Meaning 2**, and **Severity Meaning 3**.

These columns allow you to specify the additional wording that can be used in the findings sentence when a value is found to be abnormal. You can fill-in some, all, or none of rows in these columns.

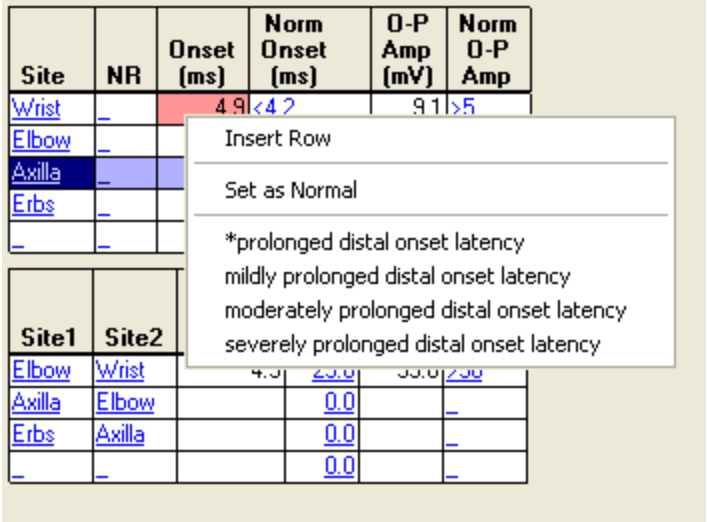
To open the NCV Sentence Setup window, go to the **TabData window** and select the top level **NCV node** in the left hand column. Click on the **Sentence Setup button** shown in the lower right hand corner.



NCV Sentence Setup window.

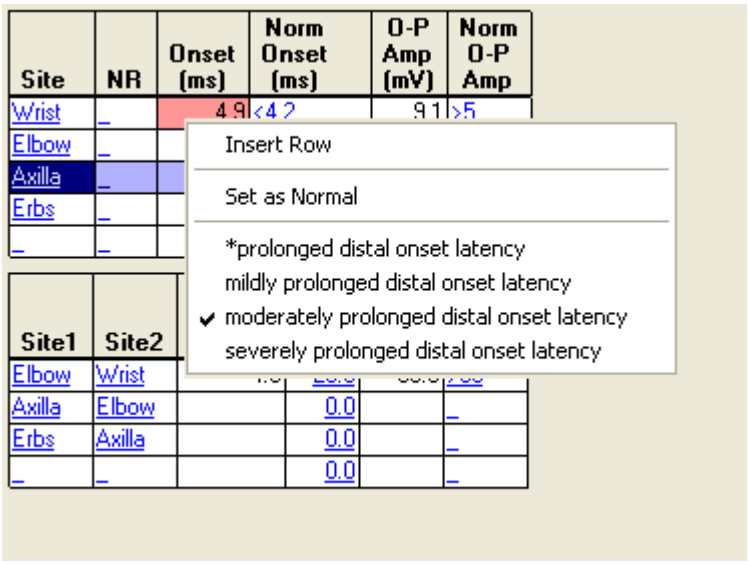
How to use the Abnormal Severity Meanings

In either the NCV Acquisition screen or from within the TabData window (if the individual nerve's node is highlighted in the left hand column) right click over the abnormal value to display a list of possible meanings. The following example shows the result of right clicking over an abnormal Onset Latency.



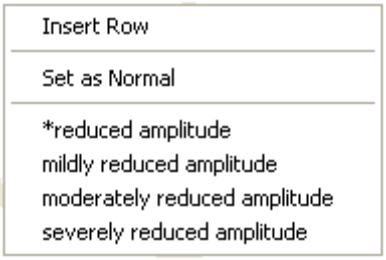
An asterisk (*) indicates the sentence generator's currently assigned default meaning. You can override the default meaning by selecting one of the additional abnormal meanings from the list. You can also override the program and set the meaning for the value to Normal.

When an abnormal meaning other than the default is selected, a check mark appears next to that meaning. To remove a selection, simply click on that meaning again and the check mark will be deleted.

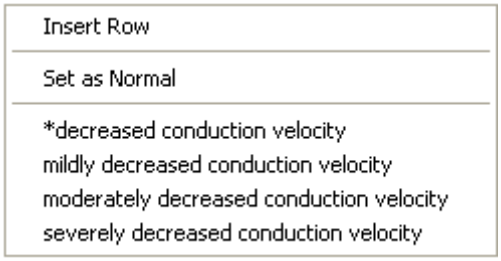


Meaning changed to "moderately".

Right clicking over an abnormal **Amplitude** or **Velocity** value will list appropriate selections for those values.

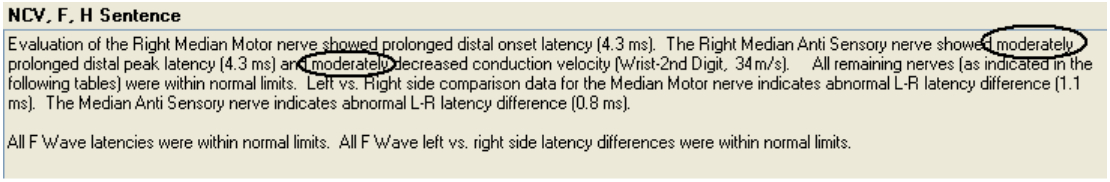


Right click over Amplitude value.



Right click over Velocity value.

In the following example, the default meaning for both the distal peak latency and conduction velocity of the Right Median Anti-Sensory nerve were changed to “moderately”.

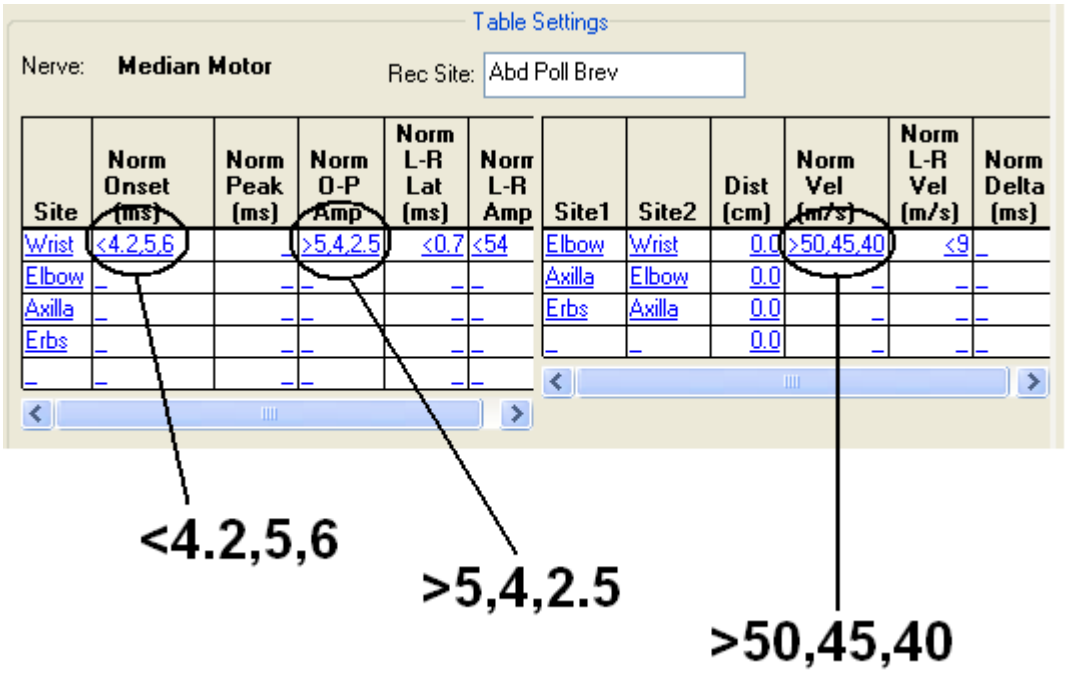


Automating this feature using Normal Value Ranges

The selection for the sentence’s abnormal meaning can be automated by specifying a range of values in the norm field of a nerve. Up to three ranges can be specified that correspond to Severity Meaning 1, Severity Meaning 2, and Severity Meaning 3.

After the initial normal value is specified (e.g. <4.2) **commas** can be used to setup the additional abnormal ranges for the sentence generator.

The following example shows how this can be done for the Onset, Amplitude, and Velocity measurements of the Median Motor nerve.



- **Using <4.2,5,6 for the Onset normal value sets up the following ranges.**

  <4.2 sets the normal limit. (Anything greater than this value is flagged as abnormal).

  4.3 – 5.0 represents the #1 severity range (i.e., mildly increased).

  5.1 – 6.0 represents the #2 severity range (i.e., moderately increased).

  6.1 and above represents the #3 severity range (i.e., severely increased).

  To determine what the three Latency ranges will be, use the following formula.

  Severity Range #1 = 1st value (**plus** 0.1) to 2nd value.

  Severity Range #2 = 2nd value (**plus** 0.1) to 3rd value.

  Severity Range #3 = 3rd value (**plus** 0.1) and above.

- **Using >5,4,2.5 for the distal Amplitude normal value sets up the following ranges.**

>5 sets the normal limit. (Anything less than this value is flagged as abnormal).

4.9 – 4.0 represents the #1 severity range (i.e., mildly decreased).

3.9 – 2.5 represents the #2 severity range (i.e., moderately decreased).

2.4 or less represents the #3 severity range (i.e., severely decreased).

 To determine what the three Amplitude ranges will be, use the following formula.

Severity Range #1 = 1st value (**minus** 0.1) to 2nd value.

Severity Range #2 = 2nd value (**minus** 0.1) to 3rd value.

Severity Range #3 = 3rd value (**minus** 0.1) or less.

- **Using >50,45,40 for the distal Velocity normal value sets up the following ranges.**

  >50 sets the normal limit. (Anything less than this value is flagged as abnormal.)

  49 – 45 represents the #1 severity range (i.e., mildly decreased).

  44 – 40 represents the #2 severity range (i.e., moderately decreased).

  39 or less represents the #3 severity range (i.e., severely decreased).

   To determine what the three Velocity ranges will be, use the following formula.

  Severity Range #1 = 1st value (**minus** 1) to 2nd value.

  Severity Range #2 = 2nd value (**minus** 1) to 3rd value.

  Severity Range #3 = 3rd value (**minus** 1) or less.

- **If only two values are used for a norm, such as <4.2,6.5 for latency.**

  <4.2 sets the normal limit.

  4.3 – 6.5 represents the #1 severity range (i.e., mildly prolonged).

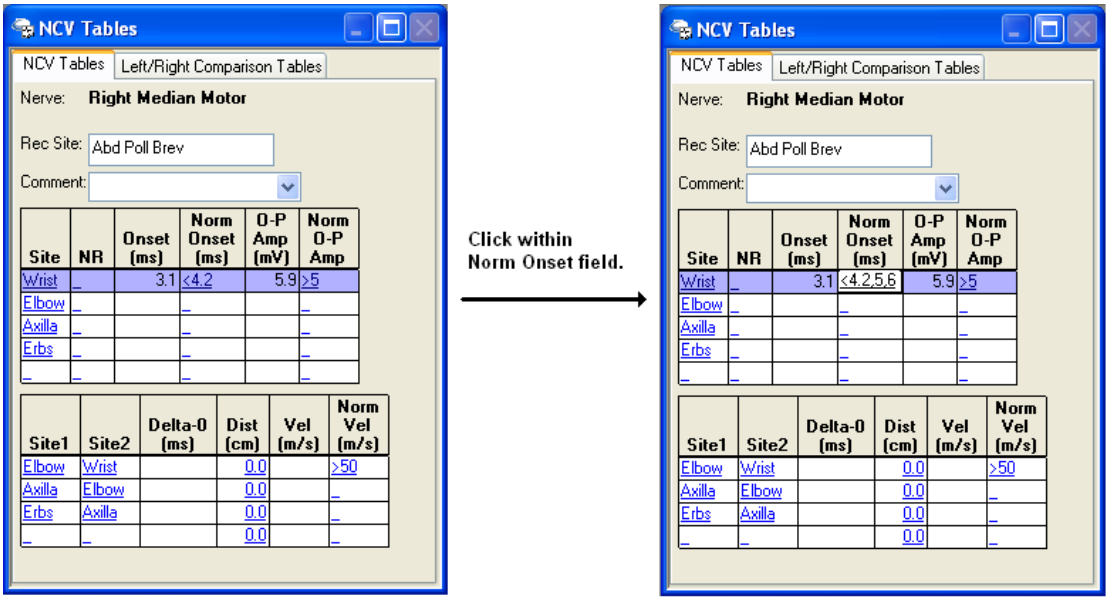
  6.6 and above represents the #2 severity range (i.e., moderately prolonged).

  Severity #3 is not used.

- **If only one value is used for a norm, such as <4.0 for latency.**

  For a latency value of 4.1 or higher the findings sentence will use the default meaning, “prolonged onset latency”.

Normal value ranges are hidden in the acquisition view unless the norm field is selected with the mouse for editing purposes. The ranges are also hidden in the TabData window and in final reports.



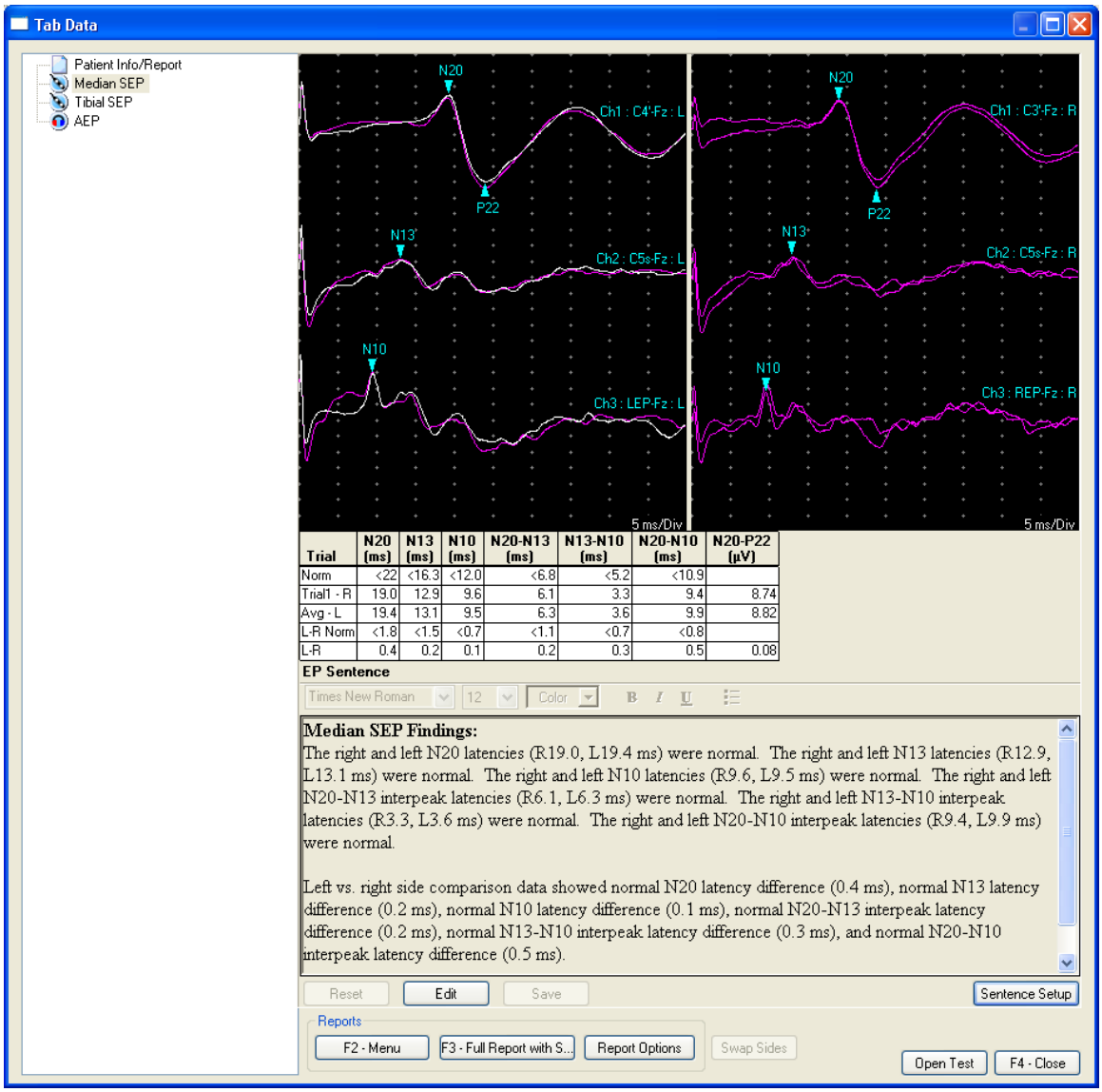
Typical Acquisition View. Only the first normal value in the range is displayed.

Norm Onset field has been selected, and now all values in the range are displayed.

EP Sentence Generator

The Sentence Generator feature, which is used to automatically create findings sentences, is integrated into the Sierra Wave's TabData window. This gives the user the ability to simultaneously view the patient's tabulated test results and the findings sentences. This is an optional feature which can be turned On or Off in the System Setup window.

When an **Evoked Potential (SEP, AEP, or VEP) node** is highlighted in the TabData window, the findings sentences for that test protocol will be displayed at the bottom of the window.

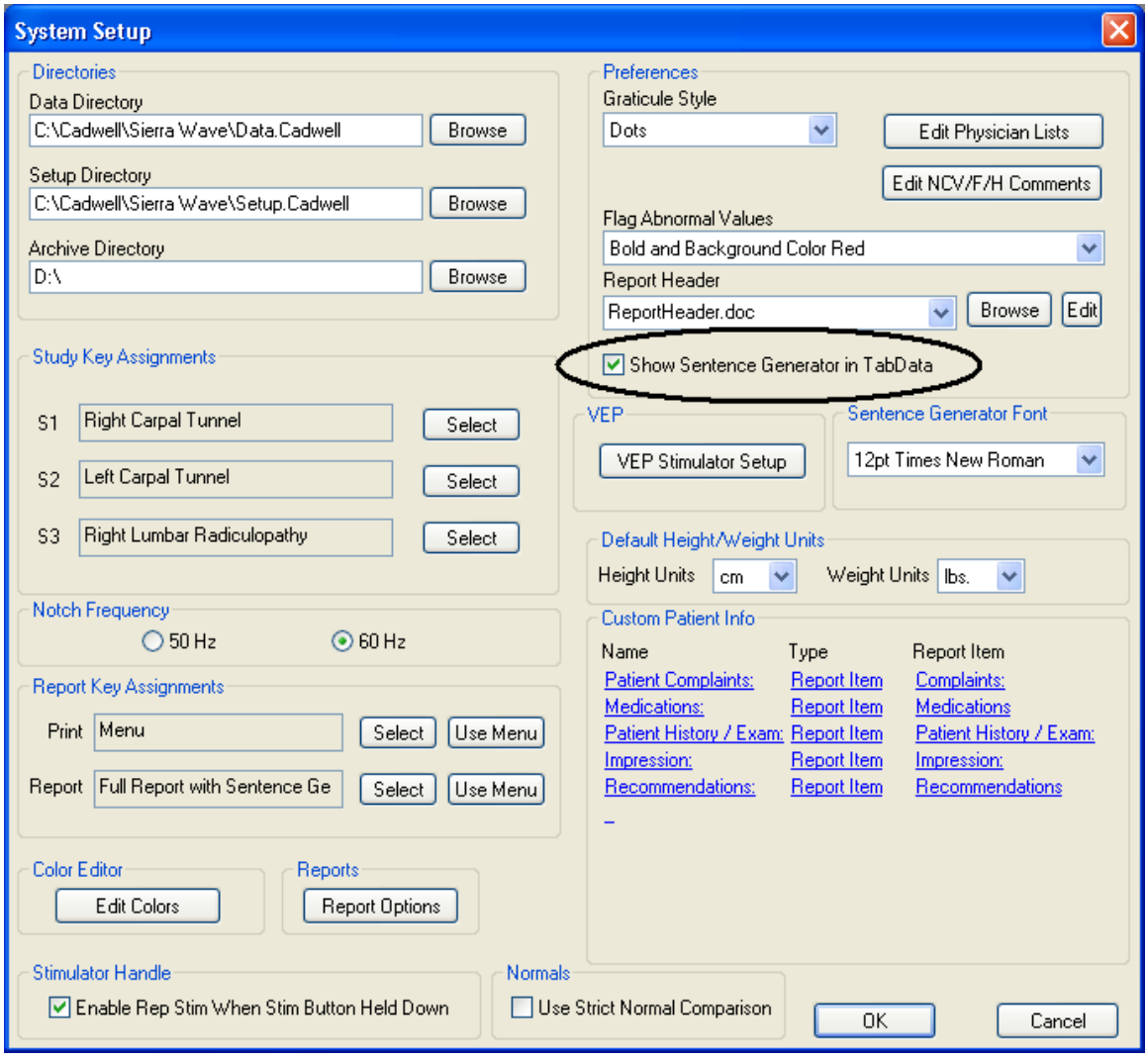


Trial	N20 (ms)	N13 (ms)	N10 (ms)	N20-N13 (ms)	N13-N10 (ms)	N20-N10 (ms)	N20-P22 (µV)
Norm	<22	<16.3	<12.0	<6.8	<5.2	<10.9	
Trial1 - R	19.0	12.9	9.6	6.1	3.3	9.4	8.74
Avg - L	19.4	13.1	9.5	6.3	3.6	9.9	8.82
L-R Norm	<1.8	<1.5	<0.7	<1.1	<0.7	<0.8	
L-R	0.4	0.2	0.1	0.2	0.3	0.5	0.08

Median SEP node highlighted and the findings sentences shown at the bottom of the TabData window.

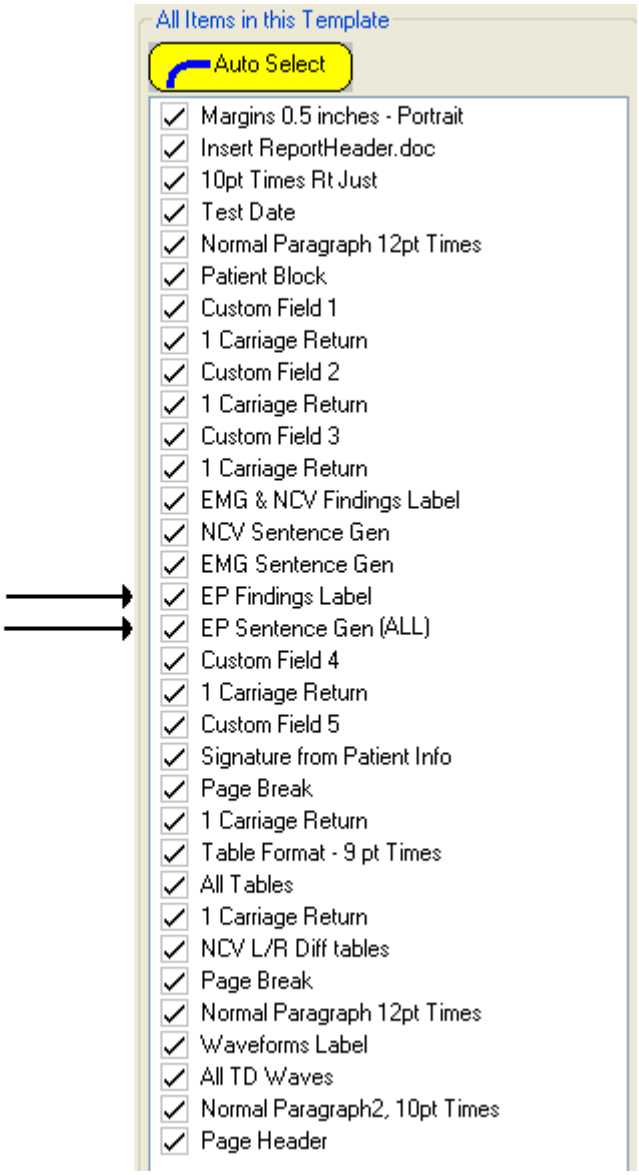
How to enable the Sentence Generator feature:

The integrated sentence generator is enabled in the System Setup window (shown below). From the **Edit** menu, select **System Setup**. Check the Sentence Generator box and then click **OK**.



How to include the Sentence Generator findings in a Report:

In order to include the EP Sentence Generator findings in your report, your QuickReport template must contain the EP sentence generator items.



Item list for the template named “Full Report with Sentence Gen”.

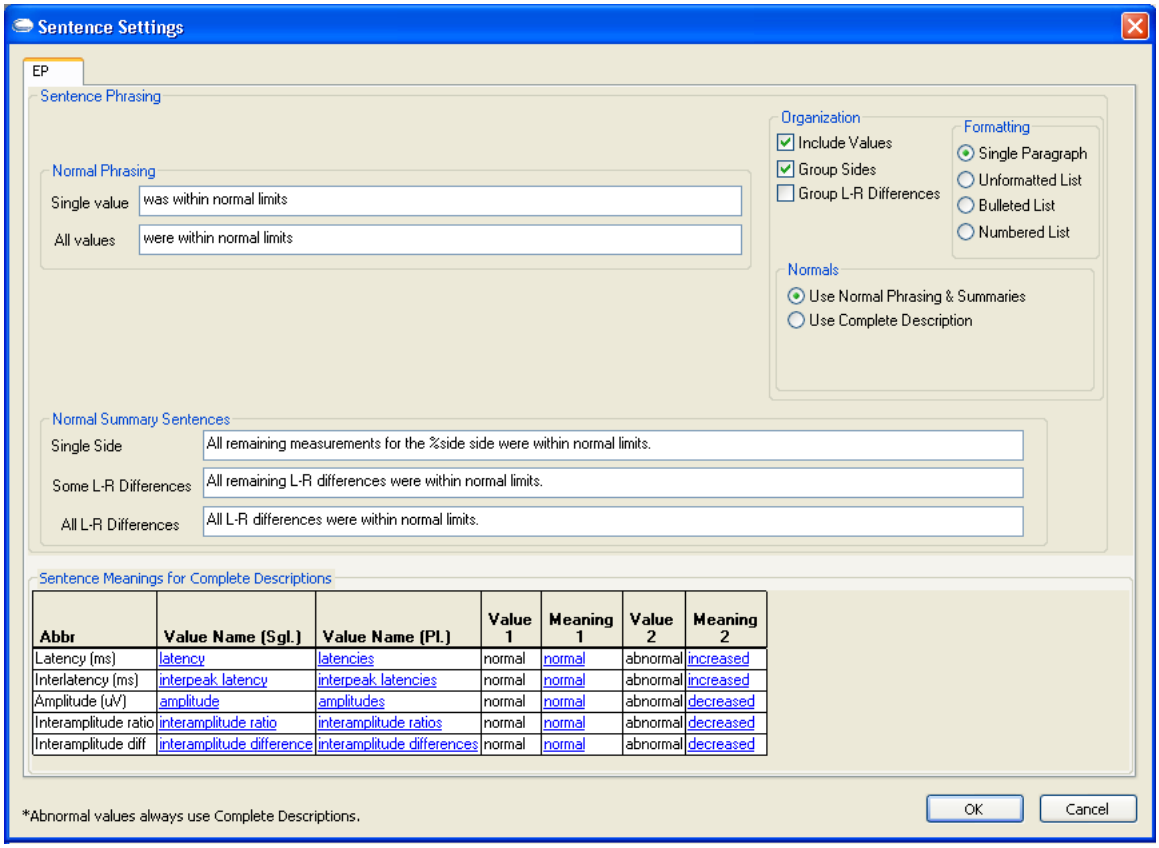
Note the arrows pointing to the EP Sentence Gen items.

If you don't have the EP Sentence Gen items in your report item list - they can be imported from the software installation CD. Please contact the **Applications Support Department** for instructions on how to do this.

Sentence Generator Setup for Evoked Potentials

When the Evoked Potential findings sentences are displayed a **Sentence Setup** button will be shown in the lower right hand corner of the TabData window. Click

on this button to make changes to the wording used by the EP Sentence Generator.



Evoked Potential sentence generator setup window.

Normals - these settings determine how normal values are described in the findings sentences.

Use Normal Phrasing & Summaries – when there is at least one abnormal value or one abnormal L-R difference, the sentence will include the summary sentence text. *Measurements for the right side showed increased N20-N13 interpeak latency. All remaining measurements for the right side were within normal limits. All measurements for the left side were within normal limits. All L-R differences were within normal limits.*

Normal Phrasing – the words used to end a sentence when a single value or all values are normal (the Use Normal Phrasing & Summaries option must be selected).

Normal Summary Sentences

- **Single Side** - summary sentence used to describe the remaining normal values for one side.
- **Some L-R Differences** - summary sentence used to describe the remaining L-R side difference normal values.

- **All L-R Differences** - summary sentence used when all L-R side difference values are normal.

Use Complete Description – uses the value name and meanings from the Complete Description table to describe the normal values. *Measurements for the right side showed normal N20 latency, normal N13 latency, normal N10 latency, increased N20-N13 interpeak latency, normal N13-N10 interpeak latency, and normal N20-N10 interpeak latency.*

Abnormals - these values always use the Complete Descriptions.

Formatting Options:

These settings determine how the sentences are formatted in the report.

Single Paragraph - the findings sentences will be grouped into a single paragraph.

AEP Findings:
The I-III interpeak latency was within normal limits on the right (2.06 ms) and was increased on the left (2.42 ms). All remaining measurements were within normal limits.

Left vs. right side comparison data showed increased I-III interpeak latency difference (0.36 ms) and increased III-V interpeak latency difference (0.37 ms).

Unformatted List - the findings sentences will appear in list format but without bullets or numbers.

AEP Findings:
The I-III interpeak latency was within normal limits on the right (2.06 ms) and was increased on the left (2.42 ms).

All remaining measurements were within normal limits.

Left vs. right side comparison data showed increased I-III interpeak latency difference (0.36 ms) and increased III-V interpeak latency difference (0.37 ms).

Bulleted List - the findings sentences will be formatted into a bulleted list. Microsoft Word's default bullets will be used.

AEP Findings:
- The I-III interpeak latency was within normal limits on the right (2.06 ms) and was increased on the left (2.42 ms).
- All remaining measurements were within normal limits.
- Left vs. right side comparison data showed increased I-III interpeak latency difference (0.36 ms) and increased III-V interpeak latency difference (0.37 ms).

Numbered List - the findings sentences will be formatted into a numbered list. Microsoft Word's default numbering format will be used.

AEP Findings:
1. The I-III interpeak latency was within normal limits on the right (2.06 ms) and was increased on the left (2.42 ms).
2. All remaining measurements were within normal limits.
3. Left vs. right side comparison data showed increased I-III interpeak latency difference (0.36 ms) and increased III-V interpeak latency difference (0.37 ms).

Sentence Meanings for Complete Descriptions:

Value Name (Single), Value Name (Plural), Meaning 1 & Meaning 2

Click on the underlined words in the Complete Descriptions table to change the words used to describe the abbreviated measurement name and value meaning (normal or abnormal meaning) for that measurement. The defined meaning is used in front of the value name in the sentence. For example, "*Measurements for the right side showed normal N20 latency." or "Measurements for the right side showed increased N20 latency."*

Organization Options:

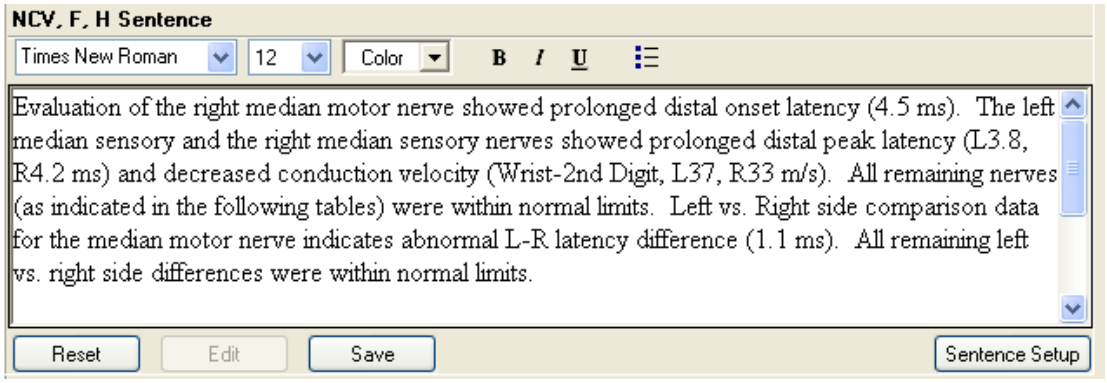
Include Values – when enabled the sentence will contain the actual latency, amplitude, interpeak latency, and L-R difference numbers in the sentence. *See example above in the TabData window*.

Group Sides – combines values from each side into one sentence when they have the same abnormality. *The right and left N20 latencies (R19.8, L19.4 ms) were normal.*

Group L-R Differences – adds the L-R difference sentences to the same paragraph that is describing the individual side values. *The right and left N20 latencies (R19.8, L19.4 ms) and right vs. left latency difference (0.4 ms) were normal.*

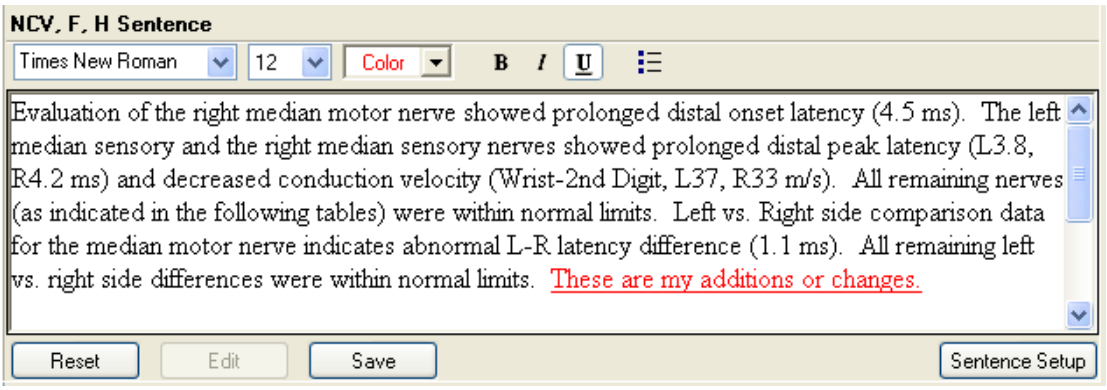
Editing the Sentences

Below each sentence is a **Reset**, **Edit**, and **Save** button. Click the **Edit button** if you want to make changes or additions to the generated sentences. The background of the sentence area will change to white color, signifying that you are in the Edit mode. The formatting controls above the sentence area will also be activated.



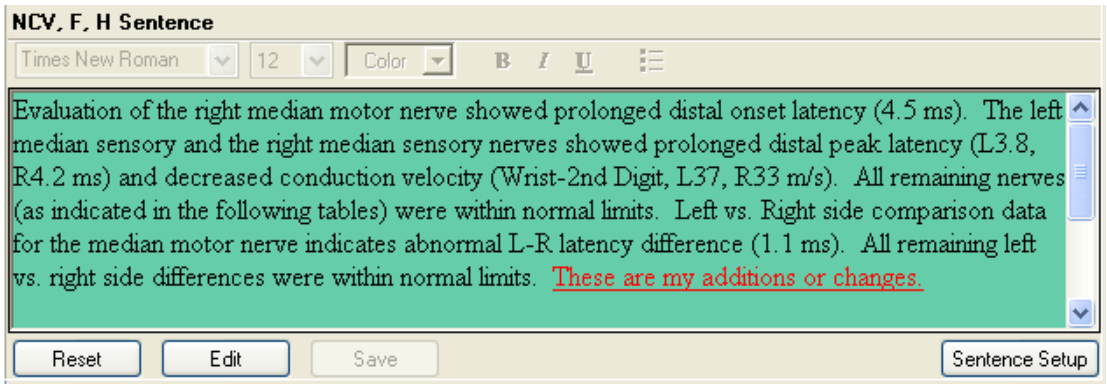
Edit mode.

Click within the sentence area and make your changes/additions.



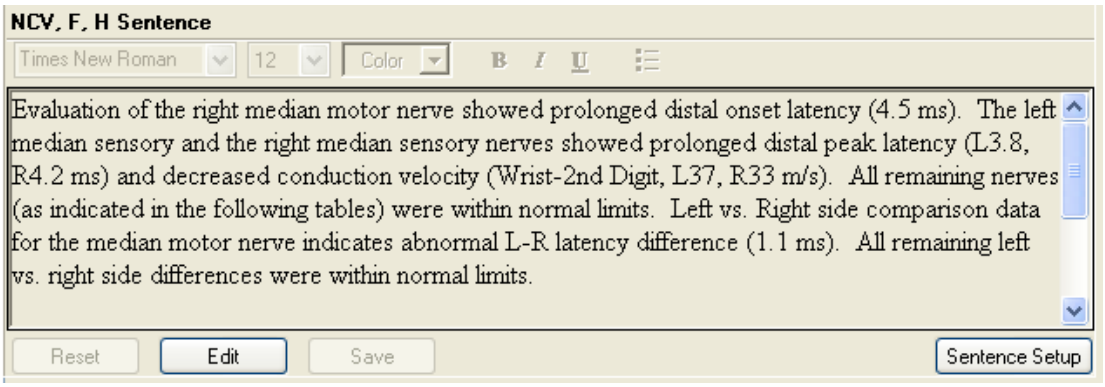
Edit mode with changes shown in red text.

To save your changes, click the **Save button**. The background will turn green, this signifies that editing has been performed and those changes/additions have been saved.



Changes to the sentences have been saved.

To cancel your changes or additions, click the **Reset button**. The sentence is returned to its default state and the background color changes back to the non-edit mode color.



Sentence has been reset to default state.

Adjusting Cursors

Adjusting Auto Cursor Positions

Begin by highlighting an individual test protocol, such as Right Median Motor. The test's traces and cursor table will be displayed on the right-hand side of the window.

Click on a cursor using the left mouse button and drag it along the trace to its new location. The information in the cursor table will be updated to reflect the new position.

Trace Context Menu

Trace Context (pop-up) Menu

Whenever traces are displayed in the right-hand side of the TabData window you can right-click the mouse over the trace area to display the same context menu that is available during data acquisition.

Use this context menu to delete traces, smooth traces, etc.

Changing Muscle Scoring

Change Muscle Scoring

If an EMG Muscle Scoring Table is selected you can change the muscle scoring selections for a muscle simply by clicking with the left mouse button within the table.

Sorting Muscle Scoring Table

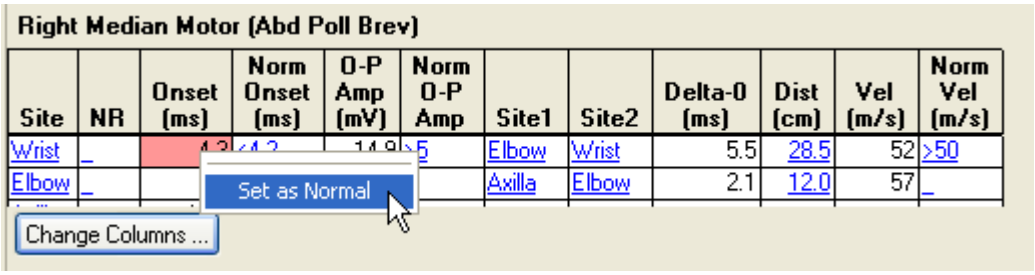
Sorting Muscle Scoring Table

If an EMG Muscle Scoring Table is selected you can click the mouse at the top of any of the table's columns to sort the table according to that column's information. To reverse the sorting, right-click the mouse over the muscle scoring table and select "Original Sort Order" from the pop-up menu.

Override an Abnormal Value

You can override the abnormal value flag when you believe that a value is actually within acceptable limits. This function can be performed from the main acquisition screen for the nerve, or from within the TabData window if the individual nerve's node is highlighted in the left hand column.

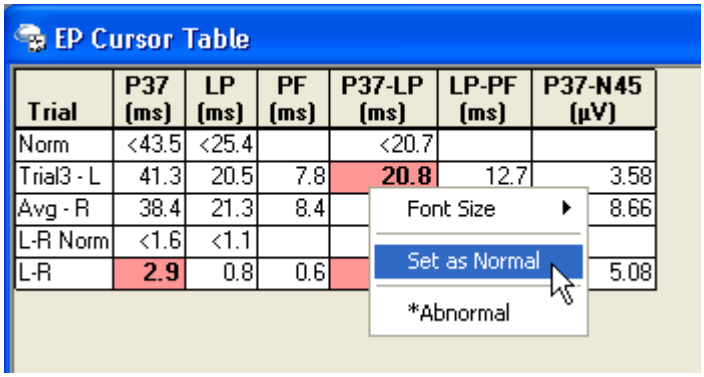
Simply **right-click** the mouse over the abnormal value, then select **Set as Normal** from the pop-up menu. The abnormal flag (red color or bold text) will be removed.



Median motor cursor table.

If you make a mistake, right click over the value again, and then remove the check mark next to Set as Normal. The abnormal flag will return.

This feature is also available in EP cursor tables.



Tibial SEP cursor table.

Swap Sides in TabData

Swap Sides

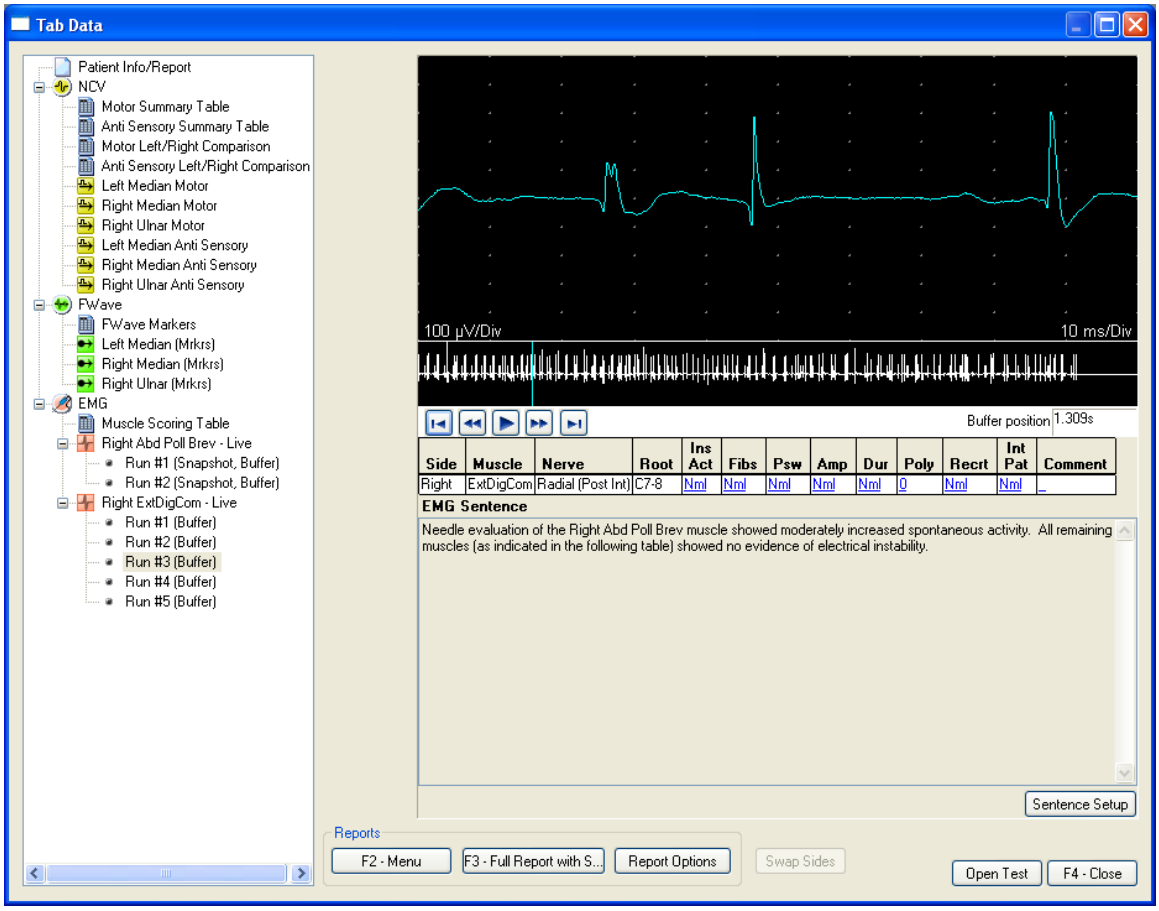
When an individual **NCV**, **F Wave**, **H Reflex**, or **RNS** test protocol is selected the Swap Side button can be used to swap the side parameter of the selected test.

 If the side you are swapping to doesn't already exist within the Study window, then that nerve will automatically be added.

 If the side you are swapping to already has stored traces, then a second run will be automatically added to that existing nerve.

Playback EMG Buffer

When a stored EMG Buffer is selected, the compressed buffer trace will be shown in the right hand portion of the TabData window. Use the playback controls to replay the buffer without having to open the EMG test protocol.



TabData window with stored EMG Buffer selected.

EMG Buffer Playback Controls.

Buffer Playback Controls.

 Go back one page.

 Go forward one page.

 Go back one division.

 Go forward one division.

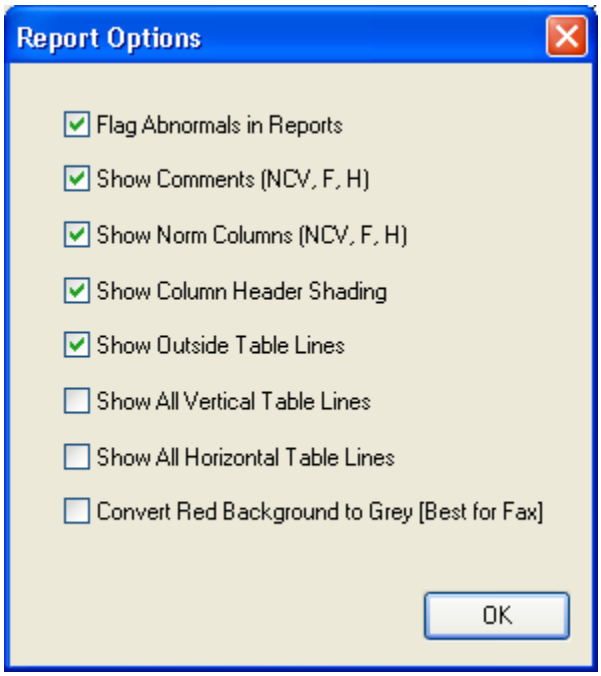
 Start EMG playback.

 Stop EMG playback.

Report Options

This button allows you to remove some elements from generated reports without removing them from the data acquisition screen or the TabData Summary view.

Clicking on the **Report Options** button displays the following window:



- **Flag Abnormals in Reports** - when this box is checked abnormal values will be indicated in reports, usually as red colored boxes or bolded numbers.
- **Show Comments (NCV, F, H)** - when this box is checked comments entered during NCV, F Wave, or H Reflex data acquisition will be displayed in the data tables of generated reports.
- **Show Norm Columns (NCV, F, H)** - when this box is checked the normal value columns for NCV, F Wave, and H Reflex tests will be included in the data tables of generated reports.
- **Show Column Header Shading** - when this box is checked the column headings at the top of each table are shaded gray.
- **Show Outside Table Lines** - when this box is checked a line is drawn between each nerve and a box is drawn around the entire table. If this box is unchecked, only the column heading row will remain underlined.
- **Show All Vertical Table Lines** - when this box is checked a vertical line is drawn between each table column.

- **Show All Horizontal Table Lines** - when this box is checked a horizontal line is drawn between each table row.
- **Convert Red Background to Grey (Best for Fax)** - when this box is checked the abnormal values, that are usually shown as red colored boxes in reports, will be changed to grey colored boxes. This is more suitable for reports that are being faxed to the referring physician.

 The Report Options button can also be accessed in the **System Setup** window.

Print A Report

Print a Report

Two buttons, representing the Print and Report keys on the Sierra Wave base unit, are displayed at the bottom of the TabData window. The name of the report template that is currently assigned to these buttons is displayed as the button's label.

To initiate a report.

- **Click** on one of these two buttons with the mouse.
- Press either the **F2** or **F3** function key on the PC's keyboard.
- Press the **Print** or **Report** keys on the Sierra Wave base unit.

Opening a Test

Open a Test Protocol

To open a test protocol and display the acquisition screen (this would be necessary to re-stimulate or collect additional traces), perform one of the following.

- Highlight the test protocol by turning **Knob #1 (Select / Open)** and then **press** to open.
- Highlight the test protocol and then click the **Open Test** button.
- **Double click** on the test protocol with the mouse.

Closing TabData

Close the TabData window

To close the TabData window and return to the previous test protocol screen, perform one of the following.

- Click on the **F4 (Close) button**.
- Press the **F4 (Close) function key** on the Sierra Wave base unit.
- Click on the TabData window's **red X**  .

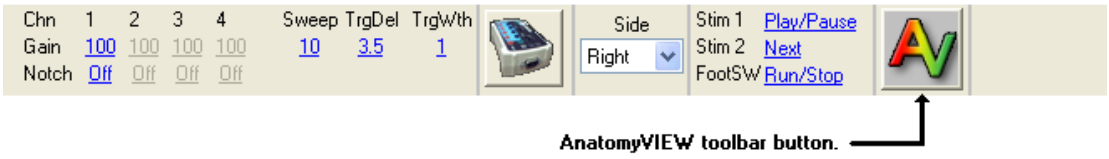
AnatomyVIEW

AnatomyVIEW Window Overview

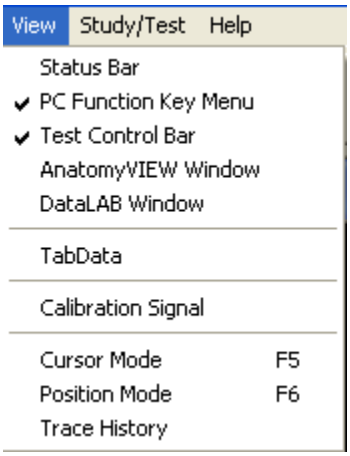
The AnatomyVIEW feature allows the EMG muscle scoring data and Nerve Conduction results to be displayed on a 3D color-coded anatomical model.

To open the AnatomyVIEW window, perform one of the following:

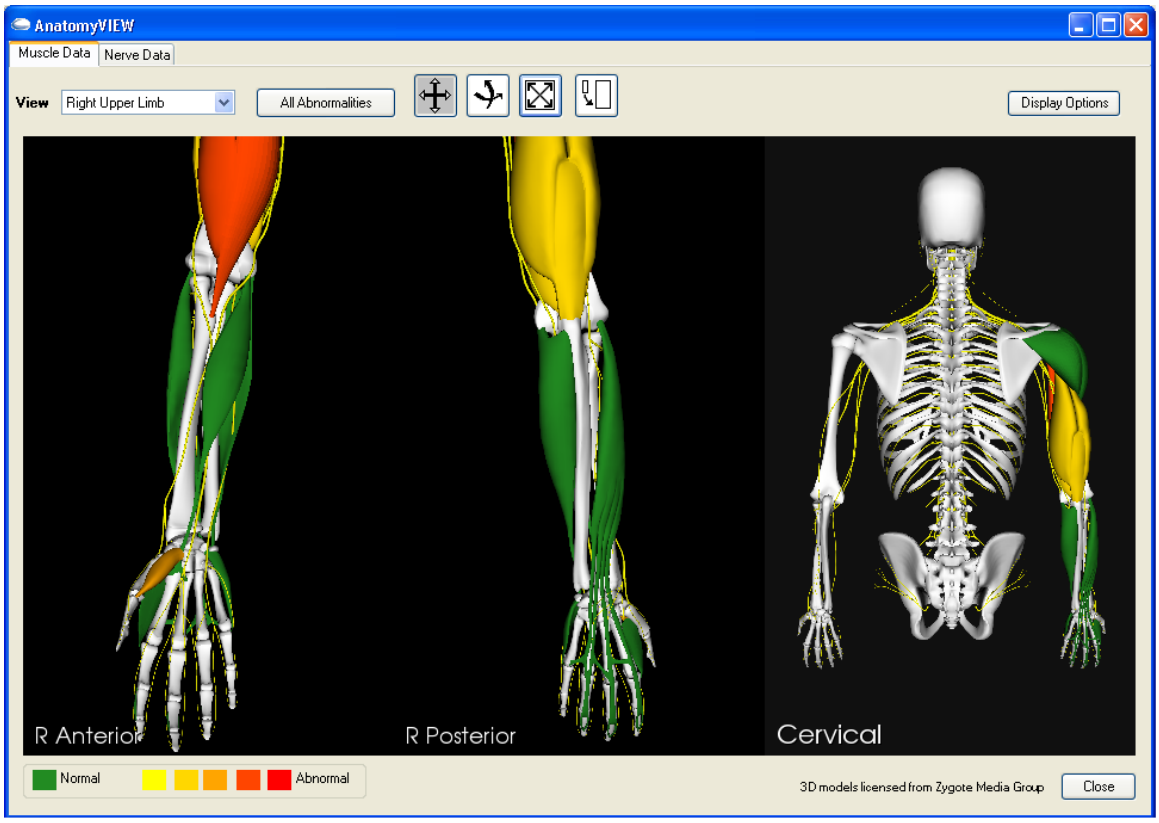
- Click on the **AnatomyVIEW button** in the test controls toolbar.



- Select **AnatomyVIEW** from the **View menu**.



It takes about 8-10 seconds for the AnatomyVIEW window to open the first time it is selected. The window will open much faster after this, as long as the Sierra Wave program is not closed. The reason for this is that the 3D modeling data has to be decrypted each time it is used, this is per the licensing agreement with the supplier of the 3D models.



AnatomyVIEW window.

Scenes:

Muscle Data:

The AnatomyVIEW window is composed of 3 scenes; **Anterior**, **Posterior,** and **Cervical / Lumbo-Sacral**. The Cervical / Lumbo-Sacral scene is intended to show the paraspinal muscles.

Nerve Data:

The AnatomyVIEW window is composed of 2 scenes; **Anterior** and **Posterior.**

Size and Position:

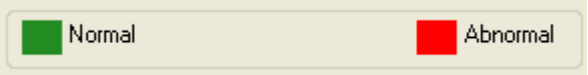
The size and position of the AnatomyVIEW window is stored by the Sierra Wave program. So, if you resize or move the window, it will return to this state the next time it is opened.

Window Controls:

Various controls and buttons for configuring the setup of the window are shown across the top of the display, the bottom left hand corner contains a color key for the muscle scoring data.

Controls

Muscle Data Color Key



Nerve Data Color Key

Closing the Window:

- Click on the **Close** button.
- Click on the **red X** in the upper right corner.

The AnatomyVIEW window must remain open (or minimized) in order to make the graphic available for QuickReport. Simply minimize AnatomyVIEW before launching the report generator.

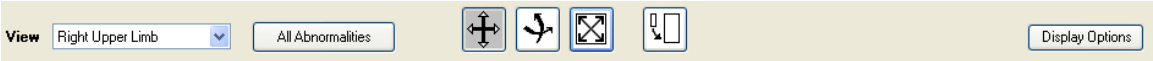
What happens if a muscle is not available in viewer?

If you score a muscle that is not available in the AnatomyVIEW window, or the muscle has not had any viewer muscles mapped to it, the following message box will be displayed upon opening the AnatomyVIEW window.

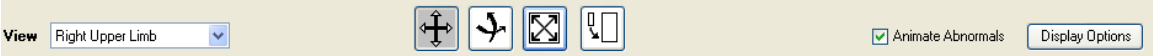
Message box indicating that the Left Soleus cannot be displayed in the AnatomyVIEW.

AnatomyVIEW Controls

Various controls and buttons for configuring the setup of the AnatomyVIEW window are shown across the top of the display.



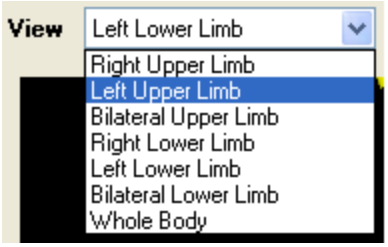
Muscle Data Controls



Nerve Data Controls

Changing Views:

To change the view shown in the window, click on the **View** drop-down list and then select a different view from the list.



Using the Mouse Tools:

The mouse tools can be used to move, rotate, and zoom in & out on each model in a scene. A reset tool allows you to quickly return the models in all scenes to their default positions.

Move Tool - this is the default tool. Left click and drag within a scene to move the model within that scene up or down.

Free Rotate Tool - use this tool to rotate the model in the X or Y plane. After selecting this tool, left click and drag within a scene to rotate the model within that scene in the X or Y plane.

Reset Tool - click on this button to return all 3 scenes to their default positions.

Expand Tool - use this tool to expand the selected scene to fit the entire width of the AnatomyVIEW window. Click on this tool a second time to return the scene to its original size.

Zoom Tool - the mouse wheel is used for this tool. Turn the mouse wheel to zoom in or out on a model in the selected scene.

When a scene is selected its background color will be shown in a slightly lighter color than the other scenes.

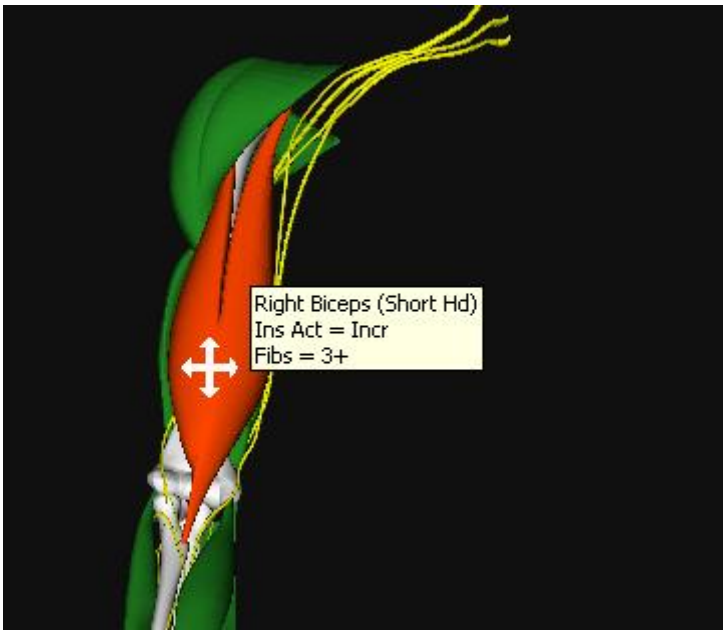
The Whole Body view only contains two scenes, Anterior and Posterior.

Animate Abnormals:

When checked abnormal nerve segments will flash on & off on the nerve data tab.

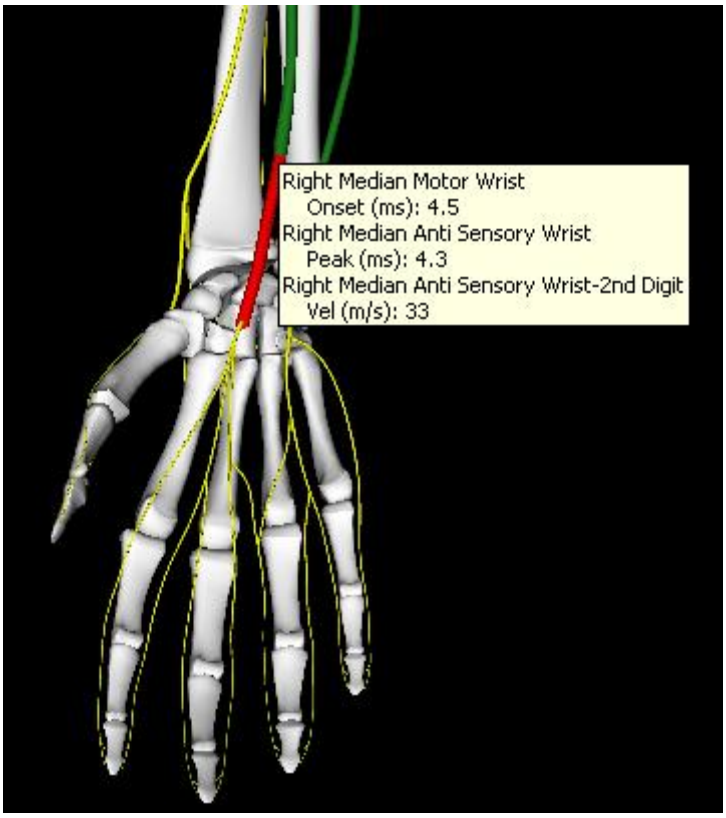
Tool Tips:

Position the mouse over a muscle to view a Tool Tip containing the muscle name and any associated muscle scoring abnormalities.



Mouse over biceps muscle with resulting tool tip.

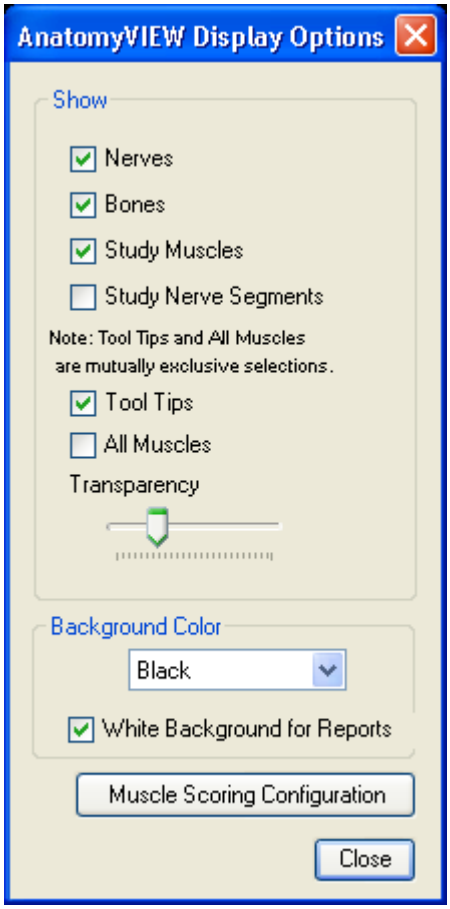
Position the mouse over an abnormal nerve segment to view a Tool Tip containing the segment name and any associated abnormalities.



Mouse over median wrist segment with resulting tool tip.

Display Options:

Clicking on the **Display Options** button will open a new window that contains several options for changing the appearance of the AnatomyVIEW and also allows for configuration of the muscle scoring data (i.e., how the color coding is setup).



Display Options window.

Show Options

- **Nerves** - when selected the nerve layer will be shown within each scene.
- **Bones** - when selected the bone layer will be shown within each scene.
- **Study Muscles** - when selected the muscles that have been scored in the EMG test protocol will be shown within each scene.
- **Study Nerve Segments** - when selected the nerve segment results will be shown within each scene.
- **Tool Tips** or **All Muscles** - these options are mutually exclusive, only one can be enabled at a time.
    - **Tool Tips** - when selected the tool tip will be displayed when the mouse hovers over a scored muscle.
    - **All Muscles** - when selected all the muscles supported by the viewer will be displayed.

- Transparency Slider - move left or right to adjust the opacity of the muscles. Moving the slider all the way to the right will make the muscles completely opaque (i.e., solid).

Background Color

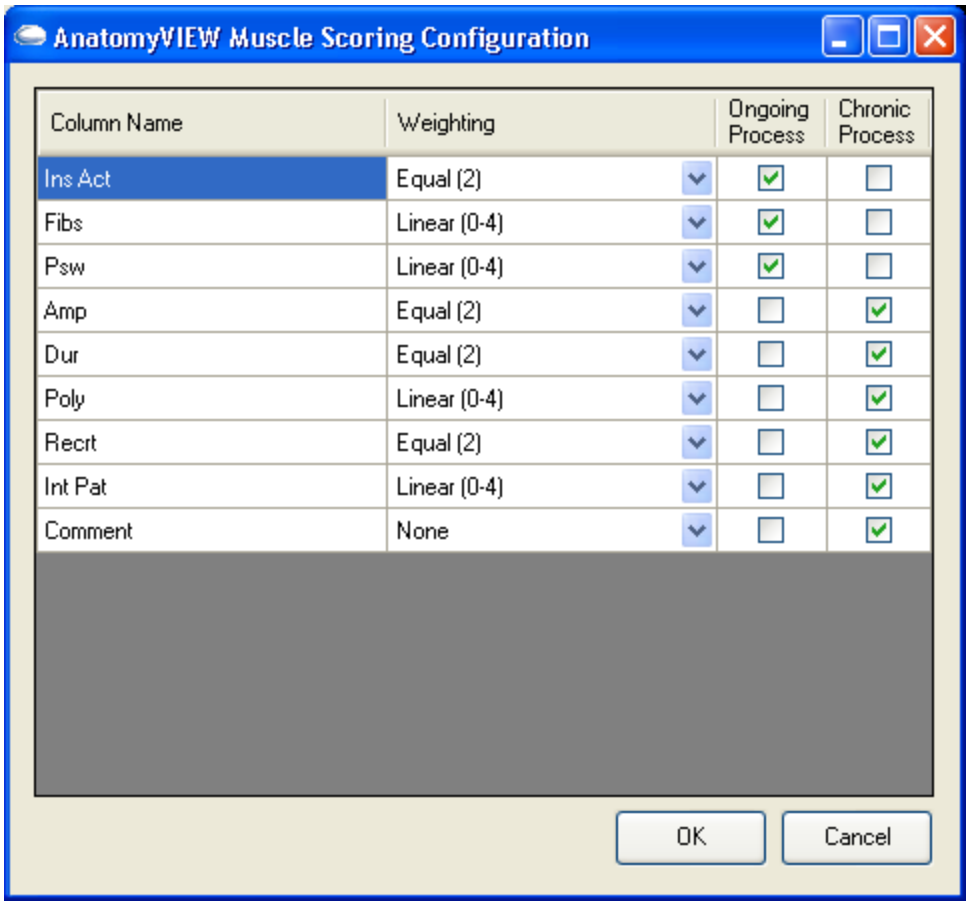
Click on the drop down list to change the background color of the view. Choices are **Black**, **Dark Blue**, and **White**. This selection is remembered by the program and will default to whatever you choose.

Use the check box to set the background color in reports to white, allowing the background color on-screen to remain set to black or dark blue.

Muscle Scoring Configuration

Clicking on the **Muscle Scoring Configuration** button opens a new window that contains the weighting factors that are used to determine how muscle scoring abnormalities are color coded.

A weighting factor is assigned to each muscle scoring column and are used to compute a composite score for each muscle, the higher the composite score the higher the color coding on the abnormal scale.



Muscle Scoring Configuration window.

- **Column Name** - shows the muscle scoring columns from the current user's EMG test protocol.
- **Weighting** - click on the drop-down arrow to assign a weighting factor to each muscle scoring column. The weighting factors are used to compute a composite score for each muscle. The higher the composite score, the higher color coding on the abnormal scale.
    - **Linear (0-4)** - use this factor for columns that use a linear scoring scale. For example, the Fibs column has choices of Normal, 1+, 2+, 3+, 4+. This is a linear scale with the most abnormal value being 4+.
    - **Equal (1)**, **Equal (2)**, **Equal (3)**, **Equal (4)** - use these factors for columns that do not use a linear scoring scale. For example, the Ins Act column has choices of Normal, Increased, or Decreased. Choosing either Increased or Decreased are equally an abnormal sign, this would be a good example for using the Equal (2) weighting factor.

Choosing either one is about the same as a 2+ on a linear scale.

- **None** - use this setting for columns that should be ignored when computing the composite score for a muscle.

- **Ongoing** or **Chronic Process** - these check boxes are used in combination with the **Abnormality button** described below. You can categorize each scoring column as either Ongoing (acute) or Chronic. Typically, fibrillation potentials are evidence of an ongoing process while changes in amplitude are evidence of a chronic process.

Clicking **OK** saves this information to a file in the user's setup folder. This file is named "AnatomyScoreMap.xml" and is automatically included in the Preserve & Restore functions.

Viewing by type of Abnormality (Muscle Data only):

Click on the **All Abnormalities button** to toggle the view to show only **Ongoing** (acute) or **Chronic Processes**. Only those muscles showing abnormalities matching the current button setting will be displayed within the view.

AnatomyVIEW Setup - Muscle Data

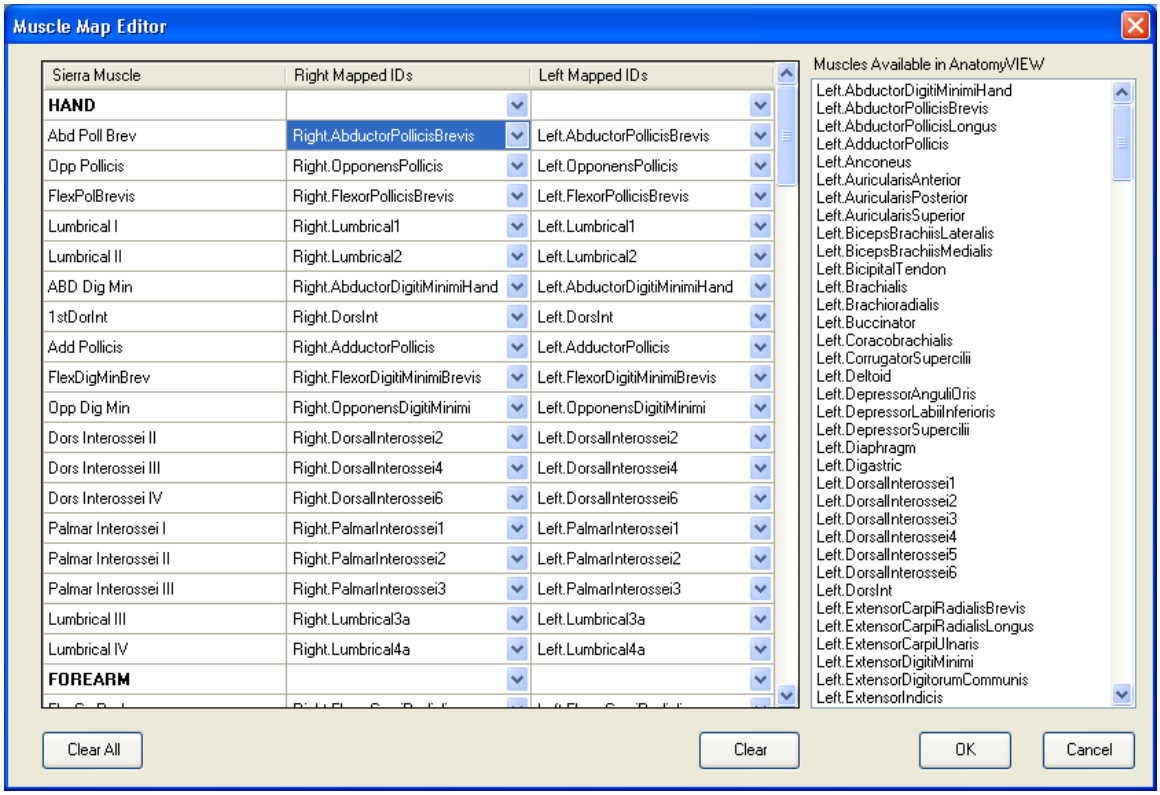
The AnatomyVIEW feature allows the EMG muscle scoring data to be displayed on a 3D color-coded anatomical model.

The Sierra Wave is very flexible in that each user can create and name their own muscles and change the name of factory default muscles. Therefore, the program must be able to match each users name for a muscle to the muscle ID that is recognized by the AnatomyVIEW window. This is done using the **Muscle Map Editor**.

To open the Muscle Map Editor:

1. From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **EMG** test protocol in the test list. The EMG test protocol settings will be displayed on the right hand side of the screen.

2. Click on the **AnatomyVIEW Muscle Map** button. The **Muscle Map Editor** window will be displayed.



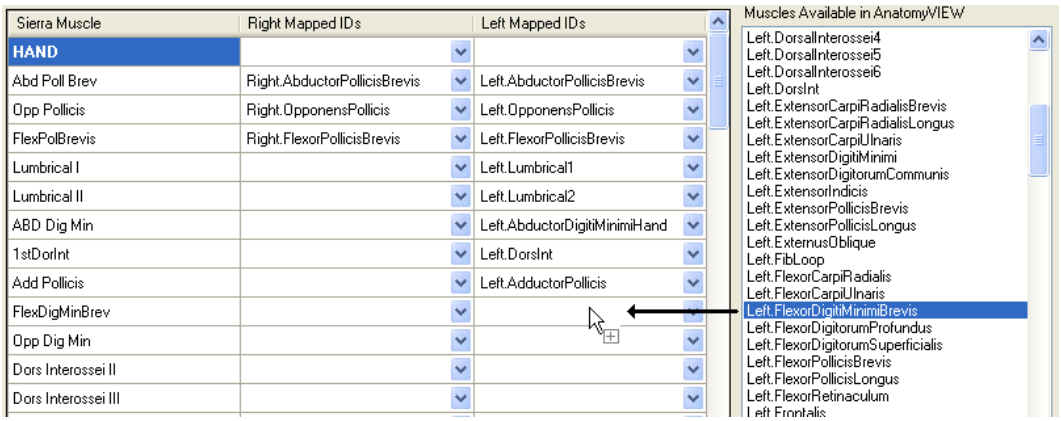
Muscle Map Editor window.

Column Descriptions:

- **Sierra Muscle** - this column shows the user's muscle list, as read from the EMG test protocol setup window.
- **Right Mapped IDs** - this column shows the muscle ID's from the Viewer that have been assigned to this muscle for the right side.
- **Left Mapped IDs** - this column shows the muscle ID's from the Viewer that have been assigned to this muscle for the Left side.
- **Muscles Available in AnatomyVIEW** - this column lists all the muscle IDs that the Viewer is able to display.

To Map a Viewer Muscle ID to a Muscle:

1. Find the appropriate **muscle ID** in the **Viewer List**.
2. **Left click** on the **muscle ID** and **drag it over** to the appropriate **Right** or **Left Mapped ID** cell.
3. **Release** the mouse button **to drop** the muscle ID into the cell.

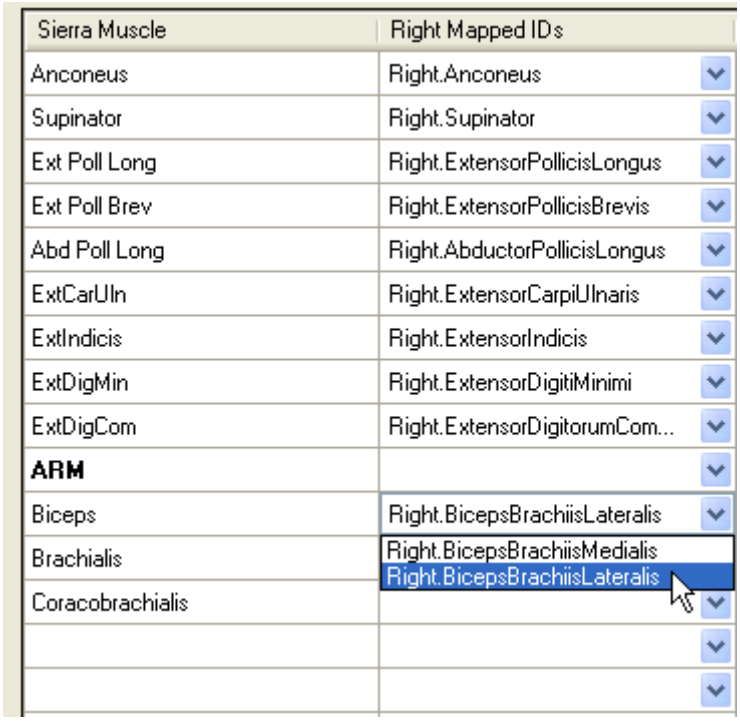


Click and Drag muscle available in Viewer and drop into appropriate user muscle.

To Map Multiple Viewer Muscle IDs to a Muscle:

You may want to map more than one Viewer muscle to a muscle in your muscle list. For example, when you score the Biceps muscle, you may want both the Lateral Biceps and the Medial Biceps to be highlighted in the AnatomyVIEW window. This can be done by mapping multiple viewer muscles to the muscle in your list.

Simply click and drag multiple muscle IDs from the viewer list and drop them onto the muscle. You can click on the drop-down arrow to view all the muscles that have been mapped to your muscle.



The Viewer's Lateral & Medial Biceps have both been mapped to the user's Biceps muscle.

To Clear an Assignment:

1. **Highlight** the appropriate cell by clicking on it with the mouse.
2. Click on the **Clear** button.

To Clear All Assignments:

1. Click on the **Clear All** button.

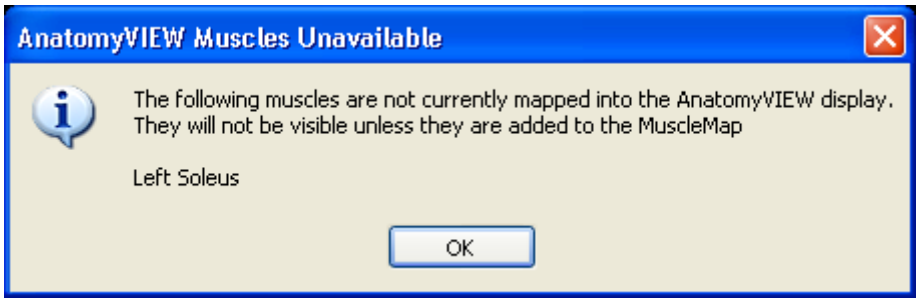
To Save the Assignments:

1. Click on the **OK** button.

The muscle mapping data is saved to a file in the user's setup folder. This file is named "MuscleMap.xml" and it is automatically included in the Preserve & Restore functions.

What happens if a muscle is not available in viewer?

If you score a muscle that is not available in the AnatomyVIEW window, or the muscle has not had any viewer muscles mapped to it, the following message box will be displayed upon opening the AnatomyVIEW window.



Message box indicating that the Left Soleus cannot be displayed in the AnatomyVIEW.

Click the **OK** button, the AnatomyVIEW will display those muscles that are available.

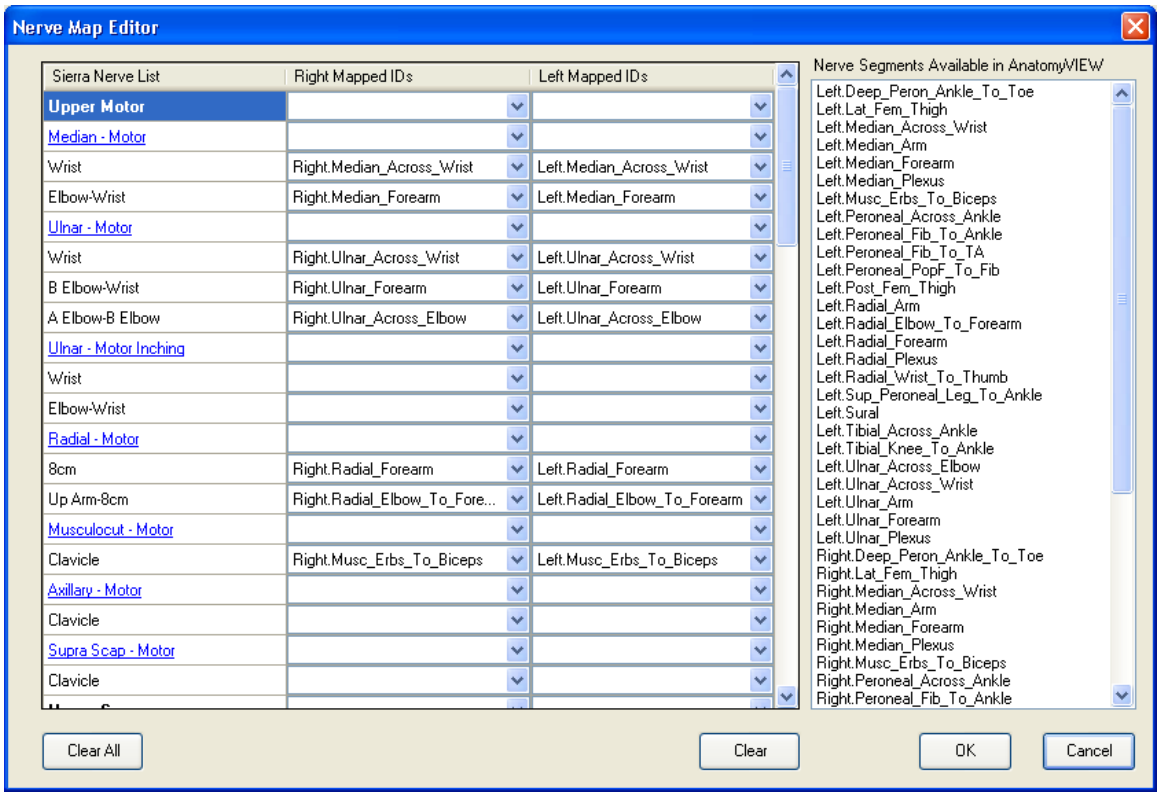
Nerve Data Setup

The AnatomyVIEW feature allows the NCV nerve segment data to be displayed on a 3D color-coded anatomical model.

The Sierra Wave is very flexible in that each user can create and name their own nerves, sites, and segments; and change the name of factory default nerves. Therefore, the program must be able to match each users name for a nerve segment to the nerve segment ID that is recognized by the AnatomyVIEW window. This is done using the **Nerve Map Editor**.

To open the Nerve Map Editor:

1. From the **Edit** menu select **Test Menu**. When the Test Menu Setup window is displayed click on the **NCV** test protocol in the test list. The NCV test protocol settings will be displayed on the right hand side of the screen.
2. Click on the **General Settings** tab.
3. Click on the **AnatomyVIEW Nerve Map** button. The **Nerve Map Editor** window will be displayed.



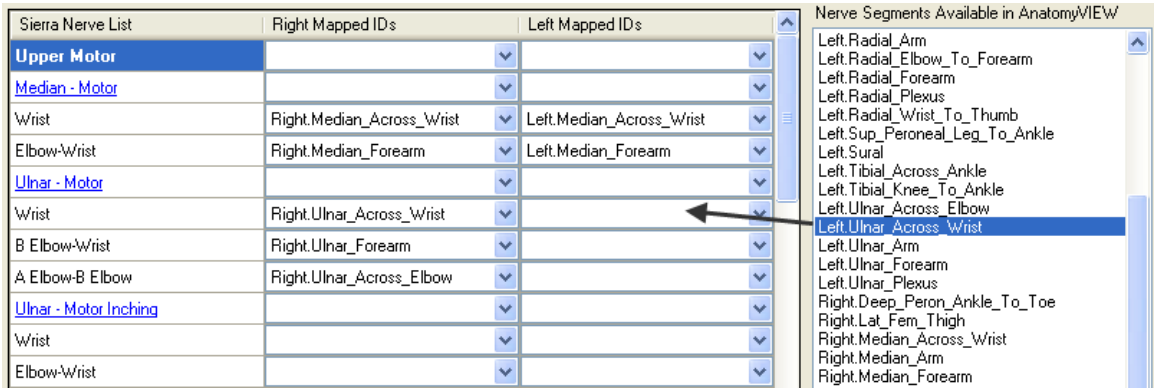
Nerve Map Editor window.

Column Descriptions:

- **Sierra Nerve List** - this column shows the user's nerve list, as read from the NCV test protocol setup window. Only those sites and segments with corresponding normal values (latency, amplitude, or velocity) are shown in the list.
- **Right Mapped IDs** - this column shows the nerve segment ID's from the Viewer that have been assigned to this site/segment for the Right side.
- **Left Mapped IDs** - this column shows the nerve segment ID's from the Viewer that have been assigned to this site/segment for the Left side.
- **Nerve Segments Available in AnatomyVIEW** - this column lists all the nerve segment IDs that the Viewer is able to display.

To Map a Viewer Nerve Segment ID to a Site/Segment:

1. Find the appropriate **nerve segment ID** in the **Viewer List**.
2. **Left click** on the **nerve segment ID** and **drag it over** to the appropriate **Right** or **Left Mapped ID** cell.
3. **Release** the mouse button **to drop** the nerve segment ID into the cell.



Click and Drag nerve segment available in Viewer and drop into appropriate user site/segment

To Clear an Assignment:

1. **Highlight** the appropriate cell by clicking on it with the mouse.
2. Click on the **Clear** button.

To Clear All Assignments:

1. Click on the **Clear All** button.

To Save the Assignments:

1. Click on the **OK** button.

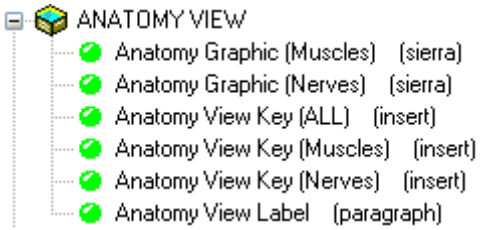
The nerve mapping data is saved to a file in the user's setup folder. This file is named "NerveMap.xml" and it is automatically included in the Preserve & Restore functions.

Including in Reports

The AnatomyVIEW graphic can be included in reports. Simply launch QuickReport and select a template that contains the report items needed in order to include the AnatomyVIEW graphic and color code. The factory default template "Full Report with SG and AV" is one example.

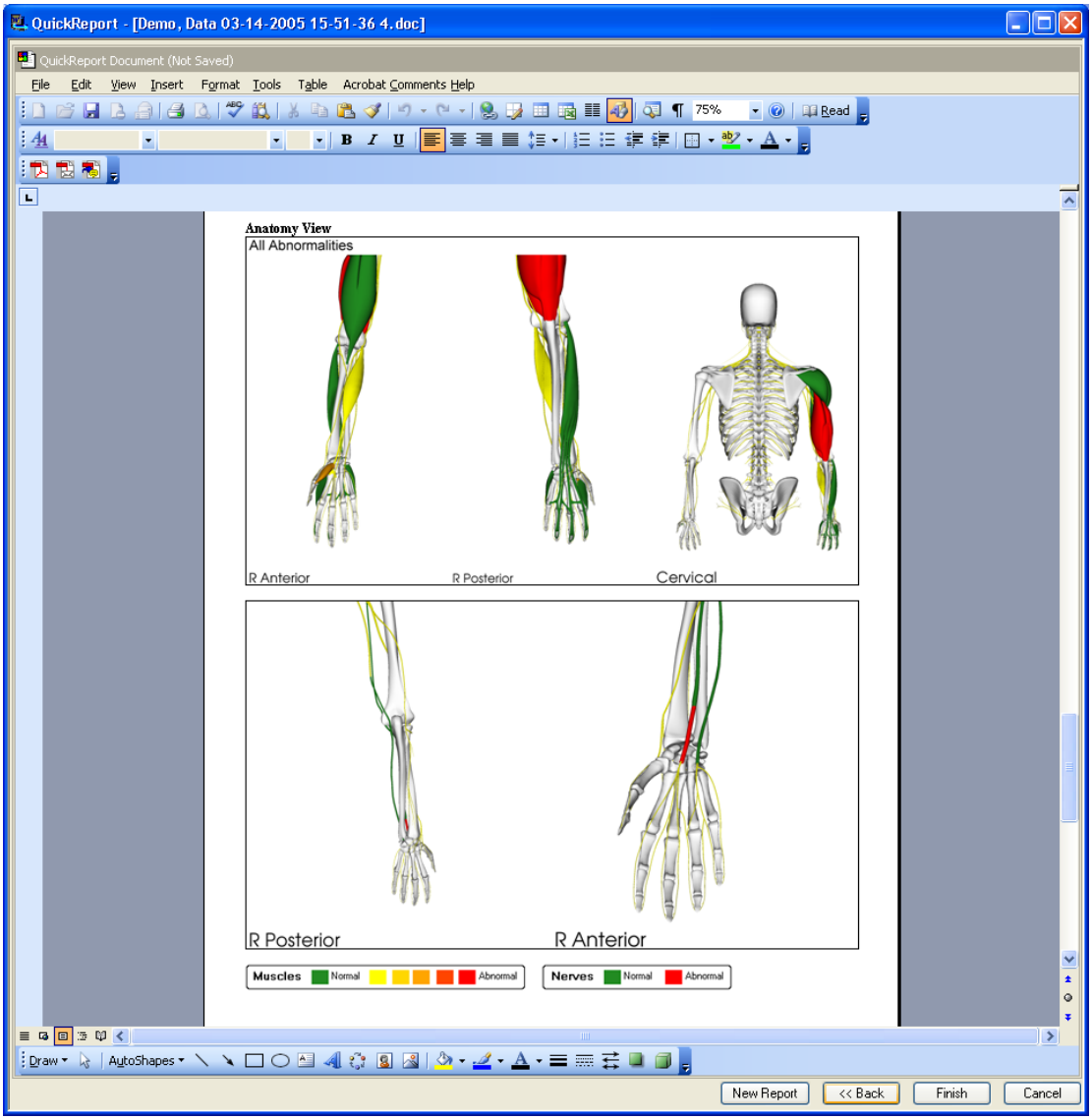
The AnatomyVIEW window must remain open (or minimized) in order to make the graphic available for QuickReport. Simply minimize AnatomyVIEW before launching the report generator.

Four report items are typically needed in the report template, they are the Sierra item "Anatomy Graphic (Muscles)", the Sierra item "Anatomy Graphic (Nerves)", the Paragraph item "AnatomyVIEW Label", and the Insert item "AnatomyVIEW Key (ALL)".



Report Items for AnatomyVIEW.

Please refer to the help topics within the QuickReport program for instructions on how to add these items to an existing report template.



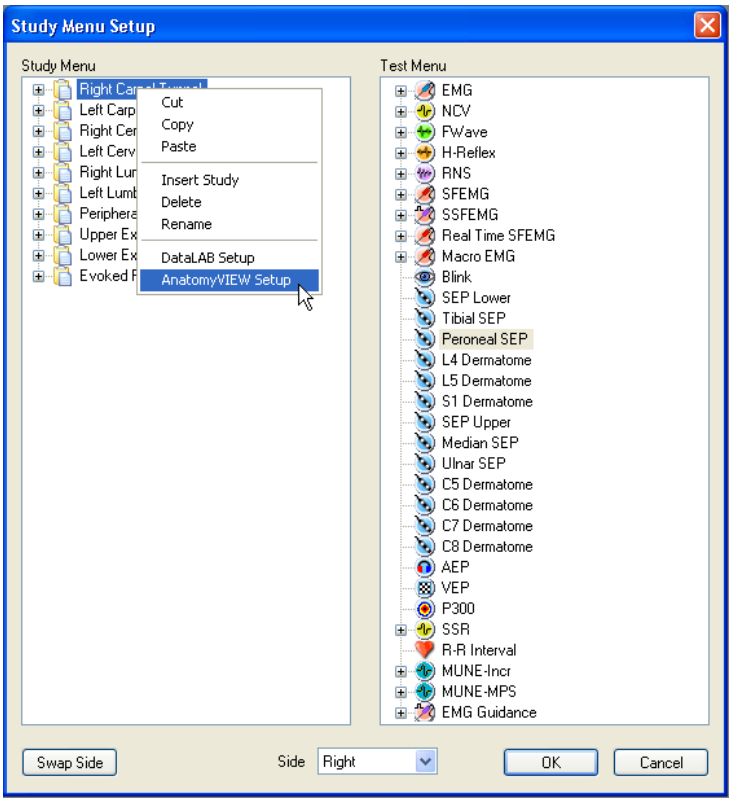
Example report with AnatomyVIEW included.

Set the Default View

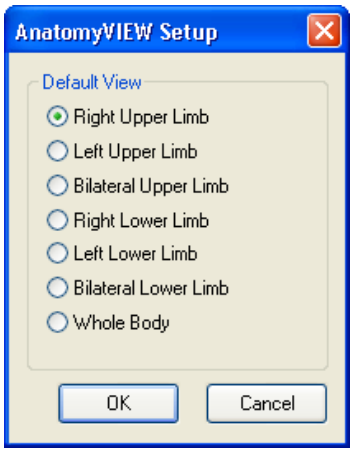
To Assign the default AnatomyVIEW for a Study:

1. From the **Edit** menu, select **Study Menu** to display the **Study Menu Setup** window.

2. **Right click** over the name of the Study and select **AnatomyVIEW Setup** from the pop-up menu. The AnatomyVIEW Setup window will be displayed.



3. Select the default view and then click the **OK** button.



DataLAB

DataLAB Overview

The **DataLAB window** is a new feature introduced in the version 8 software upgrade. This window allows for the calculation and display of user-defined formulas that are not built-in to the Sierra Wave program.

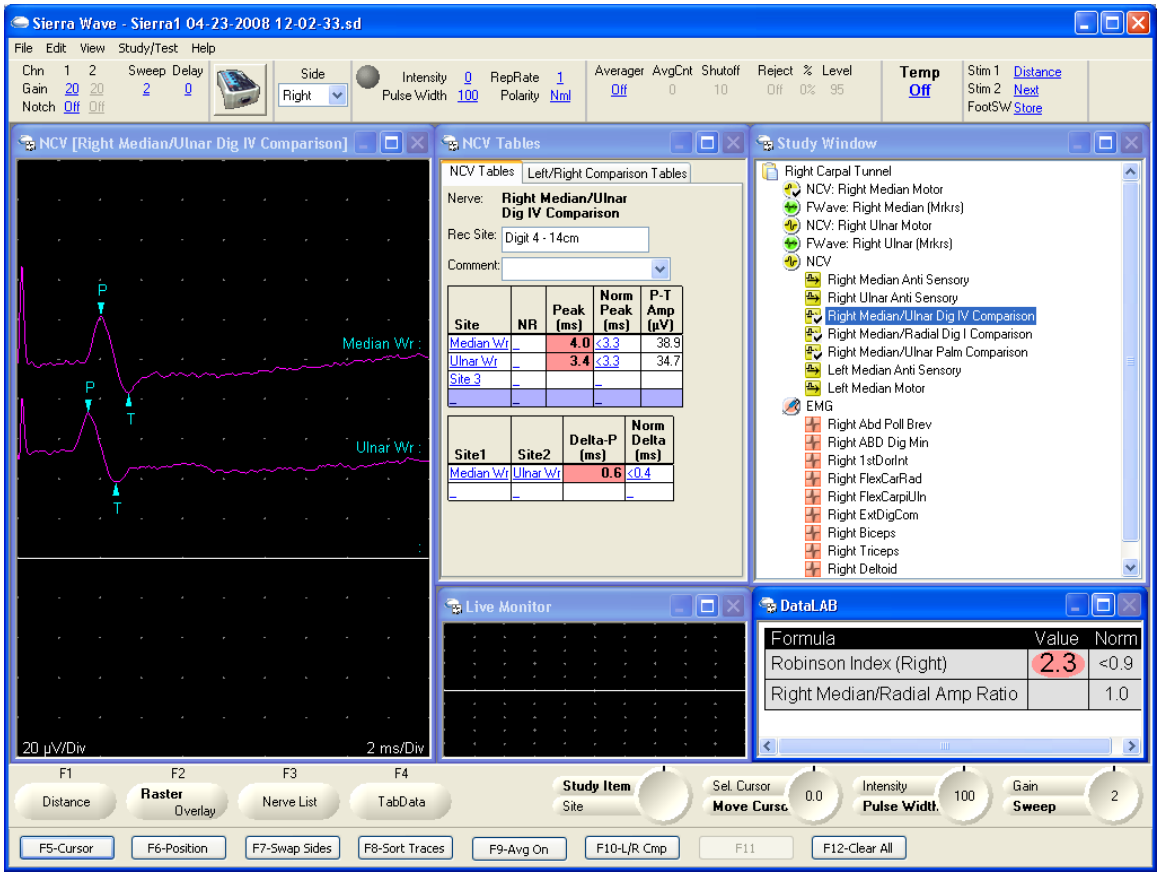
Some example formulas that could be used with DataLAB are:

- Robinson Index (also known as the Combined Sensory Index or CSI)
- Amplitude ratios between nerves, such as the Median Sensory / Radial Sensory ratio
- Calculation of proximal F Wave velocity
- Temperature correction of nerve conduction velocity

Formulas can use any measurement (latency, amplitude, velocity, etc.) that the Sierra Wave displays in the NCV, F Wave, and H Reflex test protocols. Formulas can also use temperature, patient height, patient weight, patient age, and leg length.

The DataLAB window uses two ".xml" setup files, these files are stored in the user's setup folder. One file is used to map the Sierra data needed for the formulas, the other is used to actually define the formulas.

Shown below is an example NCV screen with a DataLAB window that has been setup to calculate the Robinson Index.



Please contact the Cadwell Applications Support department for more information and assistance with the setup of the DataLAB feature.

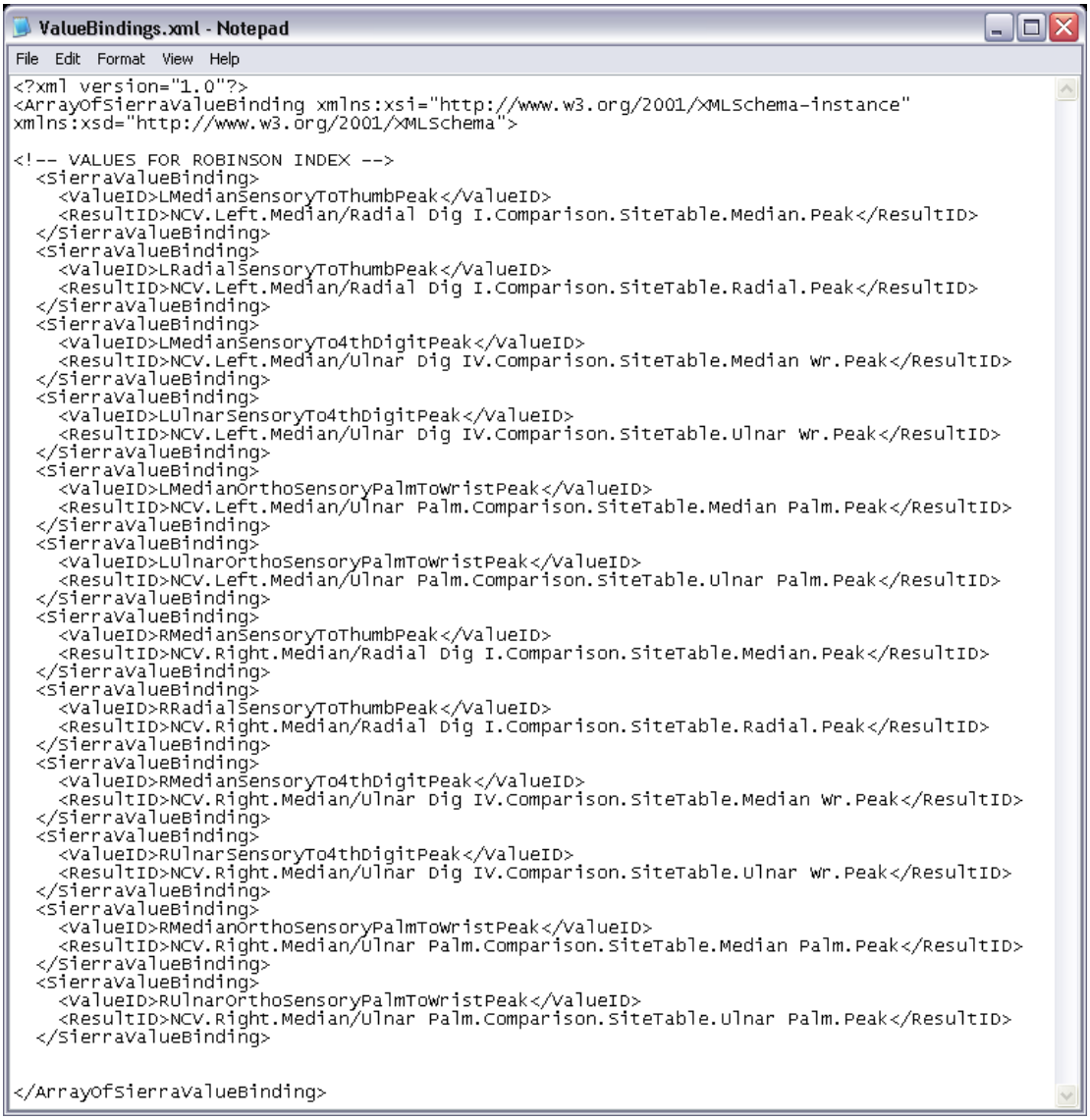
DataLAB Setup

The Sierra Wave is very flexible in that each user can create and name their own nerves and change the name of factory default nerves. Users can also create their own nerve types and stimulation site names. Therefore, we need a method to identify the Sierra's name for a value (i.e., latency, amplitude, velocity) and map it to a format that can be included in a user defined formula.

This is done by using two ".xml" files that are stored in the user's setup folder. One file, called "ValueBindings.xml", is used to map the Sierra data needed for the formulas, the other file, called "FormulaList.xml", is used to actually put the defined values into mathematical formulas. Both of these files are automatically included in the Preserve & Restore functions.

Defining the Sierra Data needed for a Formula:

Go to the user's setup folder and use the Notepad application to open the file "ValueBindings.xml". Add the values that will be needed by your formula to this file, follow the format that is shown in the file. Save your changes.



ValueBindings.xml - Notepad

File Edit Format View Help

```
<?xml version="1.0"?>
<ArrayOfSierraValueBinding xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">

<!-- VALUES FOR ROBINSON INDEX -->
  <SierraValueBinding>
    <ValueID>LMedianSensoryToThumbPeak</ValueID>
    <ResultID>NCV.Left.Median/Radial Dig I.Comparison.SiteTable.Median.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>LRadialSensoryToThumbPeak</ValueID>
    <ResultID>NCV.Left.Median/Radial Dig I.Comparison.SiteTable.Radial.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>LMedianSensoryTo4thDigitPeak</ValueID>
    <ResultID>NCV.Left.Median/Ulnar Dig IV.Comparison.SiteTable.Median Wr.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>LUlnarSensoryTo4thDigitPeak</ValueID>
    <ResultID>NCV.Left.Median/Ulnar Dig IV.Comparison.SiteTable.Ulnar Wr.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>LMedianOrthoSensoryPalmToWristPeak</ValueID>
    <ResultID>NCV.Left.Median/Ulnar Palm.Comparison.SiteTable.Median Palm.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>LUlnarOrthoSensoryPalmToWristPeak</ValueID>
    <ResultID>NCV.Left.Median/Ulnar Palm.Comparison.SiteTable.Ulnar Palm.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RMedianSensoryToThumbPeak</ValueID>
    <ResultID>NCV.Right.Median/Radial Dig I.Comparison.SiteTable.Median.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RRadialSensoryToThumbPeak</ValueID>
    <ResultID>NCV.Right.Median/Radial Dig I.Comparison.SiteTable.Radial.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RMedianSensoryTo4thDigitPeak</ValueID>
    <ResultID>NCV.Right.Median/Ulnar Dig IV.Comparison.SiteTable.Median Wr.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RUlnarSensoryTo4thDigitPeak</ValueID>
    <ResultID>NCV.Right.Median/Ulnar Dig IV.Comparison.SiteTable.Ulnar Wr.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RMedianOrthoSensoryPalmToWristPeak</ValueID>
    <ResultID>NCV.Right.Median/Ulnar Palm.Comparison.SiteTable.Median Palm.Peak</ResultID>
  </SierraValueBinding>
  <SierraValueBinding>
    <ValueID>RUlnarOrthoSensoryPalmToWristPeak</ValueID>
    <ResultID>NCV.Right.Median/Ulnar Palm.Comparison.SiteTable.Ulnar Palm.Peak</ResultID>
  </SierraValueBinding>


</ArrayOfSierraValueBinding>
```

Example ValueBindings.xml, showing values needed for the Robinson Index.

The highlighted area below is the Value ID, this is a user defined name for the value.

```
<SierraValueBinding>
  <ValueID>LMedianSensoryToThumbPeak</ValueID>
  <ResultID>NCV.Left.Median/Radial Dig I.Comparison.SiteTable.Median.Peak</ResultID>
</SierraValueBinding>
<SierraValueBinding>
```

The line that starting with Result ID is used to specify the Sierra data that will be assigned to this Value ID.

```
<SierraValueBinding>
  <ValueID>LMedianSensoryToThumbPeak</ValueID>
  <ResultID>NCV.Left.Median/Radial Dig I.Comparison.SiteTable.Median.Peak</ResultID>
</SierraValueBinding>
<SierraValueBinding>
```

The Sierra data is defined by the following syntax:

```
<SierraValueBinding>
  <ValueID>LMedianSensoryToThumbPeak</ValueID>
  <ResultID>NCV.Left.Median/Radial Dig I.Comparison.SiteTable.Median.Peak</ResultID>
</SierraValueBinding>
```

Testname.Side.Nerve Name.Nerve Type.Table Name.Site Name.Value

Explanation of syntax used to define a Sierra value.

Please contact the Cadwell Applications Support department for more information and assistance with the setup of the DataLAB feature.

Defining the Formulas:

Go to the user's setup folder and use the Notepad application to open the file "FormulaList.xml". Add your formula to this file, follow the format that is shown in the file. Save your changes.

FormulaList.xml - Notepad

File Edit Format View Help

```
<?xml version="1.0"?>
<ArrayOfCalculatorFormula xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema">

<!-- LEFT ROBINSON INDEX -->
  <CalculatorFormula>
    <FormulaID>LRobinsonIndex</FormulaID>
    <Name>Robinson Index (Left)</Name>
    <Norm>&lt;0.9</Norm>
    <Enabled>true</Enabled>
    <FormatString>f1</FormatString>
    <SourceCode>
      <string>((Math.Round(LMedianSensoryTo4thDigitPeak,1)) - (Math.Round(LUlnarSensoryTo4thDigitPeak,1)))
       + ((Math.Round(LMedianSensoryToThumbPeak,1)) - (Math.Round(LRadialSensoryToThumbPeak,1)))
       + ((Math.Round(LMedianOrthoSensoryPalmToWristPeak,1)) - (Math.Round(LUlnarOrthoSensoryPalmToWristPeak,1)))</string>
    </SourceCode>
  </CalculatorFormula>


<!-- RIGHT ROBINSON INDEX -->
  <CalculatorFormula>
    <FormulaID>RRobinsonIndex</FormulaID>
    <Name>Robinson Index (Right)</Name>
    <Norm>&lt;0.9</Norm>
    <Enabled>true</Enabled>
    <FormatString>f1</FormatString>
    <SourceCode>
      <string>((Math.Round(RMedianSensoryTo4thDigitPeak,1)) - (Math.Round(RUlnarSensoryTo4thDigitPeak,1)))
       + ((Math.Round(RMedianSensoryToThumbPeak,1)) - (Math.Round(RRadialSensoryToThumbPeak,1)))
       + ((Math.Round(RMedianOrthoSensoryPalmToWristPeak,1)) - (Math.Round(RUlnarOrthoSensoryPalmToWristPeak,1)))</string>
    </SourceCode>
  </CalculatorFormula>


</ArrayOfCalculatorFormula>
```

Example FormulaList.xml, showing formulas for Left and Right Robinson Index.

```
                    <!-- LEFT ROBINSON INDEX -->
          Start of Formula ---- <CalculatorFormula>
                Formula ID ---- <FormulaID>LRobinsonIndex</FormulaID>
Name (shown on screen) ---- <Name>Robinson Index (Left)</Name>
  Optional Normal Value ---- <Norm>&lt;0.9</Norm>
                              <Enabled>true</Enabled>
       # Decimal Places ---- <FormatString>f1</FormatString>
                              <SourceCode>
Mathmatical Formula                 <string>((Math.Round(LMedianSensoryTo4thDigitPeak,1)) - (Math.Round(LUlnarSensoryTo4thDigitPeak,1)))
(uses Value IDs from                 + ((Math.Round(LMedianSensoryToThumbPeak,1)) - (Math.Round(LRadialSensoryToThumbPeak,1)))
the ValueBindings file)              + ((Math.Round(LMedianOrthoSensoryPalmToWristPeak,1)) - (Math.Round(LUlnarOrthoSensoryPalmToWristPeak,1)))</string>
                              </SourceCode>
          End of Formula ---- </CalculatorFormula>
```

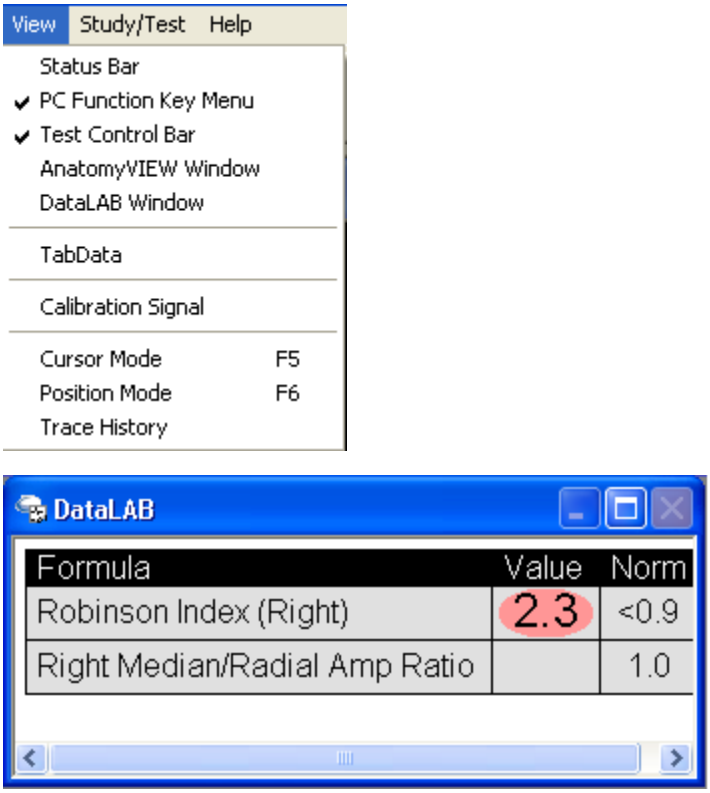
Explanation of formula syntax.

Please contact the Cadwell Applications Support department for more information and assistance with the setup of the DataLAB feature.

Displaying the DataLAB Window

To open the DataLAB window:

1. Start the Sierra Wave program and select an NCV, F Wave, or H Reflex test.
2. From the **View menu**, select **DataLAB Window**. The DataLAB window will be displayed.

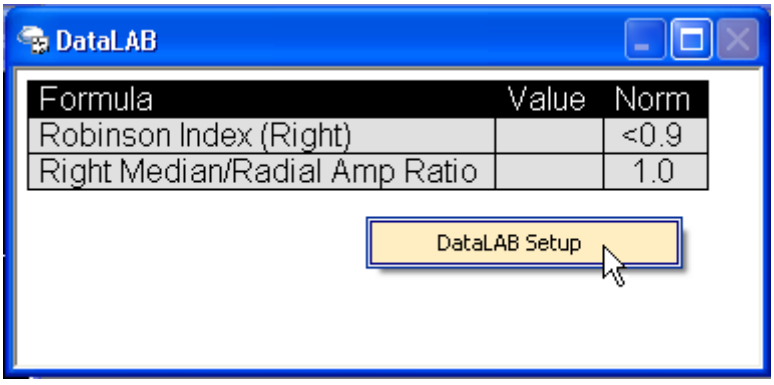


DataLAB window.

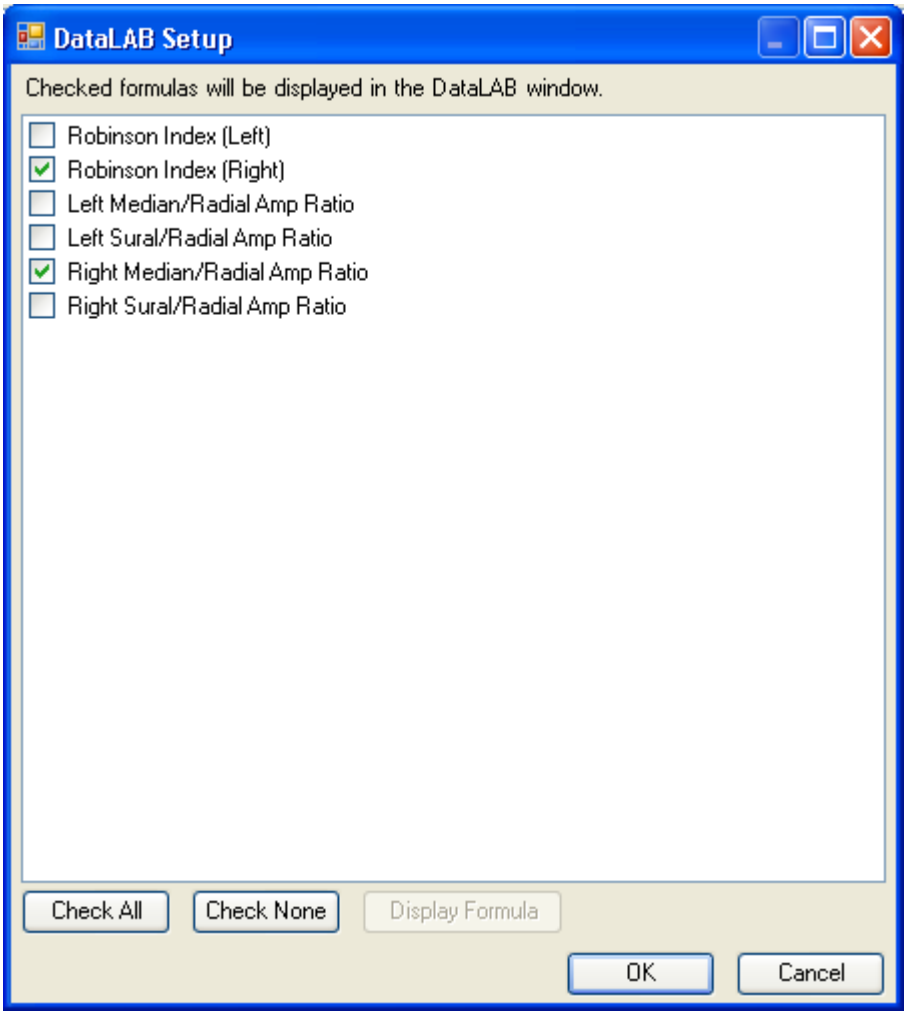
3. Set the position and size of the DataLAB window and then save the layout by selecting **Save Test Parameters** from the **Edit menu**.

To change the Formulas shown in the DataLAB window:

1. **Right click** inside the DataLAB window, click on **DataLAB Setup**.



2. In the **DataLAB Setup** window, place a check mark next the formulas you want to be displayed.



DataLAB Setup.

3. Click **OK**

Including in Reports

The DataLAB tables can be included in reports. Simply launch QuickReport and select a template that contains the report item needed in order to include the DataLAB table. The factory default template "Full Report with DataLAB" is one example.

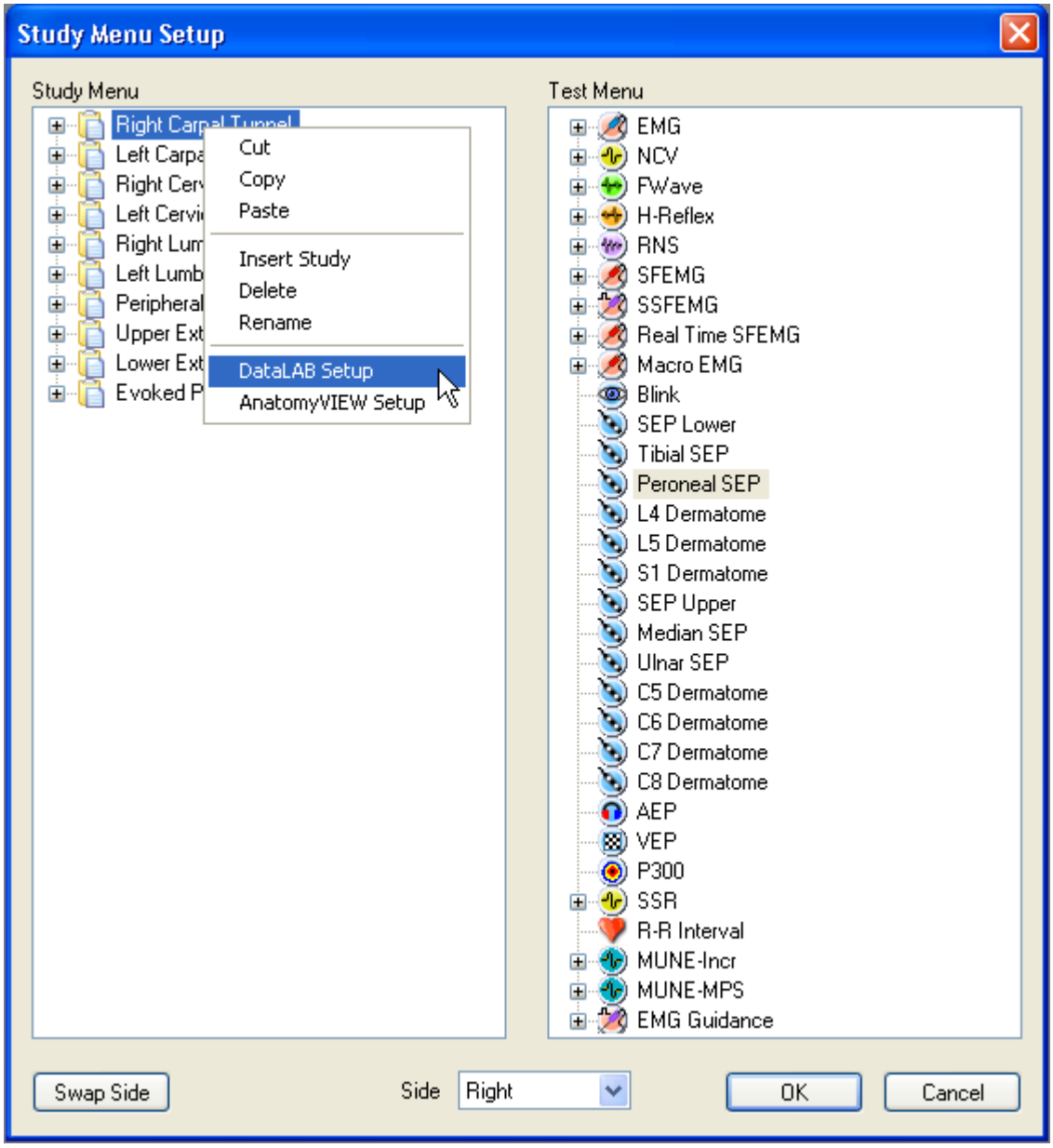
One additional report item is needed in the report template, the Sierra item "DataLAB Table".

Please refer to the help topics within the QuickReport program for instructions on how to add this item to an existing report template.

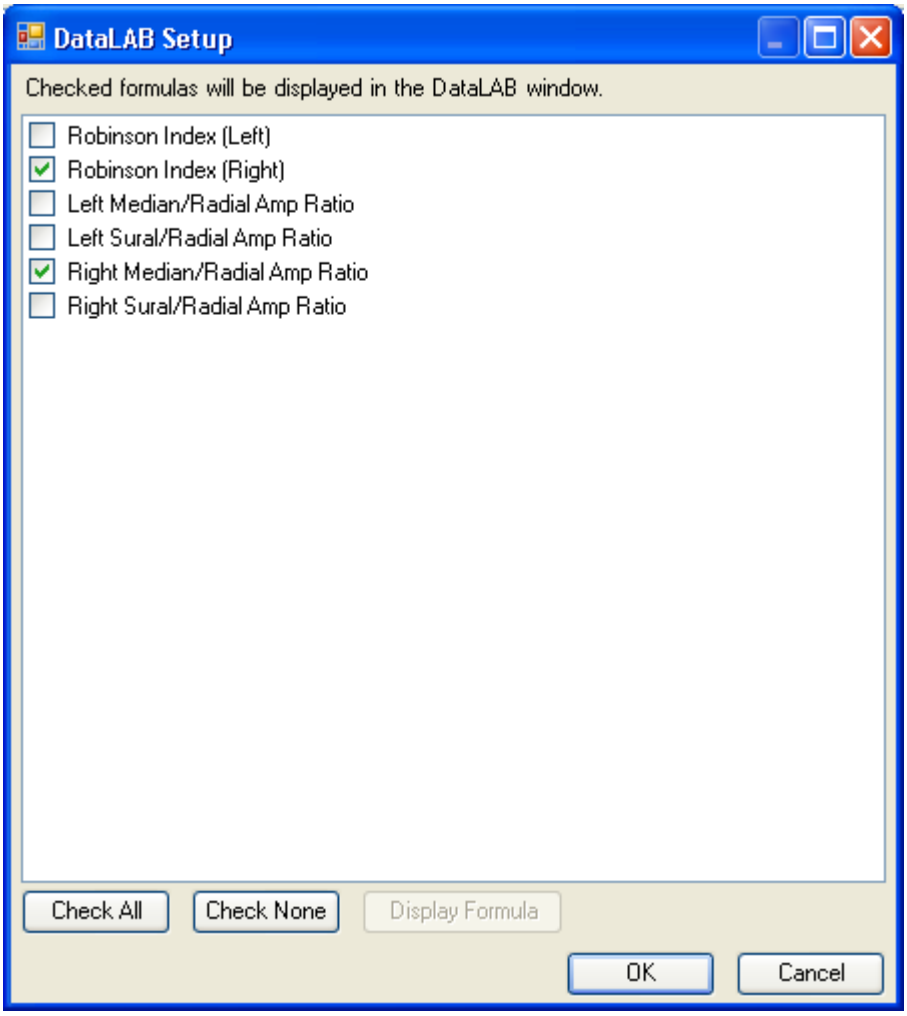
Set the Default Formulas

To Assign a DataLAB Formula to a Study:

1. From the **Edit** menu, select **Study Menu** to display the **Study Menu Setup** window.
2. **Right click** over the name of the Study and select **DataLAB Setup** from the pop-up menu. The DataLAB Setup window will be displayed.



3. Place a **check mark** next to the **formulas** you want to appear in the DataLAB window when using this Study.

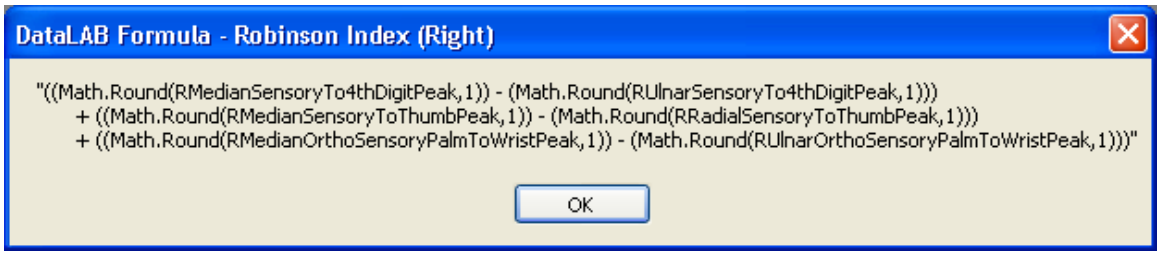


DatLAB Setup window.

4. Click **OK.**

To Display the contents of a Formula:

1. Click on the formula to highlight it.
2. Click on the **Display Formula** button.
3. The actual formula specified in the **FormulaList.xml** file will be displayed.



Display Formula window.

Report Generation

QuickReport Overview

The Sierra Wave uses a separate program for report generation, this program is called **QuickReport**.

To initiate a report you must select a template from within the Sierra Wave program. Once a template is selected the QuickReport program will start automatically.

QuickReport is a Microsoft Word™ based application and includes such Word features as spell check, grammar check, table formatting, and graphics support.

QuickReport can be run by stand-alone to edit and create the report templates used by the program.

To Select a Report Template

From within the TabData window:

- **Click** on **one of the two report buttons** shown within the TabData window. The buttons are labeled with the name of the template currently assigned to them.
- **Press** either the **Print** or **Report** key on the Sierra Wave base unit.

From within a Test Protocol screen:

- **Press** either the **Print** or **Report** key on the Sierra Wave base unit.
- Use the program's **File Menu** to select one of the following.

Launch QuickReport & Select Template - this will start the QuickReport program and allow you to select any report template available on the system.

Print *"Template Name"* for Print key - the template name currently assigned to the Print key on the Sierra Wave base unit is displayed here. Clicking this entry will select this template and start QuickReport.

Print *"Template Name"* for Report key - the template name currently assigned to the Report key on the Sierra Wave base unit is displayed here. Clicking this entry will select this template and start QuickReport.

Description of the Factory Default Report Templates

Current Test - use this template to print the results for the individual Test Protocol that is currently displayed on the screen. For example, use this to print the results for a single NCV nerve test or a single Evoked Potential test. It also includes the Chief Complaints, Medications, Physical Exam / History, and Impression custom fields from the Patient Information window.

Full Report (manual Findings) - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window as well as an interactive Findings item for manual creation of findings sentences.

Full Report with DataLAB - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator feature of the TabData window. The results of the DataLAB feature are also included in this report.

Full Report with Sentence Gen - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator feature of the TabData window.

Full Report with SG and AV - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window. A Findings section automatically imports the text from the Sentence Generator

feature of the TabData window. The AnatomyVIEW graphic is also included in this report.

Injection Report - this template to print the injection log table from the EMG Guidance protocol. It also includes an injection diagnosis and procedure code table.

MMUA Report - this template includes the summary tables and MUP waveforms from Multi-Motor Unit Analysis. It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

TabData w/ Traces - this template includes all the test protocols within the TabData window (tables & traces). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

TabData w/o Traces - this template includes all the test protocols within the TabData window (tables only). It also includes the Chief Complaints, Medications, Physical Exam / History, Impression, and Recommendation custom fields from the Patient Information window.

QuickReport Views

QuickReport has **three main views**.

Select Report - the program will go to this view if you select "Launch QuickReport & Select Template" from the Sierra Wave's file menu. This view allows you to choose any template on the system. This view is initially displayed if you start QuickReport outside of the Sierra Wave program. To select a template, either double click on it or single click on it and then click the Next button.

Fill In Report - the program will go to this view if you select a report template that requires user input. For example, the "Full Report (manual Findings)" template will go directly to this view so that the user can make manual selections for the Findings section of the report.

Document - this view shows the generated report in Word format. The program will automatically go to this view if you select a report template that does not require any user input, the "Current Test", "TabData w/ Traces", and "TabData w/o Traces" templates are examples. The program will also switch to this view when all selections are complete on the Fill In Report view.

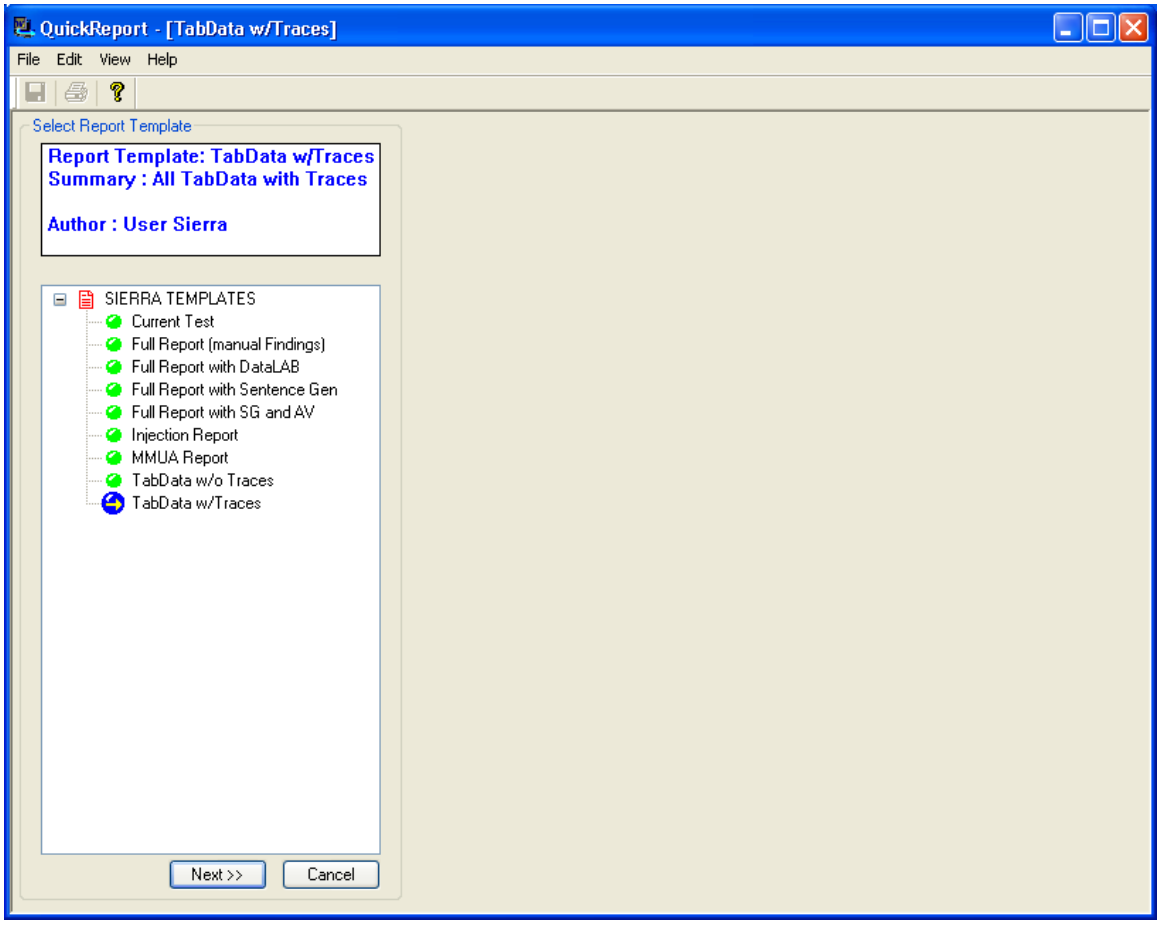
 To get a printout of the current test screen, select **Print Screen** from the Sierra Wave File menu.

For more detailed information on QuickReport and report templates, see the Help Topics within the QuickReport program.

Select Report View

The QuickReport program will go to this view if you select "Launch QuickReport & Select Template" from the Sierra Wave's file menu. This view is also displayed if you have pressed a report key with the "Menu" option assigned to it.

This view allows you to choose any Sierra report template on the system.



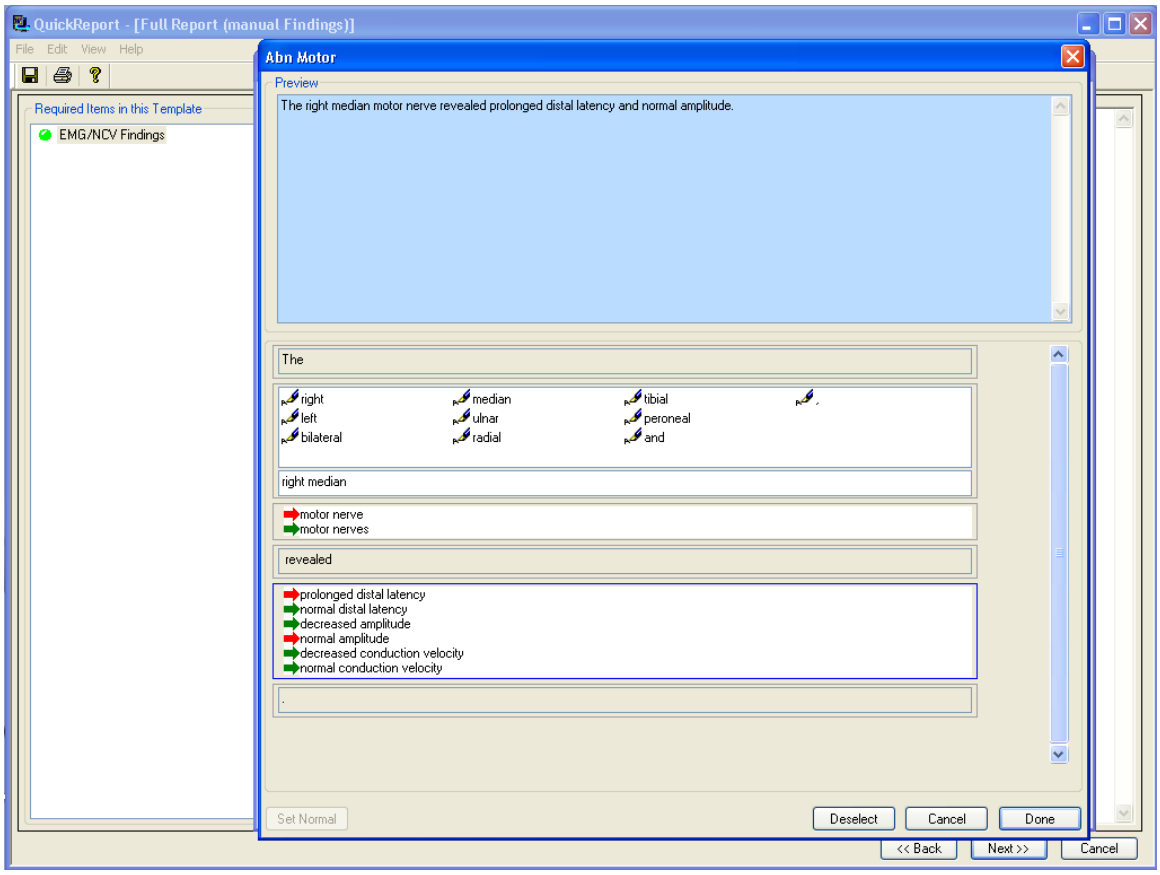
Select Report view with TabData w/Traces template selected.

To Select a Report Template

- **Single click** on the report template to select it, then click the **Next** button.
- **Double click** on the report template.

Fill In Report View

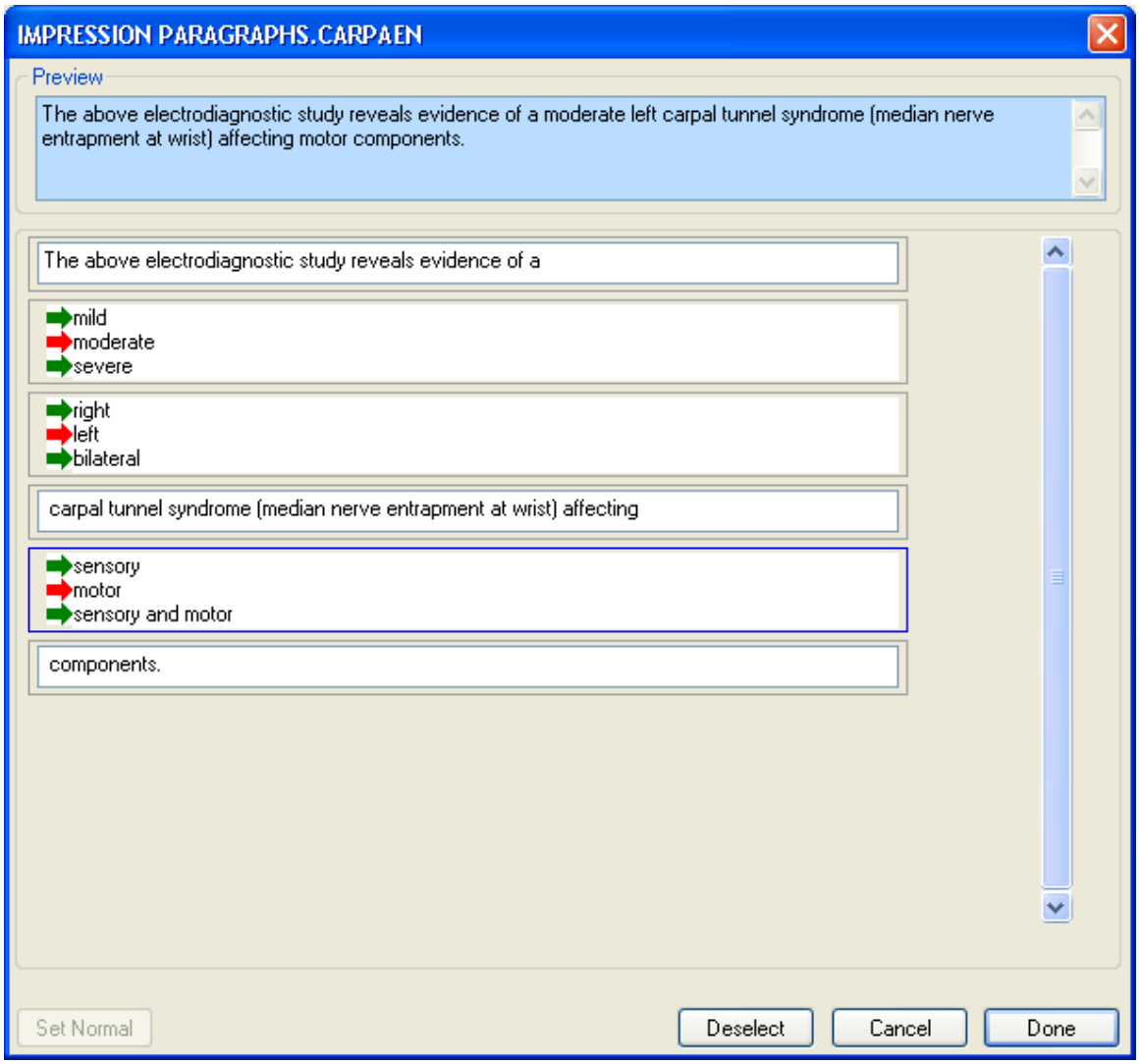
The QuickReport program will go to this view if you select a report template that requires user input. For example, the "Full Report (manual Findings)" template will go directly to this view so that the user can make manual selections for the Findings section of the report.



Fill In Report view - processing Abnormal Motor Nerve findings.

Some selections are made by simply clicking on the word or words you would like.

Other selections require that you click on the green arrow ➡ . When the selection is made the arrow is shown in red. The example shown below illustrates this.



Impressions Item - click on green arrows to make selections.

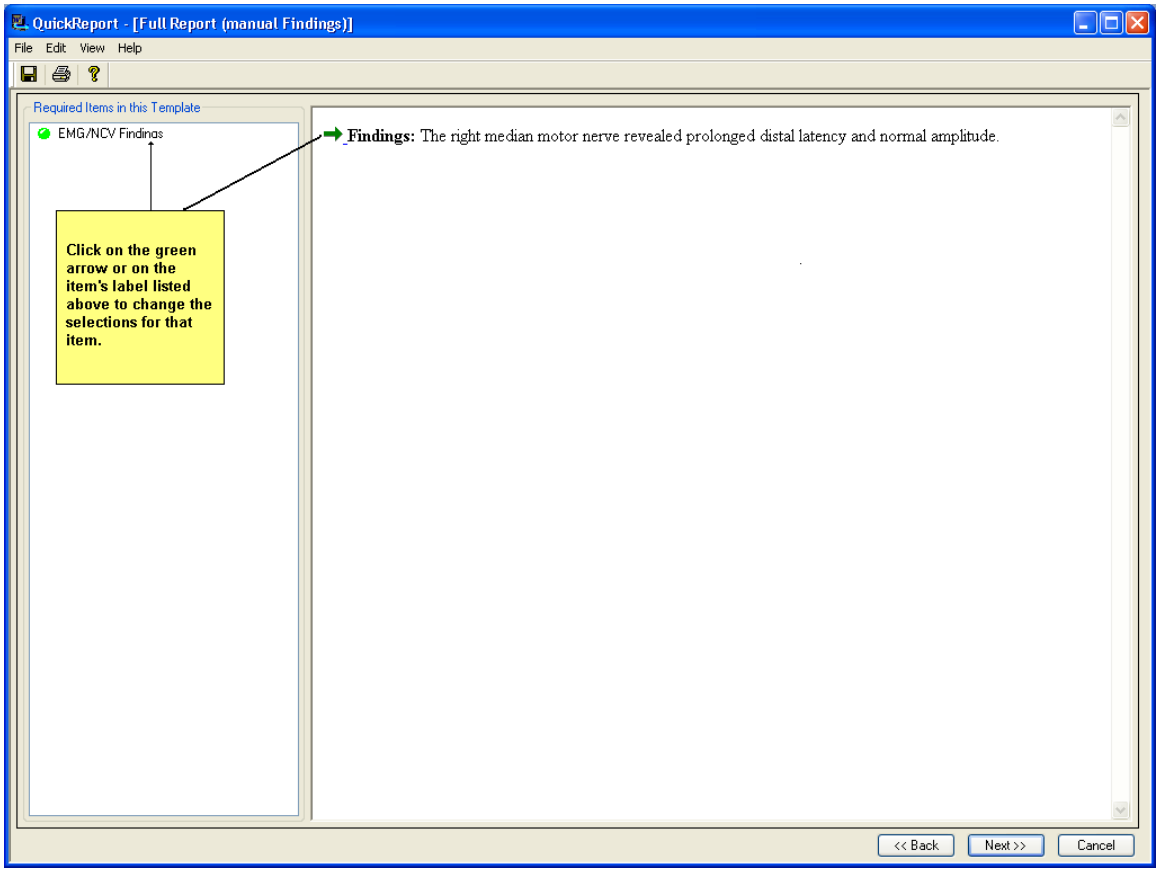
Select **Done** and/or **OK** when all selections have been made for an item.

After the last item is completed the program automatically goes to the **Document** view.

Making Changes to Previous Selections

You can go back to the Fill In Report view from the Document view. This allows you to make changes to any of the selections that were made the first time through the template. From the Document view, simply click on the **Back** button at the bottom right of the screen. To make changes to any of the selections, click on the green arrow ➡ or click on the item's label in the box shown on the left

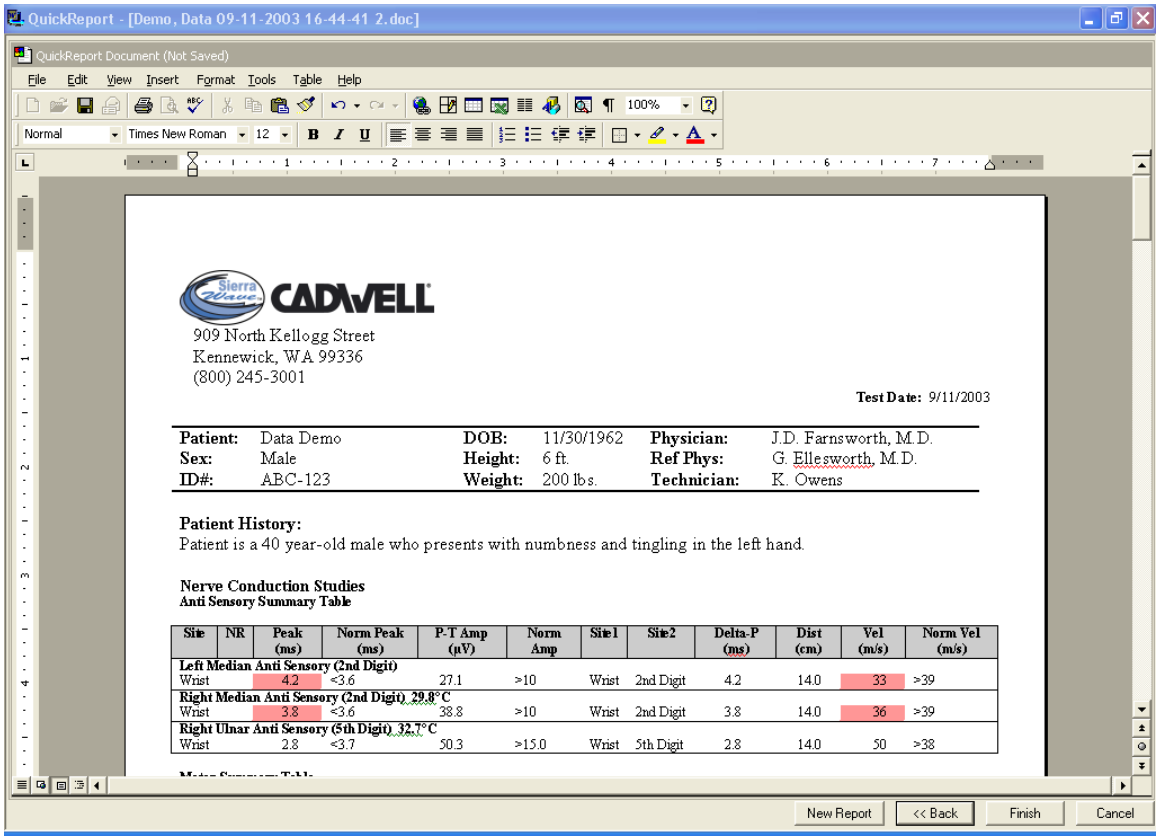
hand side of the screen. After making your changes, click the **Next** button to generate a new report with your changes.



Fill In Report view - after returning from Document view.

Document View

This QuickReport view shows the generated report in Microsoft Word™ format. The QuickReport program will automatically go to this view if you select a report template that does not require any user input, the "Current Test", "TabData w/ Traces", and "TabData w/o Traces" are examples of this kind of template. The program will also switch to this view when all selections have been completed on the Fill In Report view.



Document view.

The finished report document contains all the information specified in the report template. Usually, the document will start with a Header that contains the address for the clinic or hospital. Next, the patient information is typically displayed followed by the test results and traces.

Anything within the document can be edited. Simply click the mouse where you want to make a change, the blinking cursor will appear. Use the backspace key to delete the text then re-type the text the way you want it. To add to the report, click on a blank line, then type the text you want.

If you want to delete an entire row from a table, like the EMG Muscle Score table, click the mouse anywhere in the row you want to delete. The blinking cursor will

appear. Now, select “Delete-Row” from the Table menu at the top of the screen. If you make a mistake, select “Undo” from the Edit menu.

To insert a page-break, click the mouse above the line where you want the new page-break to start. Then, select “Break, Page Break, OK” from the Insert menu.

Use the formatting toolbar to make changes to the text size, add bolding, or italics, or change the font style.

Printing and Saving Reports

To Print the Report

From the **Document** view,

- Click on the **Printer icon**  at the top of the screen. The report will be sent to your default printer.
- Select **Print** from the **File menu**.

To Save the Report

From the **Document** view,

- click the **Finish** button, you will be prompted to save the report.
- click on the **Diskette icon**  .
- select **Save** from the **File menu**.

The report is saved to the user's Data directory with the filename of *"lastname, firstname, date, time.doc".*

To Close QuickReport

From the **Document** view,

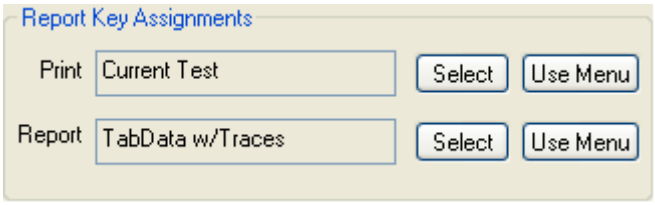
- Select **Exit** from the **File menu**.
- Click the **Finish** button at the bottom right of the screen.
- Click the **Red X**  in the top right-hand corner.
- Click the **Cancel** button at the bottom right of the screen.

If the report has not been saved the program will ask you if you would like to save the report before exiting.

Configuring Report Keys

From the **Edit** menu, select **System Setup**.

The Report Key Assignments section allows you to assign specific report templates to the **Print** and **Report** keys on the Sierra Wave base unit. Click on the **Select** button; click the plus **(+)** sign in front of the report category; **highlight the report template** and click **OK** to change the Report Key Assignment. You can also assign "Use Menu" to bring up the complete report template list when the appropriate key is pushed.



Editing Report Templates

This topic is covered in greater detail within the Help Topics of the QuickReport program.

To Edit an Existing Template

Start the QuickReport program by double clicking on its icon on the Windows desktop.

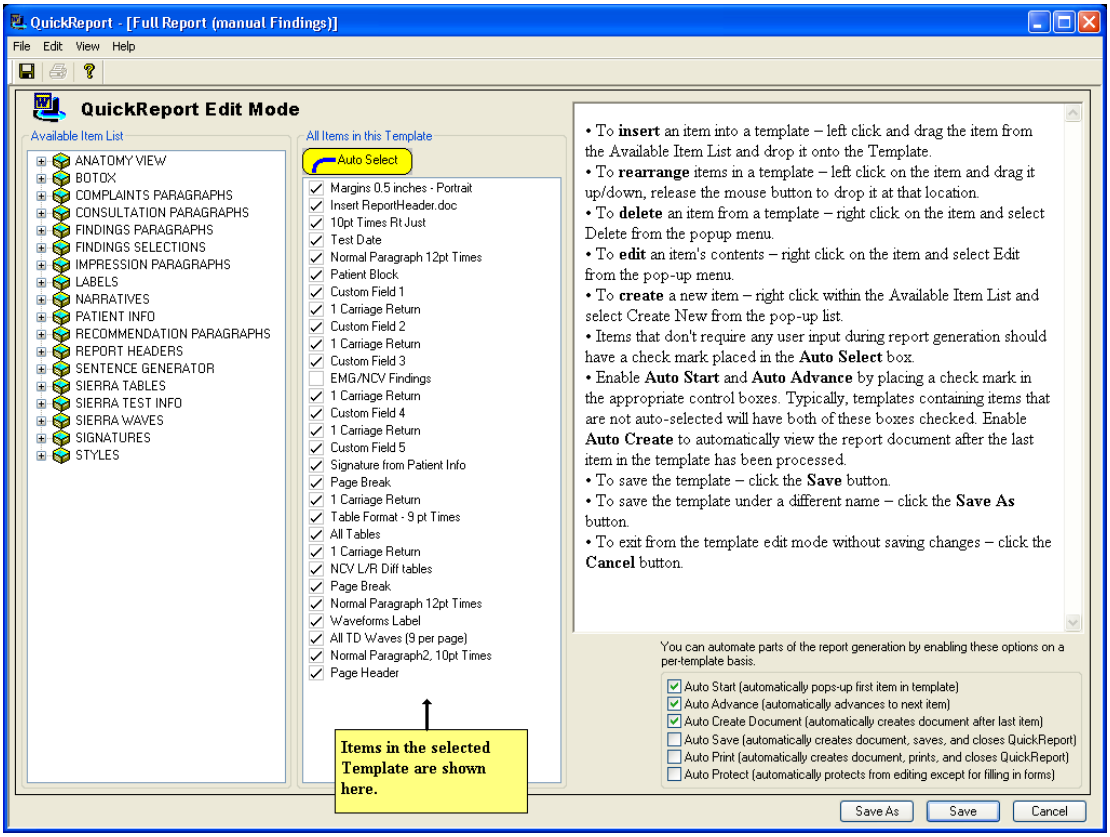
From the Select Report view:

- **Right click** the mouse over the template that you want to edit, from the pop-up menu select **Edit *"template name"*.**

From the Fill In Report view:

- Select **Edit Template** from the **View** menu.

The **Edit Template mode** will be displayed.



Edit Template Mode.

In Edit mode, the individual Items that make up the template are listed down the center of the screen. A **check mark** in front of an item indicates that **no user input** is required for that item during report generation. If an item doesn't have a check mark in front of it, then it will require the user to make selections on the Fill In Report view when the report is generated.

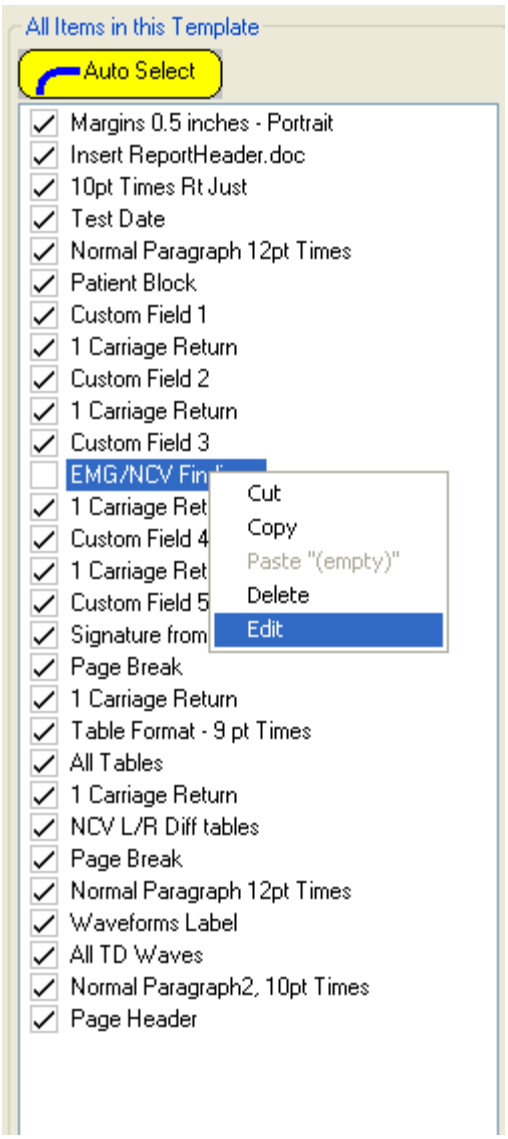
Items with a check mark are also known as **Auto-Selected Items**. These items are hidden from view unless the Edit mode is activated.

To Edit Report Items

Report templates are composed of **Items**. There are several item types and they each have a specific function. To edit an existing item perform one of the following steps.

From the Fill In Report view:

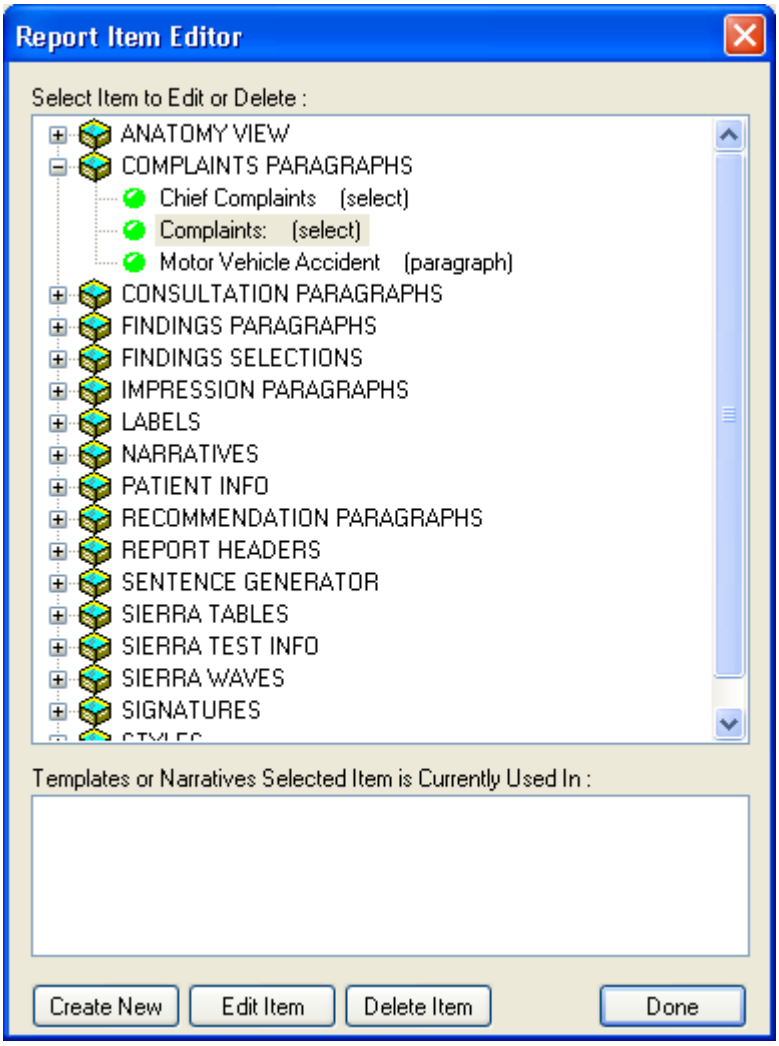
- Enter the Edit Template mode by selecting **Edit Template** from the **View** menu.
- **Right click** over an **Item**, then select **Edit** from the pop-up menu.



- Make your changes, then click the **Update** button. All templates that use this Item will be updated to reflect the new changes.

From the Select Report view:

- Select **Edit Items** from the **File** menu.
- The **Report Item Editor** will be displayed.
- Select the **Item** you want to change, then click on the **Edit Item** button.
- Make your changes, then click the **Update** button. All templates that use this item will be updated to reflect the new changes.



Report Item Editor

For more detailed information on creating and editing report templates and report items, see the Help Topics within the QuickReport program.

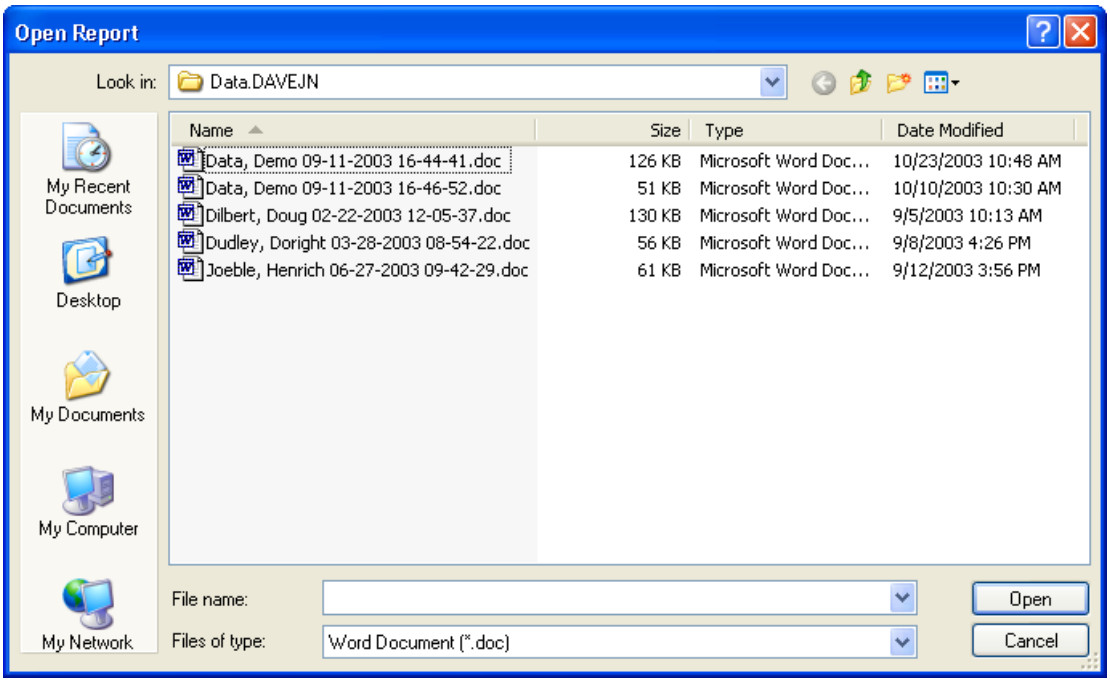
Reviewing a Stored Report

By default, reports are saved as Microsoft Word™ documents. They can be easily opened for review by following one of the steps shown below.

From within the Sierra Wave program

- Start the Sierra Wave program
- From the **File** menu, select **Review Report,** or press the **F2-Review Report** function key. The **Open Report** window will be displayed.

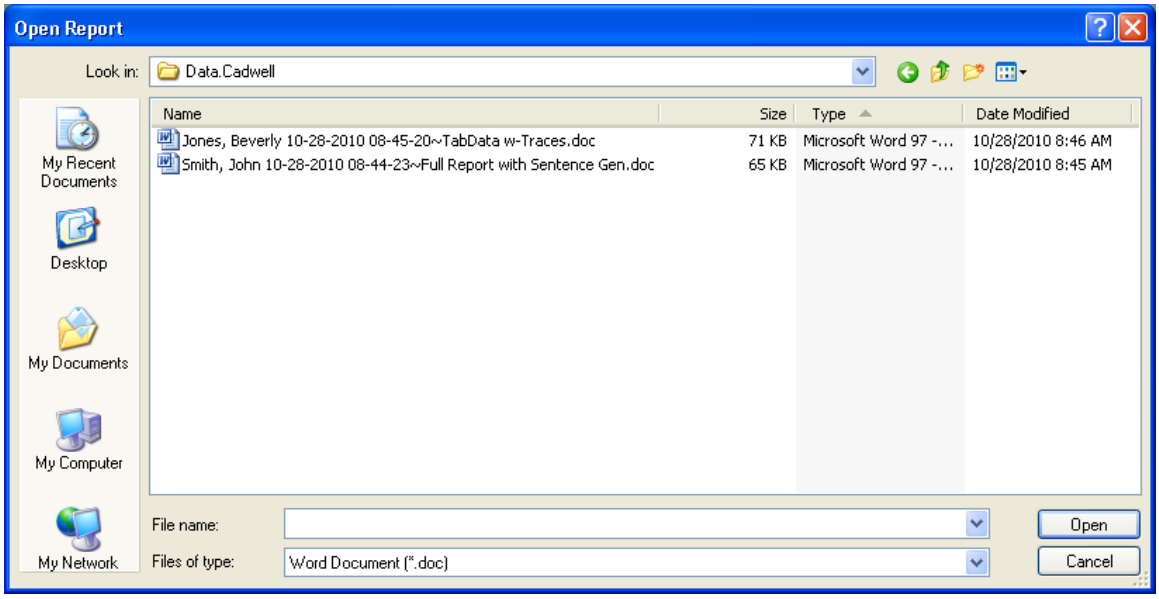
This window defaults to the data directory path that is specified in the System Setup window and lists all the stored reports found in this location.



Open Report window.

- Select a report by turning **Knob #1** on the Wave base unit until the desired report is highlighted, **press the same Knob to Open** the file. You can also select the report by clicking on the file with the **mouse** and then clicking the **Open** button.
- The stored report is opened in the Microsoft Word™ program.

The version 11 software upgrade adds the template name to the filename of the report. Example reports saved with version 11 are shown below.



Report filenames after version 11 software upgrade.

From Outside the Sierra Wave program

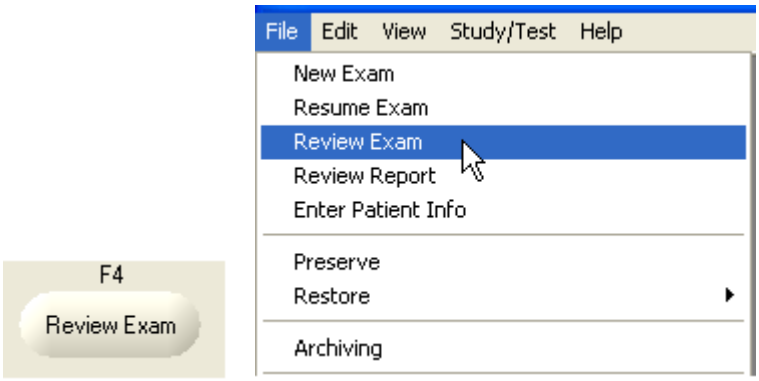
- Go to the appropriate Sierra Wave Data folder.
    - Doulble click **My Computer**
    - Double click the **Local Disk (C:)**
    - Double click the **Cadwell** folder
    - Double click the **Sierra Wave** folder
    - Double click on the appropriate user's **Data** folder
- Double click on the stored report document to open it.

Reviewing an Exam

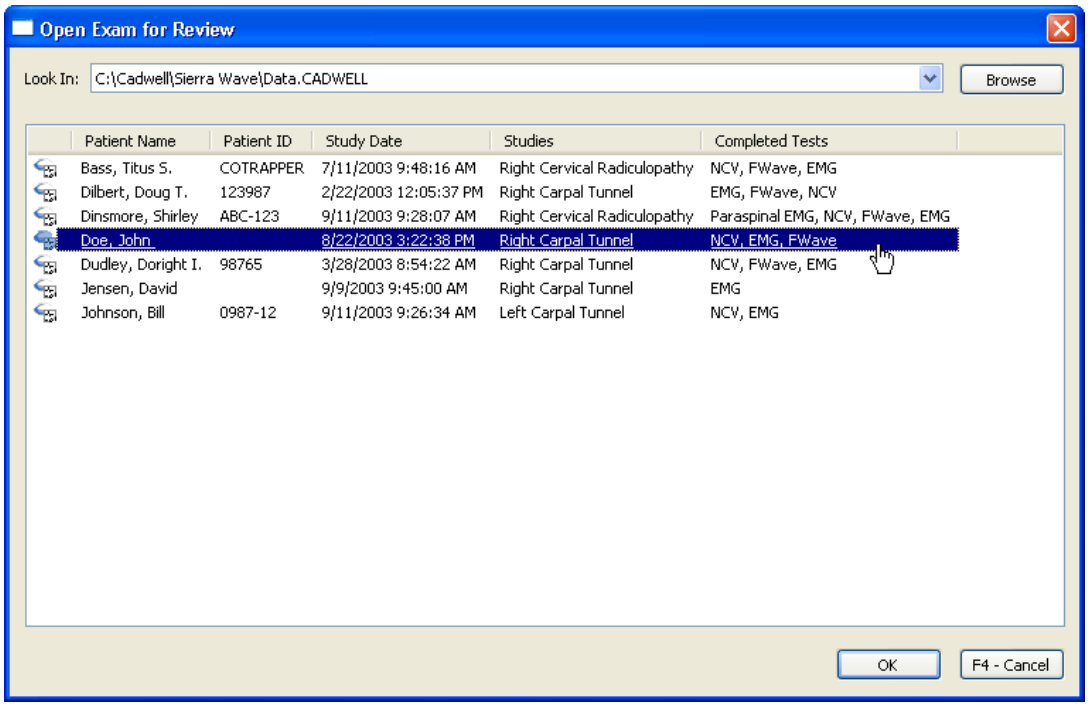
Reviewing an Exam

To Review a patient's exam:

1. Start the Sierra Wave program.
2. Press the **F4-Review Exam** key or select **Review Exam** from the **File** menu.

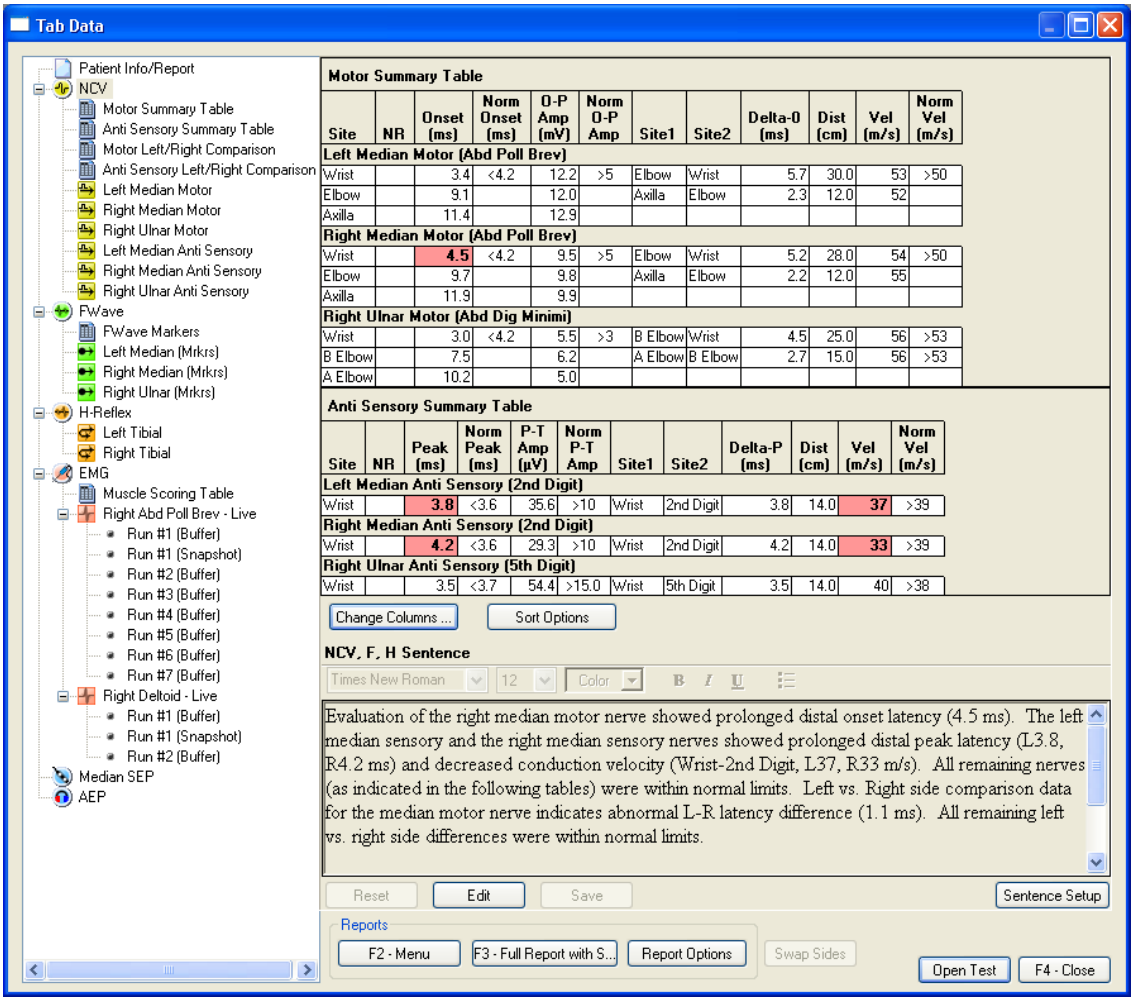


3. The **Open Exam for Review** window will be displayed. This window defaults to the data directory path that is specified in the System Setup window and lists all the patient files found in this location.



4. Select a patient by turning **Knob #1** on the Wave base unit until the desired patient is highlighted, **press the same Knob to Open** the file. You can also select the patient by clicking on the patient file with the **mouse** and then clicking the **OK** button.

5. The patient's file will be opened and the **TabData** window will be displayed.



TabData window, NCV Summary Tables selected.

The left hand side of the TabData window shows all the tests that were performed on the patient. It also has entries for summary tables (i.e., Motor Summary table, Anti Sensory table, Muscle Scoring table).

To view the results for an individual test:

Highlight the test by turning **Knob #1** on the Sierra Wave base unit or by clicking on the test with the mouse. The selected test's traces and cursor information will be displayed on the right hand side of the window.

To view a summary table:

Highlight the table by turning **Knob #1** on the Sierra Wave base unit or by clicking on the summary table with the mouse. The selected table will be displayed on the right hand side of the window.

For more information on the TabData window, see the topic TabData Window Overview.

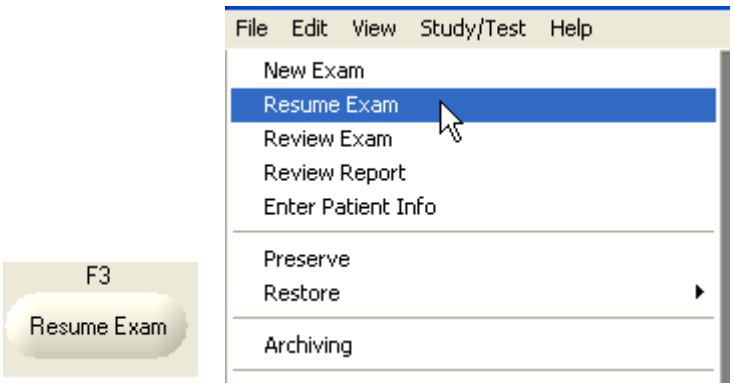
Resuming an Exam

Resuming an Exam (Append To)

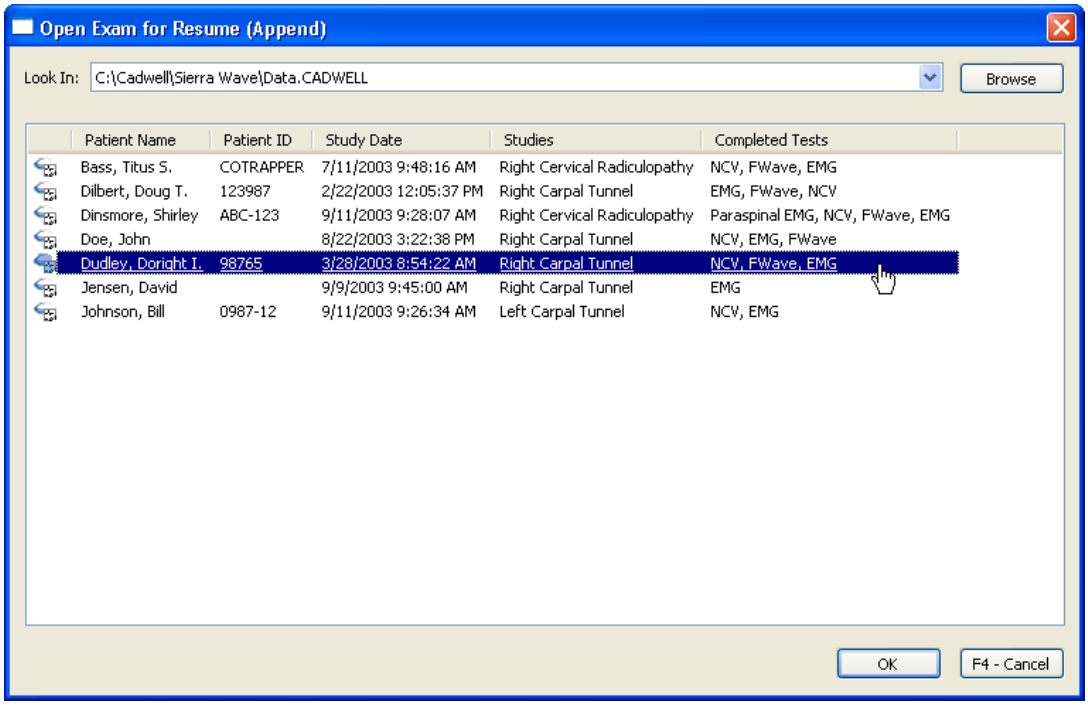
This feature is used to open an existing patient exam and **add** more test data to the file.

To Resume a patient's exam:

1. Start the Sierra Wave program.
2. Press the **F3 - Resume Exam** key or select **Resume Exam** from the **File** menu.



3. The **Open Exam for Resume** window will be displayed. This window defaults to the data directory path that is specified in the System Setup window and lists all the patient files found in this location.

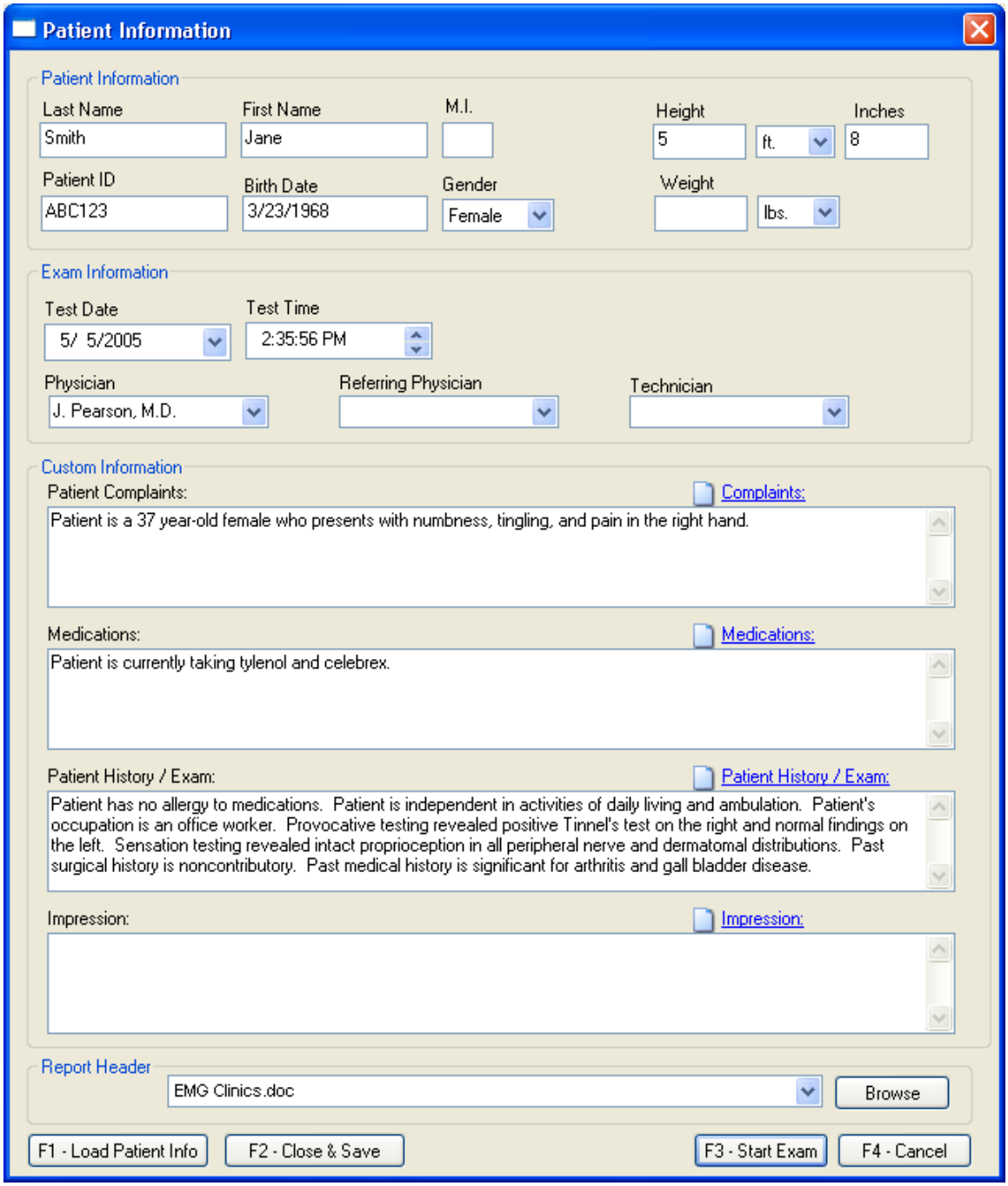


4. Select a patient by turning **Knob #1** on the Wave base unit until the desired patient is highlighted, **press the same Knob to Open** the file. You can also select the patient by clicking on the patient file with the **mouse** and then clicking the **OK** button.
5. The patient's file will be opened and the **Study** window will be displayed.
6. Select an existing test within the Study window or select a new test from the **Study/Test** menu.
7. Continue testing on the patient. When your finished, close the exam in the normal fashion (i.e., **File - Close Exam**).

Working with Patient Information

Editing Patient Information during an Exam

From the **Edit** menu, select **Patient Information**. The patient information window will be displayed.



Patient Information window

Make the appropriate entries or changes and click the **F3 - OK** button when finished.

To close the window **without saving** your changes, click the **F4- Cancel** button.

To load patient information from a file, click the **F1- Load Patient** Info button. See the topic "Loading Patient Information" for more details.

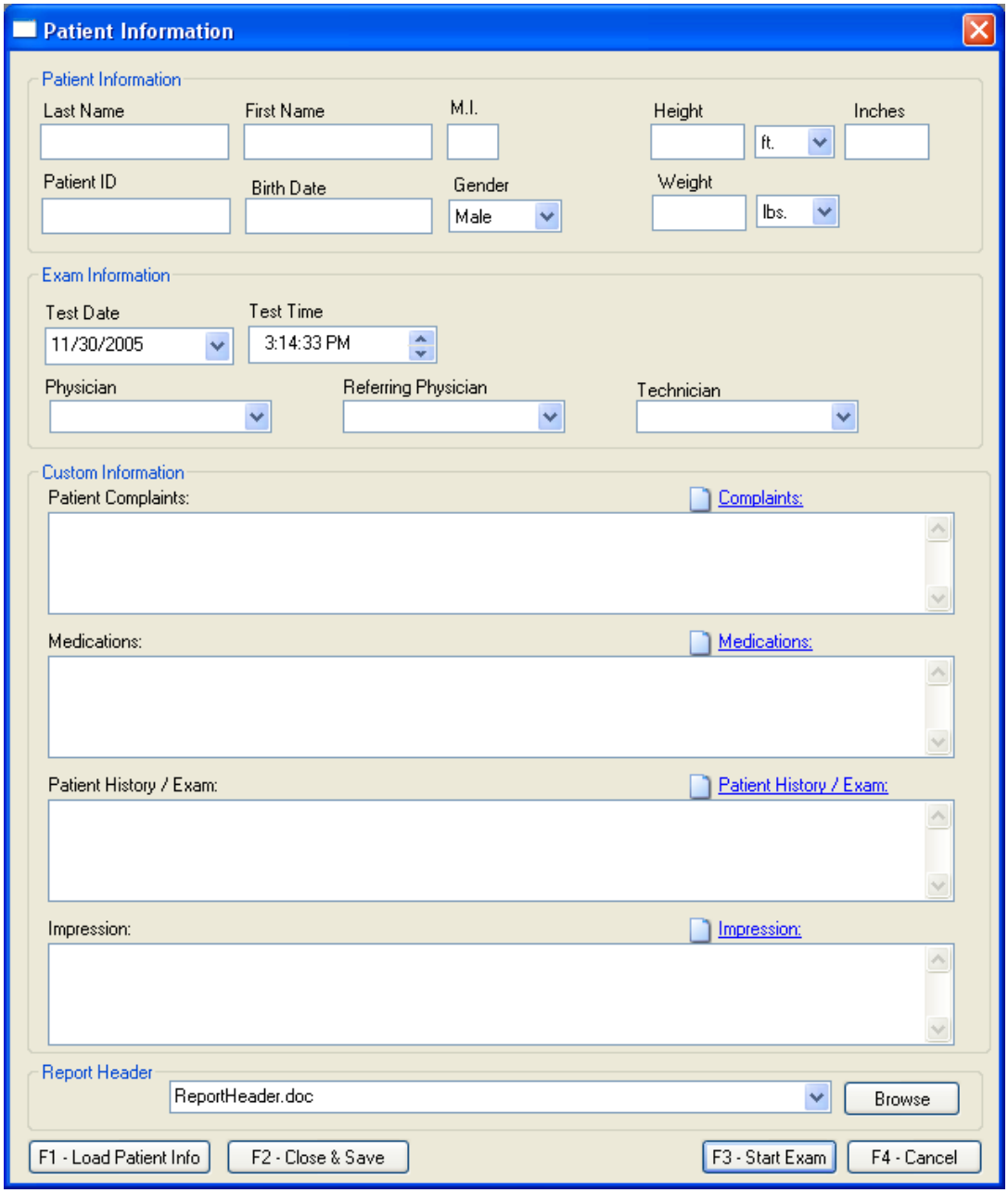
The **Report Header** can be selected from the drop-down list or by clicking on the Browse button. The report header can also be selected from within the System Setup window.

Pre-entering and Saving Patient Information

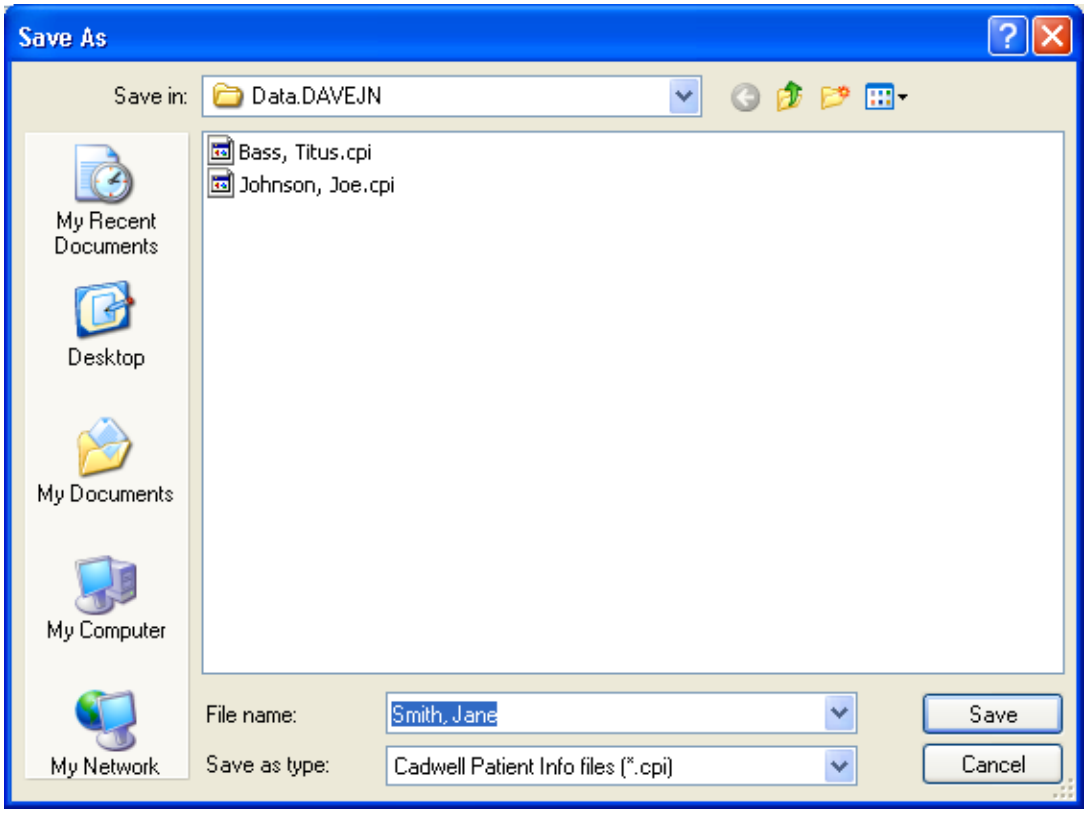
Patient information can be entered and saved to a file before the patient arrives for testing. After testing begins this information can be quickly retrieved.

To pre-enter patient information:

1. Start the Sierra Wave program.
2. Press the **F1- New Exam** button on the Sierra Wave base unit, or select **Enter Patient Info** from the **File** menu.
3. The **patient information window** is displayed.



4. At a minimum, enter the **Lastname** and **Firstname** for the patient.
5. Click the **F2 - Close & Save** button.
6. A standard **Save As** window will be displayed with the **Save In** location defaulting to the user's **Data folder**. The filename is automatically created using the patient's lastname & firstname. To save the patient information in this location, click the **Save** button.



Save As window for Patient Information

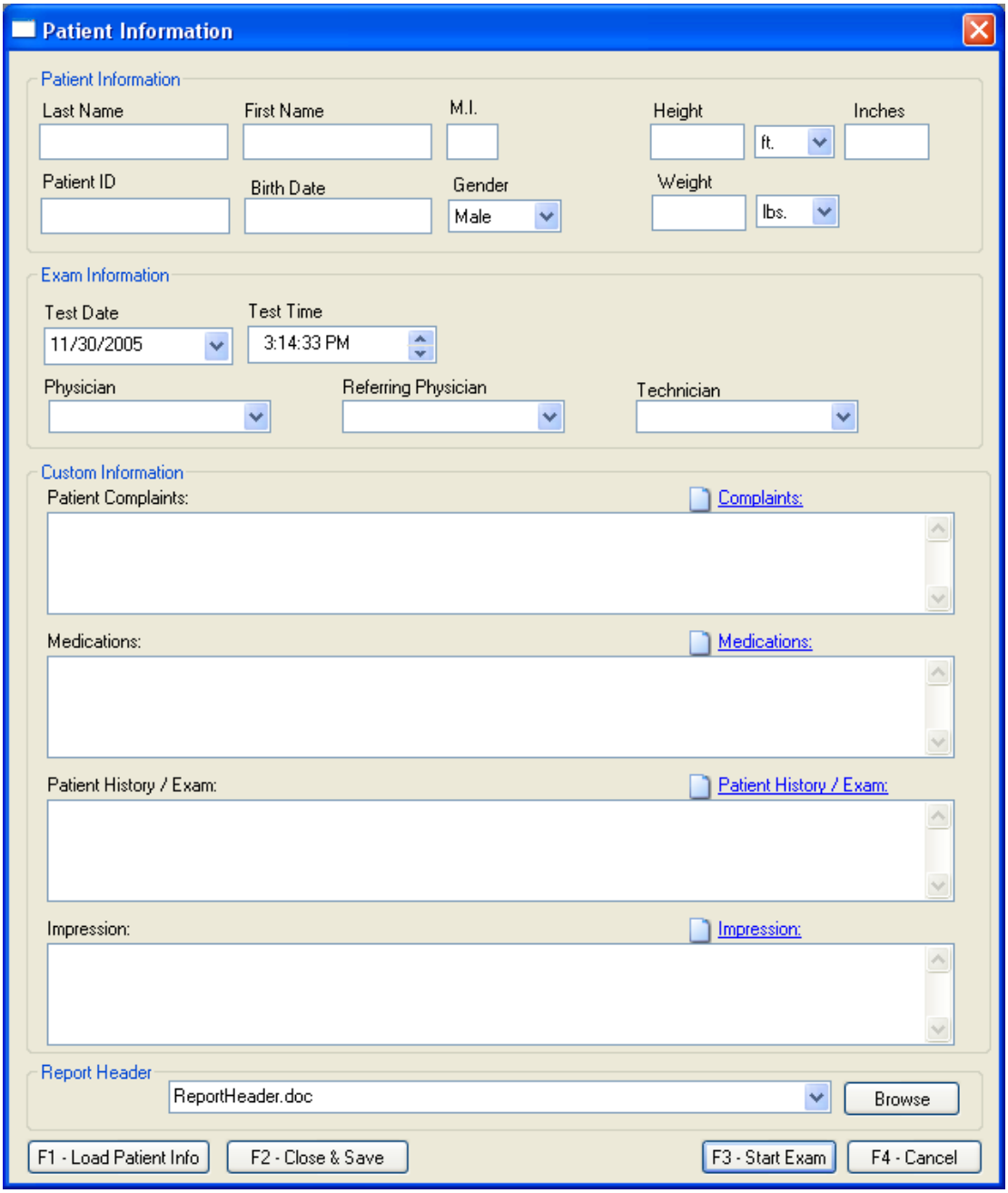
Patient Information files have the file extension, **cpi**.

The **Report Header** can be selected from the drop-down list or by clicking on the Browse button. The report header can also be selected from within the System Setup window.

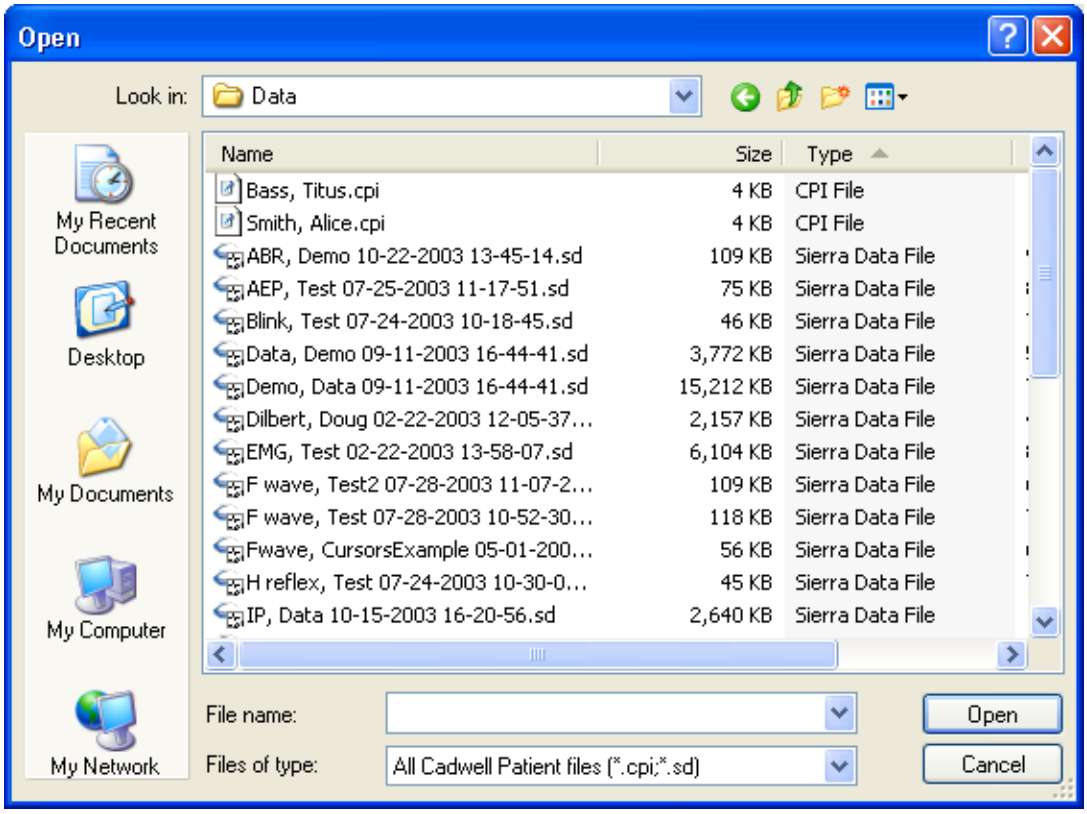
Loading Patient Information

To load patient information from a patient information or patient data file, follow the steps shown below.

1. Start the Sierra Wave program.
2. Press the **F1- New Exam** button on the Sierra Wave base unit, or select **Enter Patient Info** from the **File** menu.
3. The **patient information window** is displayed.



4. Click the **F1 - Load Patient Info** button
5. A standard **Open** window is displayed with the **Look In** location defaulting to the user's **Data** folder.



Open window for pre-entered patient information.

6. **Highlight** either a **patient information file (*.cpi)** or a **previous patient data file (*.sd)**, then click the **Open** button.
7. The information contained in the file will be loaded into the Patient Information window.
8. Select **F3 - Start Exam** to begin testing.

Custom Fields

The Patient Information window can be customized by adding up to 20 user-defined fields. These fields are displayed at the bottom of the patient information window and can be of varying lengths.

To setup the custom patient information fields, select **System Setup** from the **Edit** menu.

The **Custom Patient Info** section lists the custom fields that are currently defined for the system.

Up to 20 fields can be created and there are 5 types (length) to choose from. The information entered in these fields can be transferred to your report.

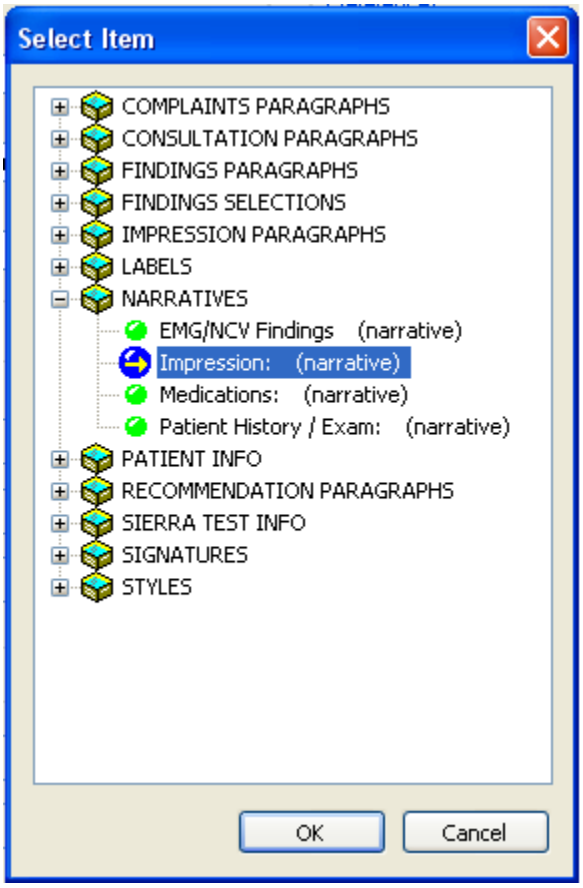
Name:

Enter the name of the Custom Field. To change an existing field name, click on it with the mouse. To enter a new field, click on the blank blue line at the bottom of the list.

Type:

Click here to specify the length of each Custom Field. Choices are **Short** (15 characters max), **Medium** (40 characters max), **Long** (110 characters max), **Paragraph** (unlimited characters), and **Report Item**. A selection of Short, Medium, Long, or Paragraph for a custom field will setup a simple text box in the patient information window.

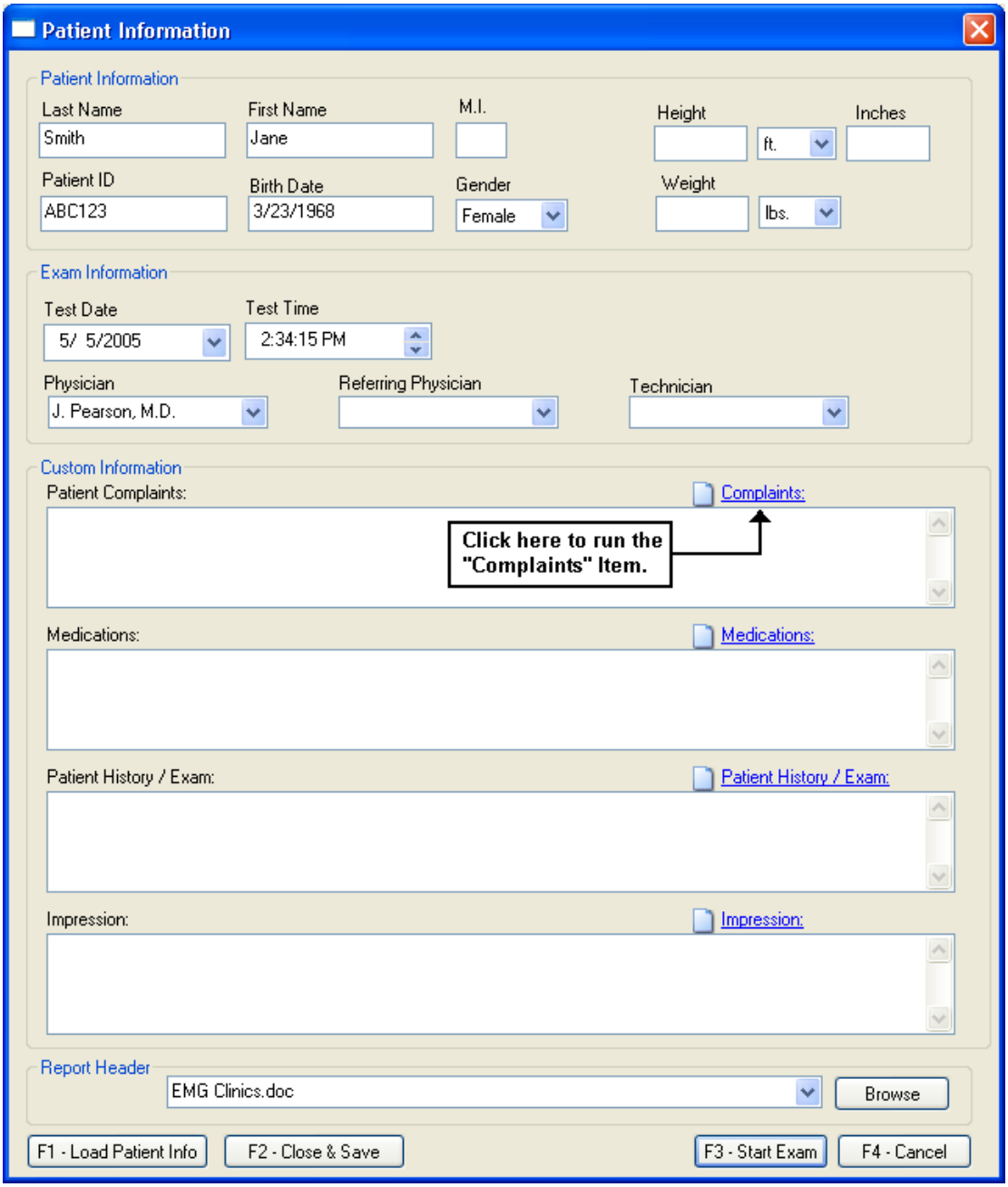
If **Report Item** is selected an additional column will be displayed. This additional column, titled Report Item, allows you to assign a QuickReport Item to this custom field. Simply click within the Report Item column and the **Select Item** window will be displayed. This window displays all the available Narrative, Paragraph, and Select items that are stored within QuickReport's database. Only one report item can be assigned to each custom field.



Select Item window.

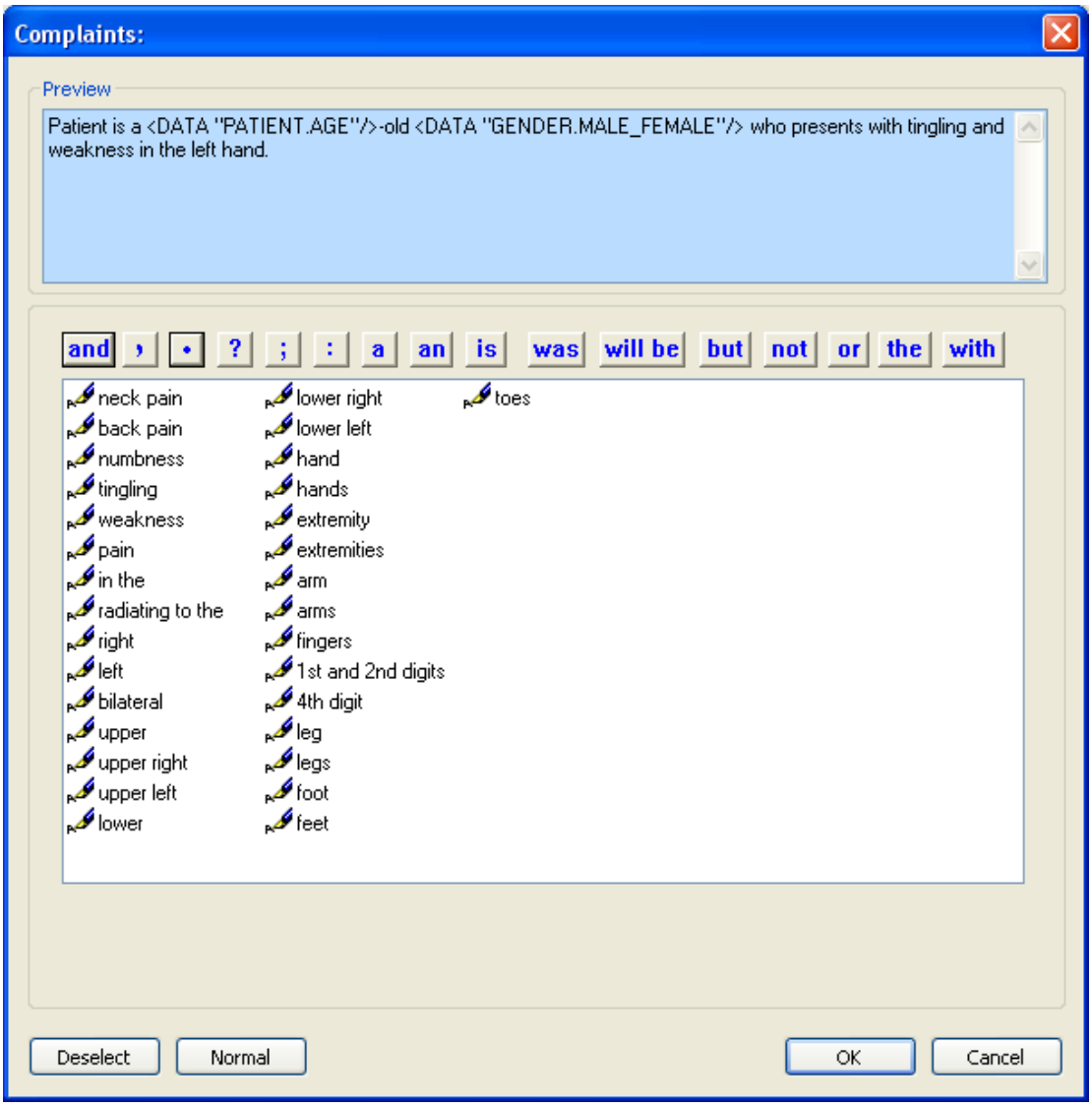
Using a Report Item with a Custom Field

When a report item has been assigned to a custom field, the label of that report item and a small document icon will be displayed above and to the left of the custom field in the patient information window. The user still has the option of simply typing into the custom field, or they can click on the report item's name and process that item. This gives the user the ability to 'pre-process' the report item before starting the report generator.



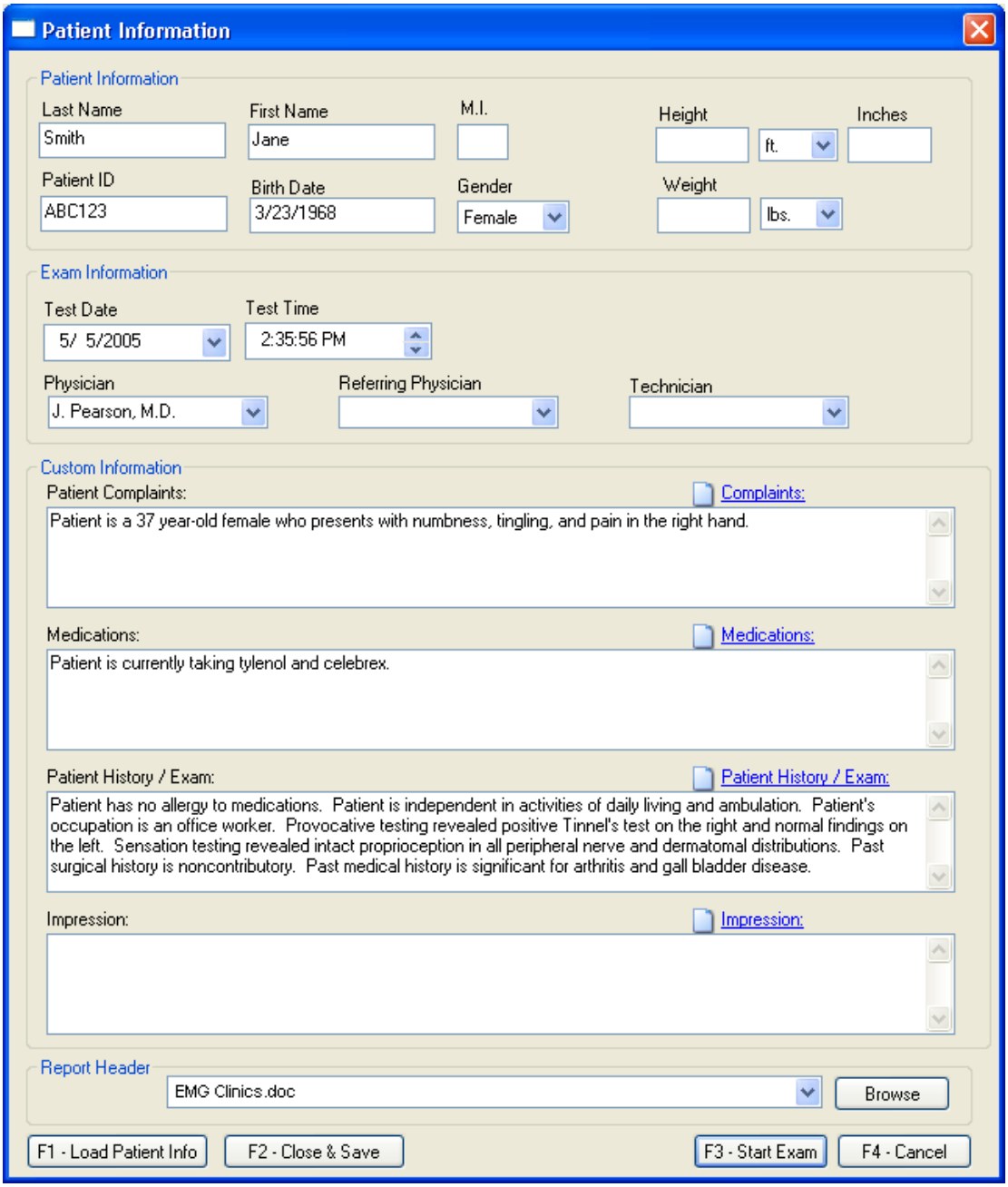
Patient Information window.

Clicking on the Complaints item Complaints: , in the above example, will pop-up the typical QuickReport window for that item which is shown below.



Chief Complaints report item.

You can complete the report item in the normal fashion and when the OK button is clicked the output of the report item (i.e., the data in the blue preview box) is inserted into the custom field in the patient information window.



Patient Information window with the Patient Complaints, Medications, and Patient History/Exam custom fields completed.

If you click on a report item a second time, it will simply add the results to the end of the text already inside the field.

Utilities & Converters

Preserve Settings

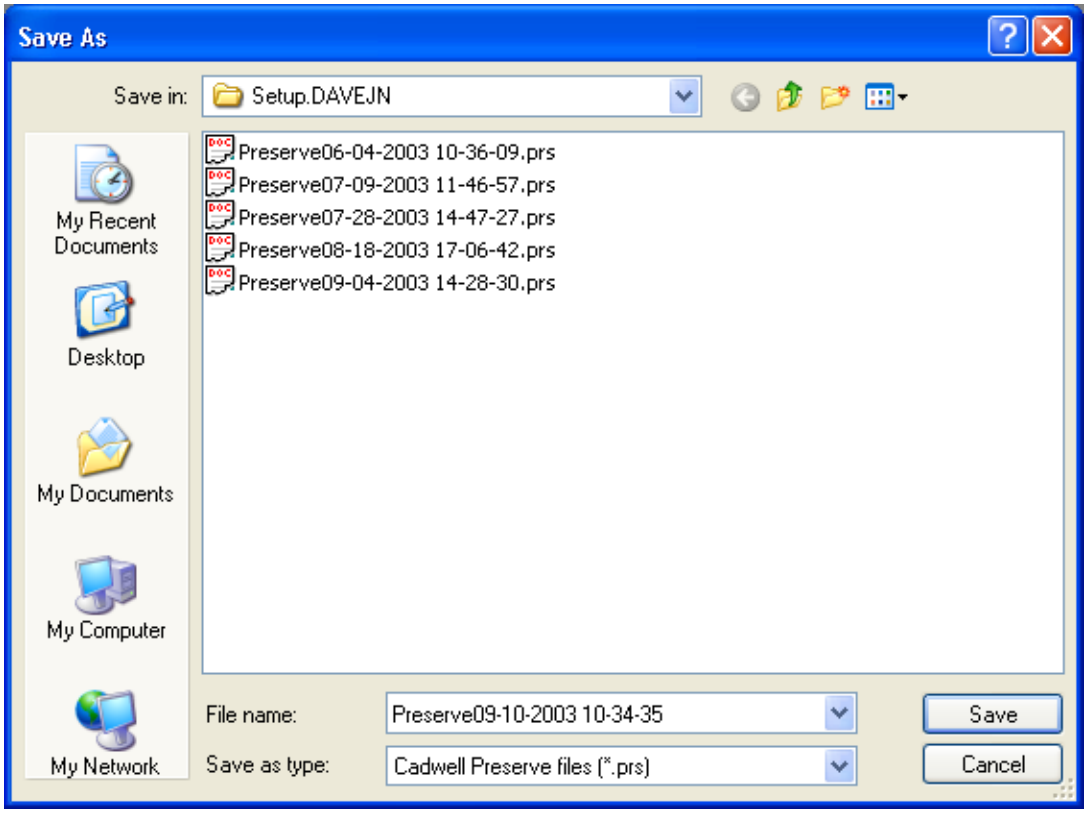
The **Preserve** feature creates a single backup file with the current user's test protocol settings (including nerve lists, and muscle lists), the user's report headers, and all of the system's report templates.

If you have made changes to the default factory settings, it is recommended that you make a preserve file.

In the unlikely event that a user's settings become corrupted, the preserve file can be used to restore the settings.

To make a Preserve File:

1. Start the Sierra Wave program.
2. From the **File** menu, select **Preserve**.
3. A standard **Save As** window will be displayed with the location of the "Save In" field defaulting to the current user's Setup folder (e.g., *Setup.username*). The filename for the preserve file is automatically created but can be changed to something more descriptive, like the user's name.



Save As window for Preserve Settings.

4. To create the preserve file in this location, click the **Save** button. If you want to create the file in a different location, use the drop-down arrow of the "Save In" field to change the location prior to clicking the Save button.

Preserve files have the file extension, **prs**.

Preserve files can be written directly to a writable CD. The built-in Windows XP CD Writing Wizard will automatically be displayed.

If there are multiple users of the Sierra Wave machine, with each using a different setup directory, then each user should create their own preserve file.

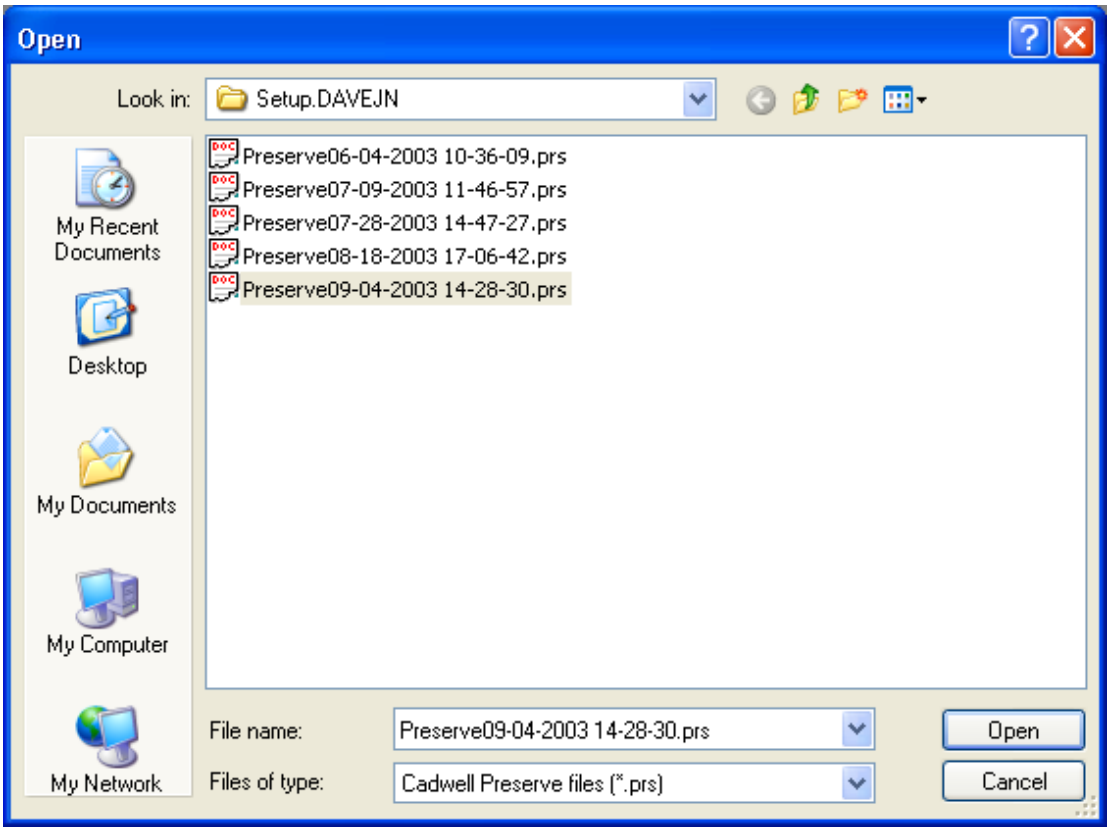
Restore Settings

The **Restore** feature is used to restore test settings and report templates from a Preserve file. There are two types of restore methods, **All** or **Selected**.

To Restore All Settings:

1. Start the Sierra Wave program.

2. From the **File** menu, select **Restore All**.
3. A standard **Open** window will be displayed with the location of the "Look In" field defaulting to the current user's Setup folder (e.g., *Setup.username*). All preserve files in this location will be listed.



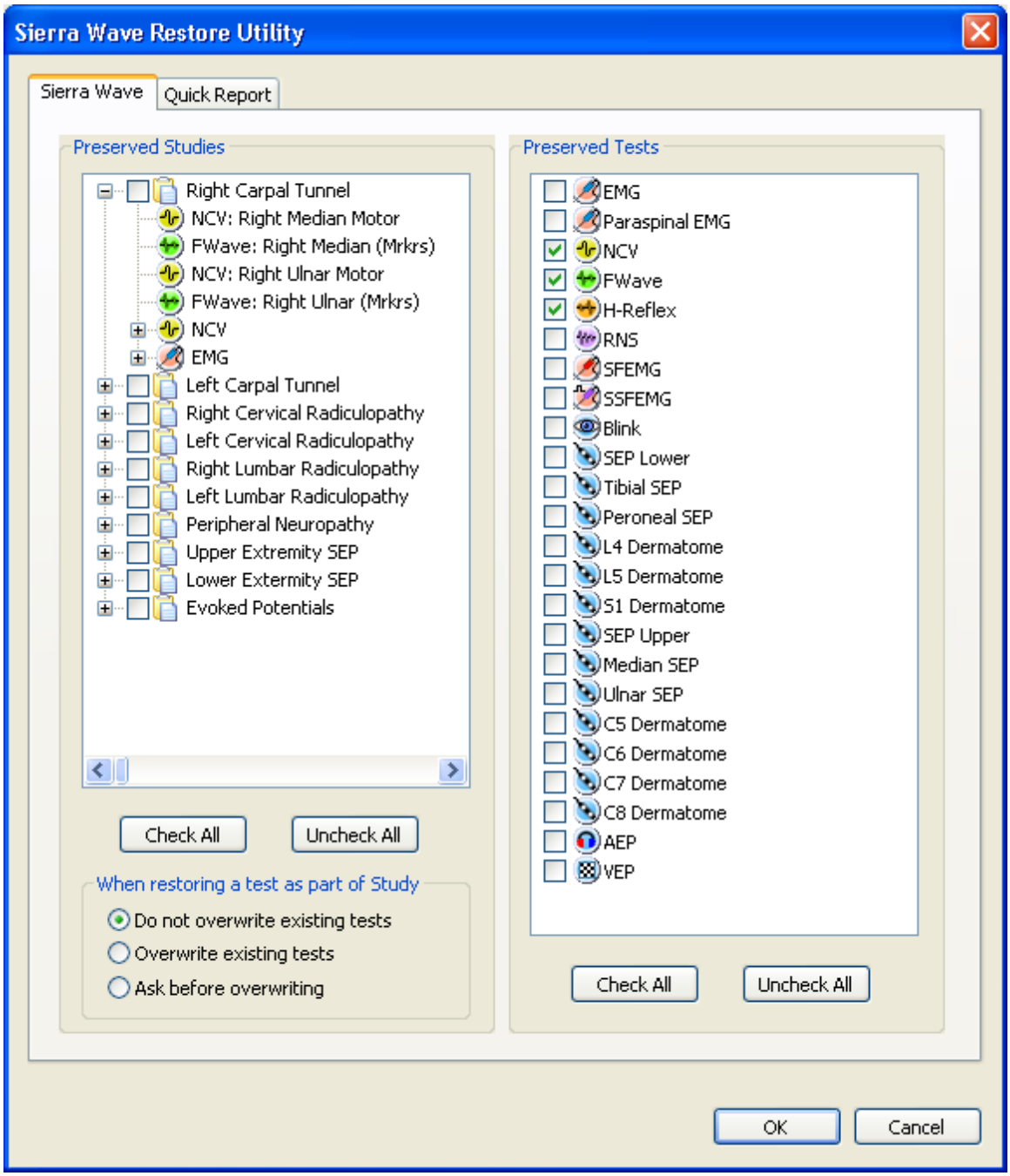
Open window for selecting a preserve file.

4. **Select** the preserve file and click the **Open** button. All the test settings and report templates within the preserve file will be loaded and will replace the current settings. If the preserve file is in a different location, use the drop-down arrow for the "Look In" field and change the location prior to selecting the preserve file.

To Restore Selected Test Protocols or Study Lists:

1. Start the Sierra Wave program.
2. From the **File** menu, select **Restore**, then click on **Selected**.
3. A standard **Open** window will be displayed with the location of the "Look In" field defaulting to the current user's Setup folder (e.g., *Setup.username*). See example above. All preserve files in this location will be listed.

4. **Select** the preserve file and click the **Open** button. The **Sierra Wave Restore Utility** window will be displayed. This window will default to the Sierra Wave view. **Study Lists** contained in the preserve file are listed in the left hand column, **Test Protocols** contained in the preserve file are listed in the right hand column. You can expand a study by clicking on the (+) sign in front of the study name, this will show you the individual test protocols composing the study.



Restore Selected Sierra Wave Studies and/or Test Protocols.

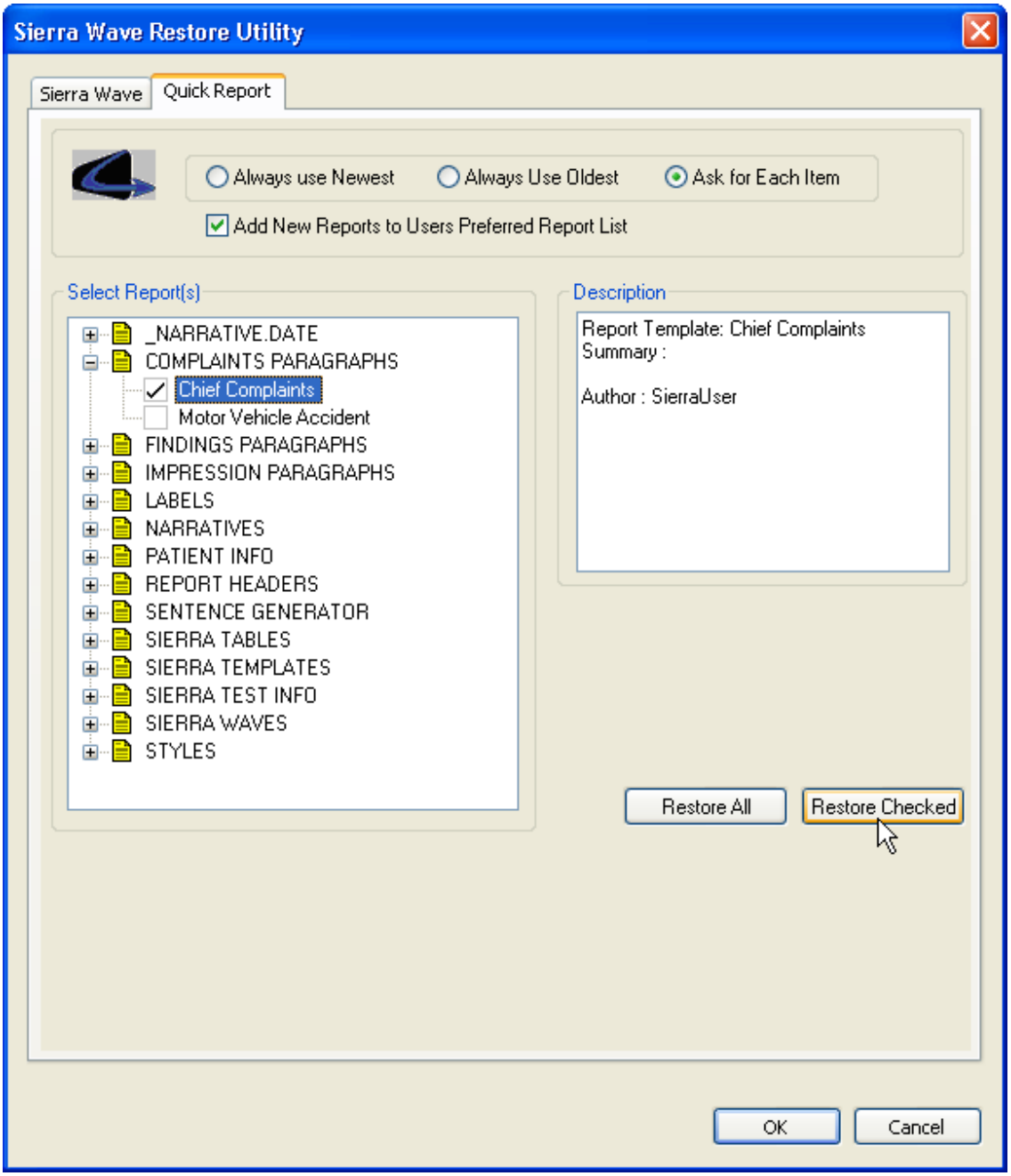
5. To restore a **Study List**
    - **Select** the **Study** by clicking on the box in front of the study name, a **green check mark** will appear to indicate the study has been selected.
    - Select a **restore option** at the bottom of the Study List, the options are "Do not overwrite existing tests", "Overwrite existing tests", and "Ask before overwriting". When you restore a Study from a preserve file you have the option of not only restoring the study name, and the names of the test protocols within the study, but also of restoring the test settings for those test protocols.
        - **Do not overwrite existing tests -** the name of the study and test protocols within the study will be restored but the program will not restore any of the test protocol settings. The existing test settings will continue to be used.
        - **Overwrite existing tests -** the name of the study and test protocols within the study will be restored, in addition, the test settings for the test protocols used in the study will be copied over the existing settings.
        - **Ask before overwriting -** the program will prompt the user when it needs to overwrite existing test settings at which time the user can answer "Yes" or "No".
    - Click the **OK** button.
6. To restore a **Test Protocol**
    - **Select** the **Test Protocol** by clicking on the box in front of the test protocol name, a **green check mark** will appear to indicate the test protocol has been selected.
    - Click the **OK** button.

To Restore Selected Report Templates:

1. Start the Sierra Wave program.
2. From the **File** menu, select **Restore**, then click on **Selected**.
3. A standard **Open** window will be displayed with the location of the "Look In" field defaulting to the current user's Setup folder (e.g., *Setup.username*). See example above. All preserve files in this location will be listed.

4. **Select** the preserve file and click the **Open** button. The **Sierra Wave Restore Utility** window will be displayed. This window will default to the Sierra Wave view.

5. Click on the **QuickReport** tab. The **Select Report(s)** section will display the report templates and report items that are available in the preserve file. You can expand a category by clicking on the plus (+) sign in front of the category name, this will show you the individual report templates or report items contained within the category.



Restore Selected QuickReport Templates and/or Items.

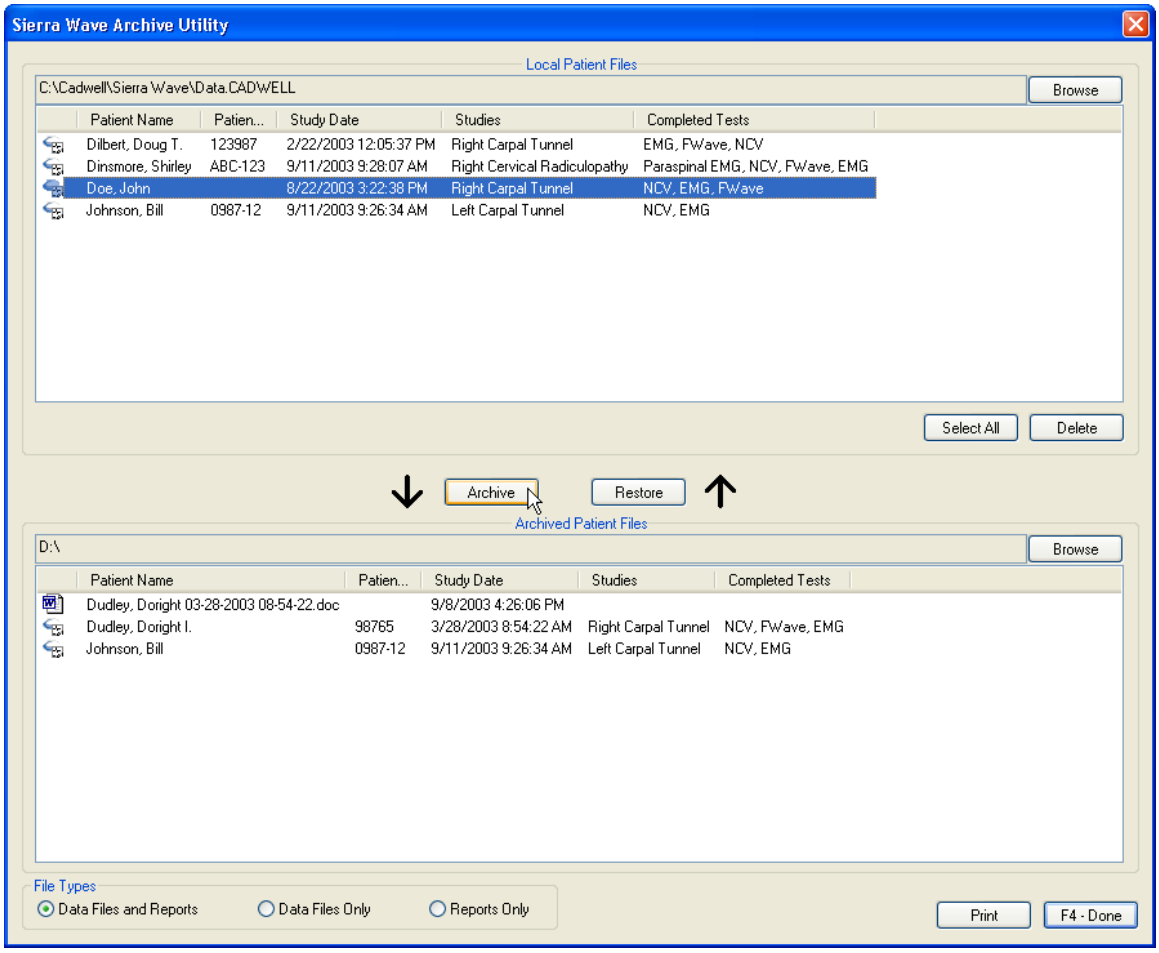
6. To restore **All Templates and Items**.
    - Click on the **Restore All** button.
7. To restore **Selected Templates and Items.**
    - Expand the appropriate categories by clicking on the **(+)** sign in front of the category name.
    - **Click on the box** in front of the template or item name to select it, a **green check mark** will appear to indicate it has been selected.
    - Click on the **Restored Checked** button.
8. Click the **OK** button to close the Restore window.

Archiving Overview

Archive Utility Overview

The Sierra Wave's Archiving feature can be used to archive **(i.e., copy)** patient files and stored report documents to a CD-R / CD-RW drive, to another location on the computer's hard disk drive, or to a location on a networked computer. It can also be used in the opposite direction, to restore patient files or reports from an archive media back to the Sierra Wave's data directory.

From the **File** menu, select **Archiving**. The **Archive Utility** window will be displayed.



Archive Utility window.

Local Patient Files

The top of the Archive Utility window lists the patient files that are currently present in the local data folder. The default location of this folder is set in the System Setup window. The browse button can be used to change this location.

Archived Patient Files

The bottom of the Archive Utility window lists the patient files currently located on the archive media. The default location for this media is set in the System Setup window. The browse button can be used to change this location.

File Types

Three options are available for selecting the types of files that are displayed.

- **Data Files and Reports** - both Sierra Wave patient data files and stored report documents are listed.
- **Data Files only** - only Sierra Wave patient data files are listed.

- **Reports only** - only stored report documents are listed.

Sorting Files

The listed files can be sorted by clicking on the top of the displayed columns. For example, to sort by patient name simply click at the very top of the Patient Name column. To sort by Study Date, click at the top of the Study Date column.

Selecting Files

- **Select All** - click the Select All button to highlight all of the files listed in the Local Patient Files area.
- **Select a single file** - point at the file and click the left mouse button.
- **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.

Deleting Files

The **Delete** button can be used to delete files from the local data folder. Typically this would be done after the patient files have been successfully archived.

Printing a Directory

The **Print** button can be used to print a listing of the files on the currently selected archive media.

Archiving in Windows XP

Archiving to CD-R/DVD in Windows XP:

3 possible archiving options are described.

- **OPTION 1** - Archiving to CD **within the Sierra Wave program** (using built-in Windows XP burner).
- **OPTION 2** - Archiving to CD **outside of the Sierra Wave program** (using built-in Windows XP burner).
- **OPTION 3** - Archiving to another folder on the local hard disk drive or to a network drive.

Third party software such as **Easy CD Creator**, **Direct CD**, and **Drag-N-Drop** are not supported within the Sierra Wave Archive Utility window. These programs can be used outside of the Sierra Wave program, please refer to each program's instructions for proper use.

Option 1: **Archiving to a CD within the Sierra Wave program (using built-in Windows XP burner).**

1. **Start** the **Sierra Wave** program.
2. **Insert a CD-R disc** into the drive.

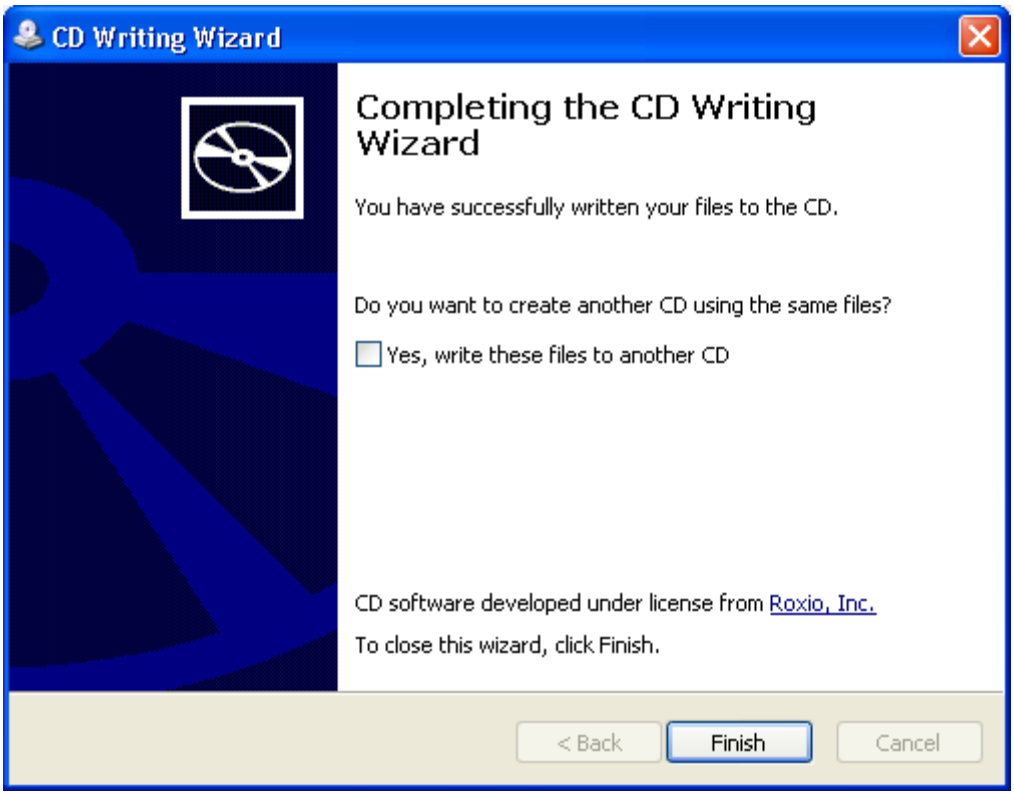
   If a window is displayed, asking you what you would like to do with the CD, click the **Cancel** button.

   If a window is displayed showing you the contents of the CD drive, **close** or **minimize** the window.
3. From the **File** menu, select **Archiving**
4. **Select** the **patient files** you want to archive in the **Local Patient Files** area.
   - **Select All** - click the Select All button to highlight all of the files listed in the Local Patient Files area.
   - **Select a single file** - point at the file and click the left mouse button.
   - **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.
5. **Click** the **Archive** button.
6. The **CD Writing Wizard** window will be displayed.

CD Writing Wizard window

5.

7. Type the **Name** you want to give to the CD, or use the name that is already entered. **Click** the **Next** button. The selected files will be copied to the CD. After the files are copied, the CD is ejected and the following window is displayed.



CD Writing Wizard window - after writing is complete.

7.

8. **Click** on the **Finish** button, the above window closes and you are returned to the Archive Utility window.
9. Close the Archive Utility window by clicking the **Done** button.
10. The archive process is complete. It is a good idea to put the CD back into its protective case until the next archiving session.

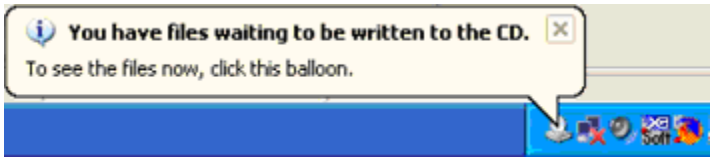
Option 2: **Archiving to CD outside the Sierra Wave program (using Windows XP's built-in CD burner).**

1. **Close** the **Sierra Wave** program.
2. **Insert a CD-R disc** into the drive.

If a window is displayed, asking you what you would like to do with the CD, click the **Cancel** button.

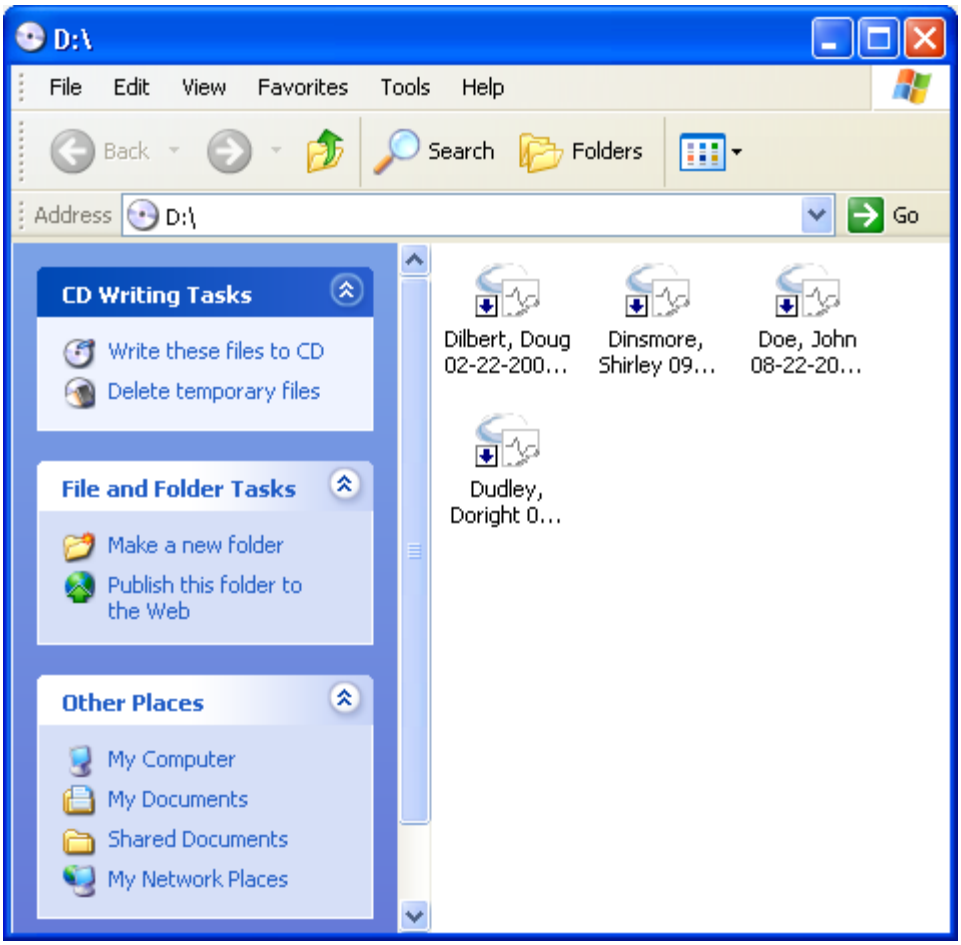
If a window is displayed showing you the contents of the CD drive, **close** or **minimize** the window.

3. **Open** the **Data folder** (here is one possible way of doing this).
   - Double click on **My Computer**.
   - Double click on **Local Drive (C:)**.
   - Double click on the **Cadwell** folder.
   - Double click on the **Sierra Wave** folder.
   - Double click on the appropriate **Data.*username*** folder.
4. **Select the files** to be archived.
   - **Select a single file** - point at the file and click the left mouse button.
   - **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.
5. **Right click** the mouse **over one of the selected files** and select **Send To - CD Drive (D:)** from the pop-up menu. Do not select "Send To Drag N Drop" if it is listed in the menu.
6. A message will appear in the lower right corner of the screen. This message tells you that there are files waiting to be written to the CD. **Click on the balloon message**.



Balloon Message

7. The **CD Drive Window** will be displayed. **Click** on the task, **Write these Files to CD**.

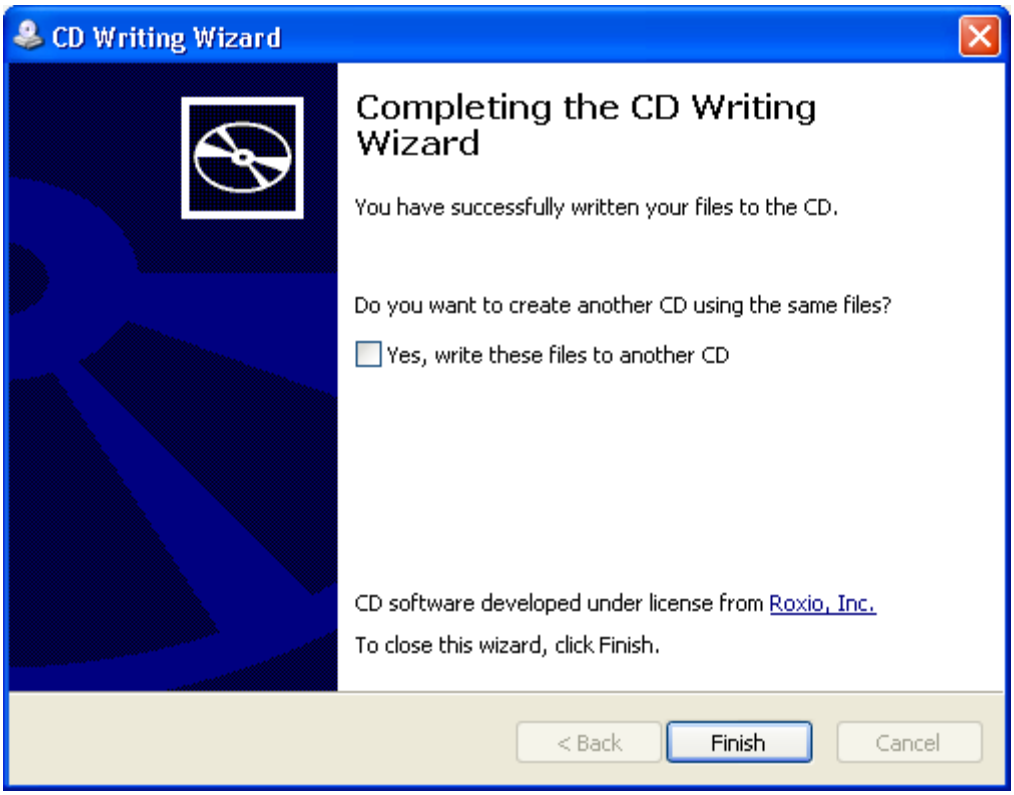


CD Drive window.

8. The **CD Writing Wizard** window will be displayed.

CD Writing Wizard window

9. Type the **Name** you want to give to the CD, or use the name that is already entered. **Click** the **Next** button. The selected files will be copied to the CD. After files are copied, the CD is ejected and the following window is displayed.

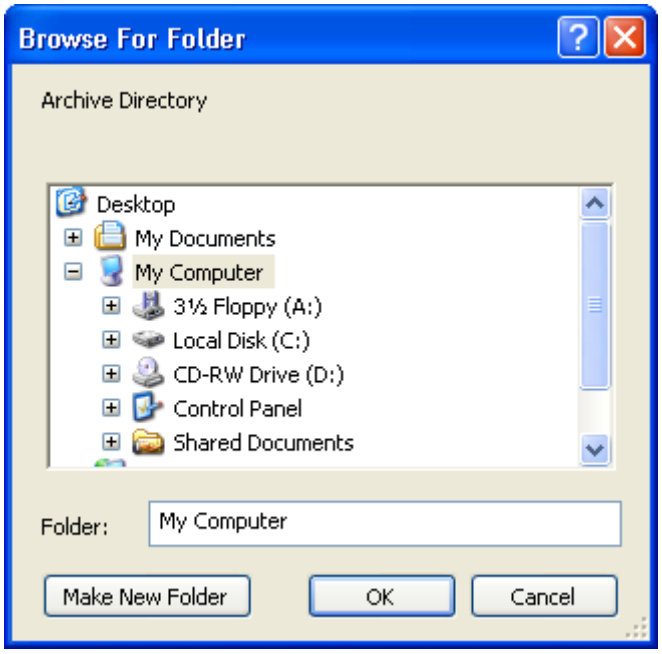


CD Writing Wizard window - after writing is complete.

10. **Click** on the **Finish** button, the above window closes and you are back to the CD Drive Window.
11. **Click** on the **X** in the upper right hand corner to close this window.
12. The archive process is complete. It is a good idea to put the CD back into its protective case until the next archiving session.

Option 3: **Archiving to another folder on the local hard disk drive or to a network drive.**

1. **Start** the **Sierra Wave** program.
2. From the **File** menu, select **Archiving**.
3. **Verify** the **Archive destination**. If necessary, use the **Browse** button to display the **Browse For Folder** window and change this location.



Browse For Folder window.

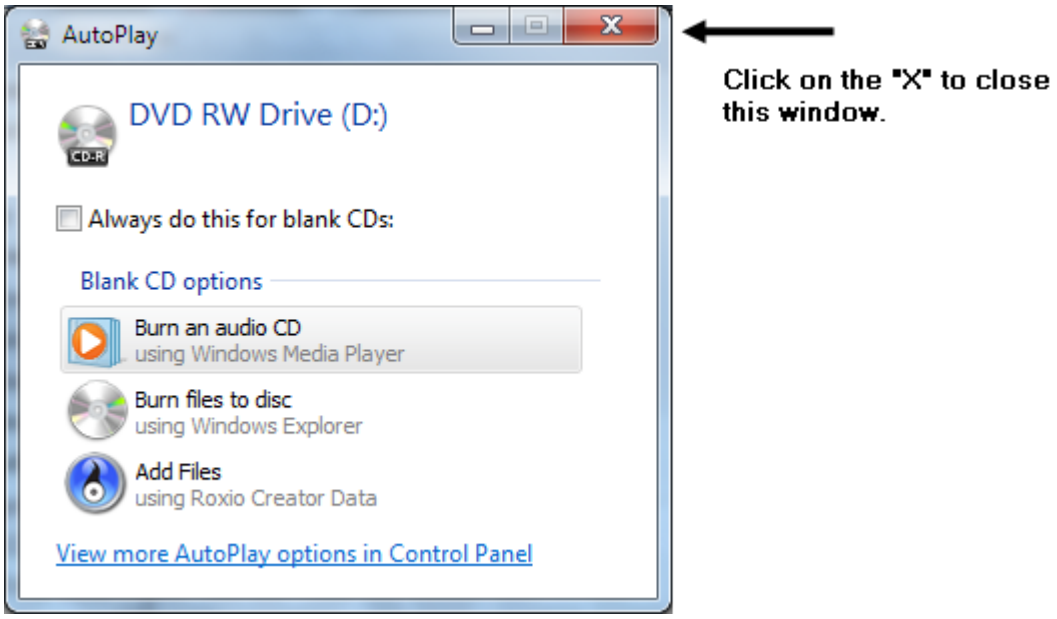
4. **Select** the **patient files** you want to archive in the **Local Patient Files** area.
   - **Select All** - click the Select All button to highlight all of the files listed in the local data folder.
   - **Select a single file** - point at the file and click the left mouse button.
   - **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.
5. **Click** the **Archive** button. The selected files will be copied to the archive destination and will be listed in the **Archived Patient Files** area.
6. **Click** the **Done** button to close the **Archive Utility**.

Archiving in Windows 7

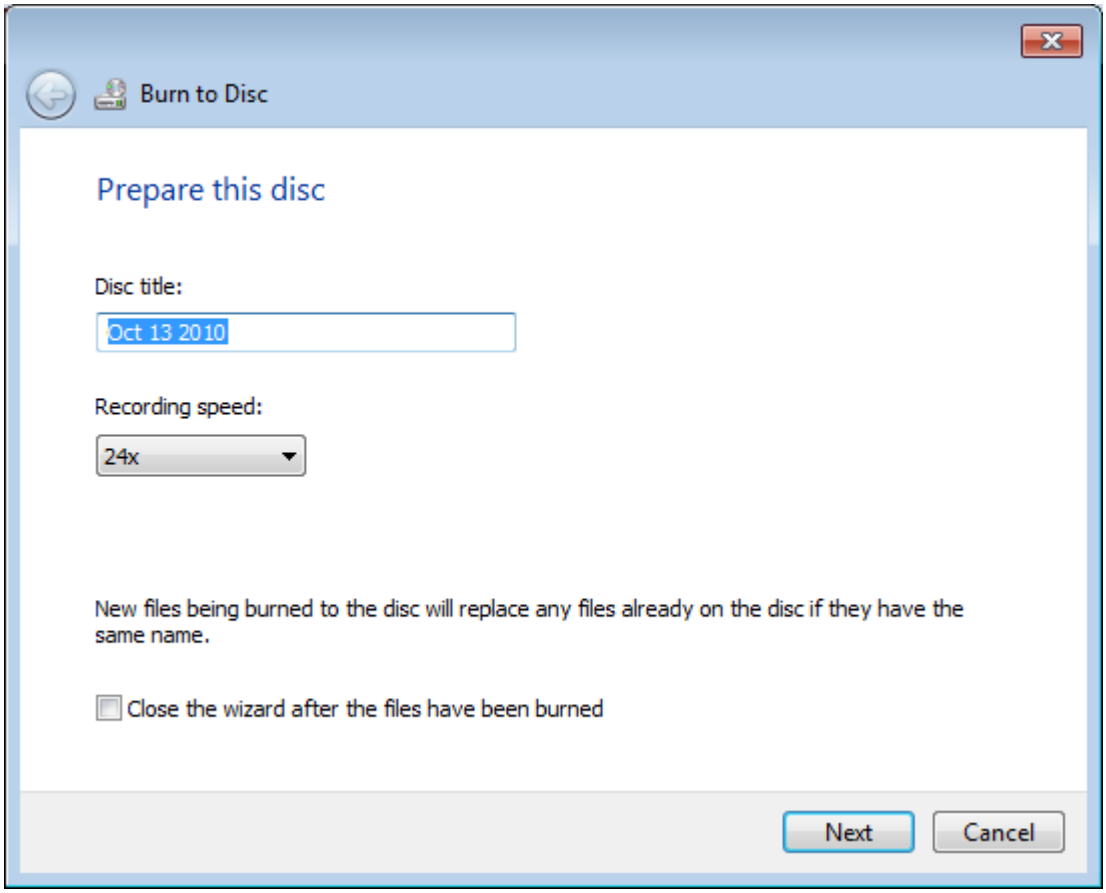
Archiving to CD-R/DVD in Windows 7

With a Blank Disc: (go to the next section if using a non-blank disc)

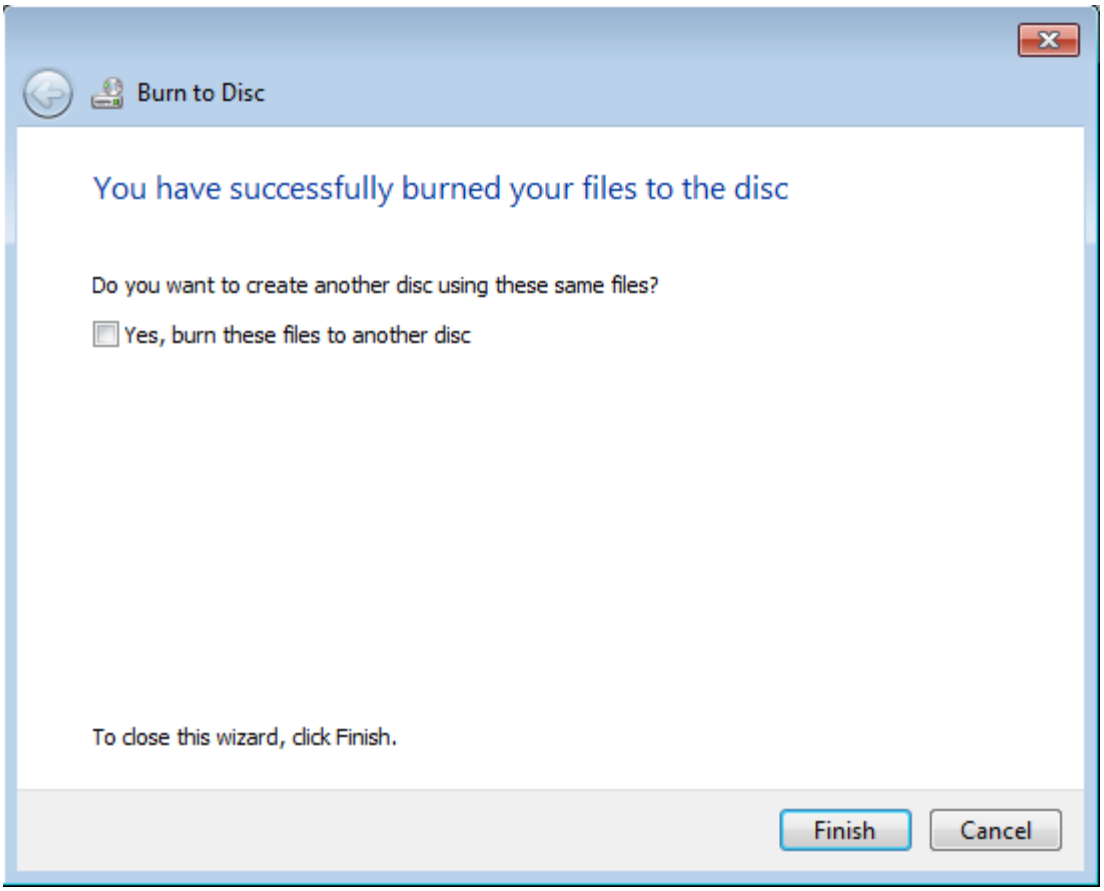
1. Insert the CD or DVD. Close any windows that might come up, like the Autoplay window, by clicking on the **X.**



2. Start the Sierra Wave program.
3. From the **File menu**, select **Archiving**.
4. Select the patient files you want to archive in the **Local Patient Files** area (at the top).
5. Click the **Archive** button.
6. A dialog called “Burn to Disc” will be displayed.



7. Enter a title for the disc.
8. Click the **Next** button.
9. The files will now be written to the disc. The disc will automatically eject when the process is complete.
10. Click the **Finish** button.

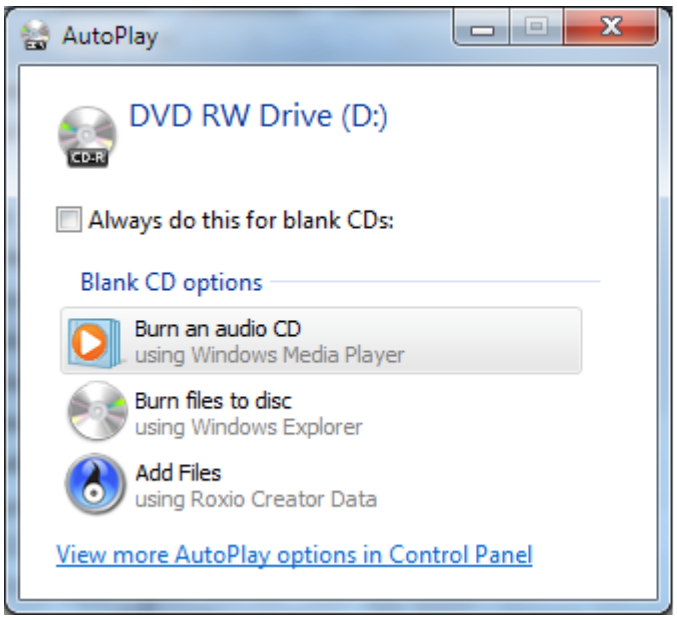


11. Click the **Done** button to close the Archiving window.

With a Non-Blank Disc:

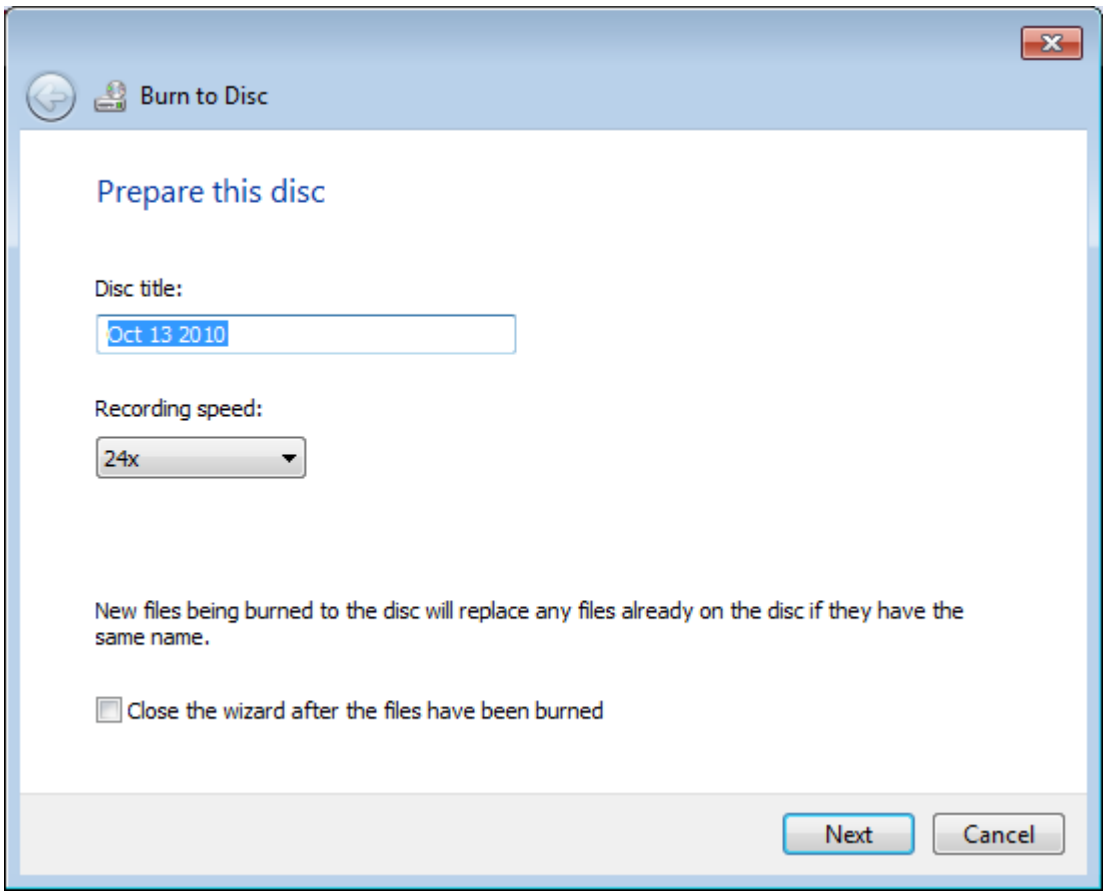
You can burn additional patient files directly to a non-blank CD/DVD, but you will receive an error message during the process. Follow the steps below to archive patient files to a non-blank CD/DVD and answer the error message correctly.

1. Insert the CD or DVD. Close any windows that might come up, like the Autoplay window, by clicking on the **X.**

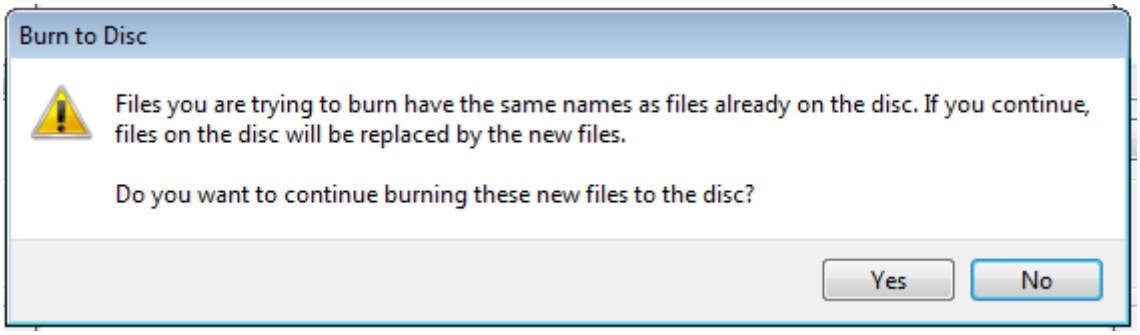


Click on the "X" to close this window.

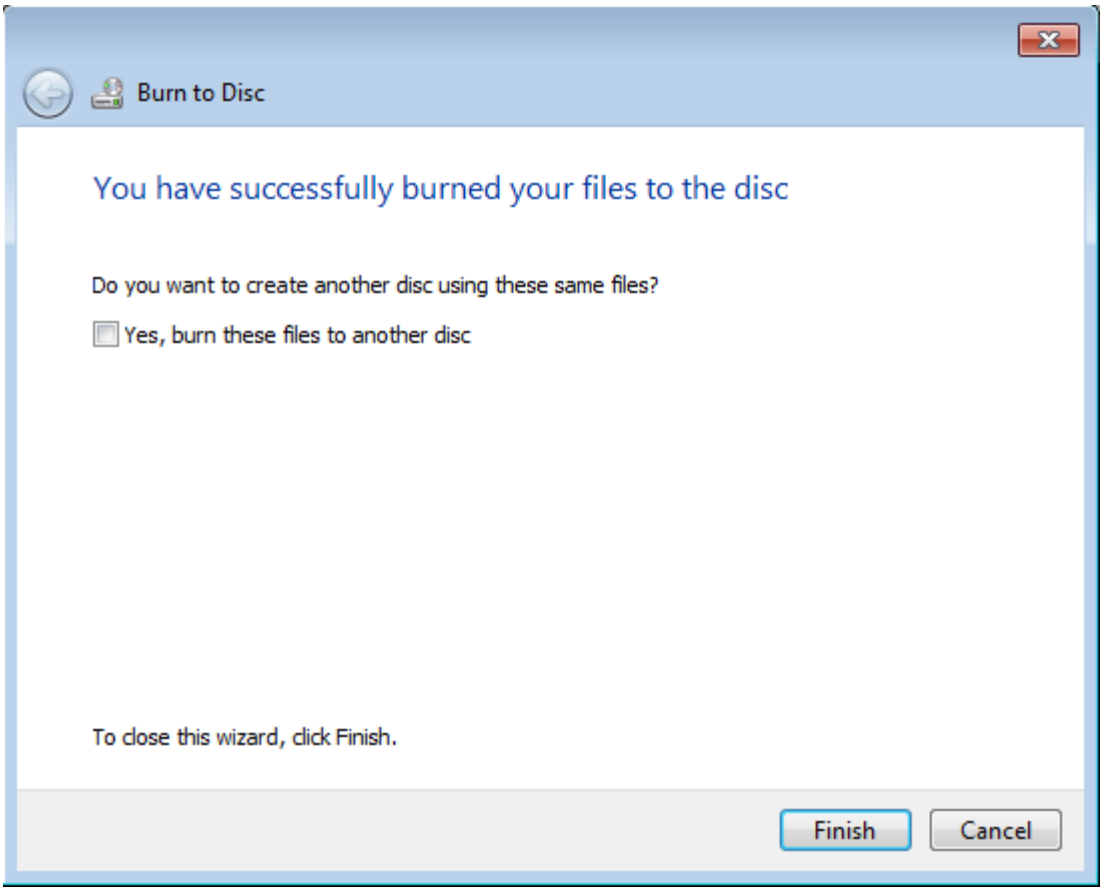
2. Start the Sierra Wave program.
3. From the **File menu**, select **Archiving**.
4. Select the patient files you want to archive in the **Local Patient Files** area (at the top).
5. Click the **Archive** button.
6. A dialog called “Burn to Disc” will be displayed.



7. Enter a title for the disc.
8. Click the **Next** button.
9. The following error message is displayed.



10. Click the **YES** button. ***The new files have not actually been written to the disc at this point.***
11. After clicking on Yes, the new patient files will now be written to the disc. The disc will automatically eject when the process is complete.
12. Click the **Finish** button.



13. Click the **Done** button to close the Archiving window.

Deleting Patient Files

Typically this would be done after the patient files have been successfully archived.

Option 1: **Use the Archive Utility**

1. **Start** the **Sierra Wave** program.
2. From the **File** menu, select **Archiving**. The **Archive Utility** window will be displayed.
3. **Select** the **patient files** you want to delete from the **Local Patient Files** area.
   - **Select All** - click the Select All button to highlight all of the files listed in the local patient files area.
   - **Select a single file** - point at the file and click the left mouse button.

- **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.

4. Click the **Delete** button.

Option 2: **Delete directly from the Data folder outside the Sierra Wave program.**

1. **Close** the **Sierra Wave** program.
2. **Open** the **Data folder** (here is one possible way of doing this).
   - Double click on **My Computer**.
   - Double click on **Local Drive (C:)**.
   - Double click on the **Cadwell** folder.
   - Double click on the **Sierra Wave** folder.
   - Double click on the appropriate **Data.*username*** folder.
3. **Select the files** to be deleted.
   - **Select a single file** - point at the file and click the left mouse button.
   - **Select multiple files** - hold down the **Control** key on the PC's keyboard while you click on the files.
4. **Right click** the mouse **over one of the selected files** and select **Delete** from the pop-up menu.

Calibration Signal

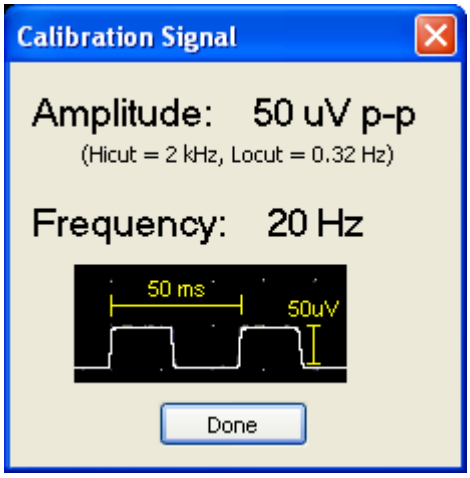
In all test protocols an internal calibration signal can be displayed, recorded, and printed. The calibration signal is a **50 uV, 20 Hz square wave**.

 In order to use the calibration signal a minor modification has to be made to the Sierra Wave Amplifier. Please contact the Application Support or Service Department to verify that your amplifier has the modification and to enable the calibration feature. If your amplifier doesn't have the necessary modification, arrangements can be made to have this modification performed.

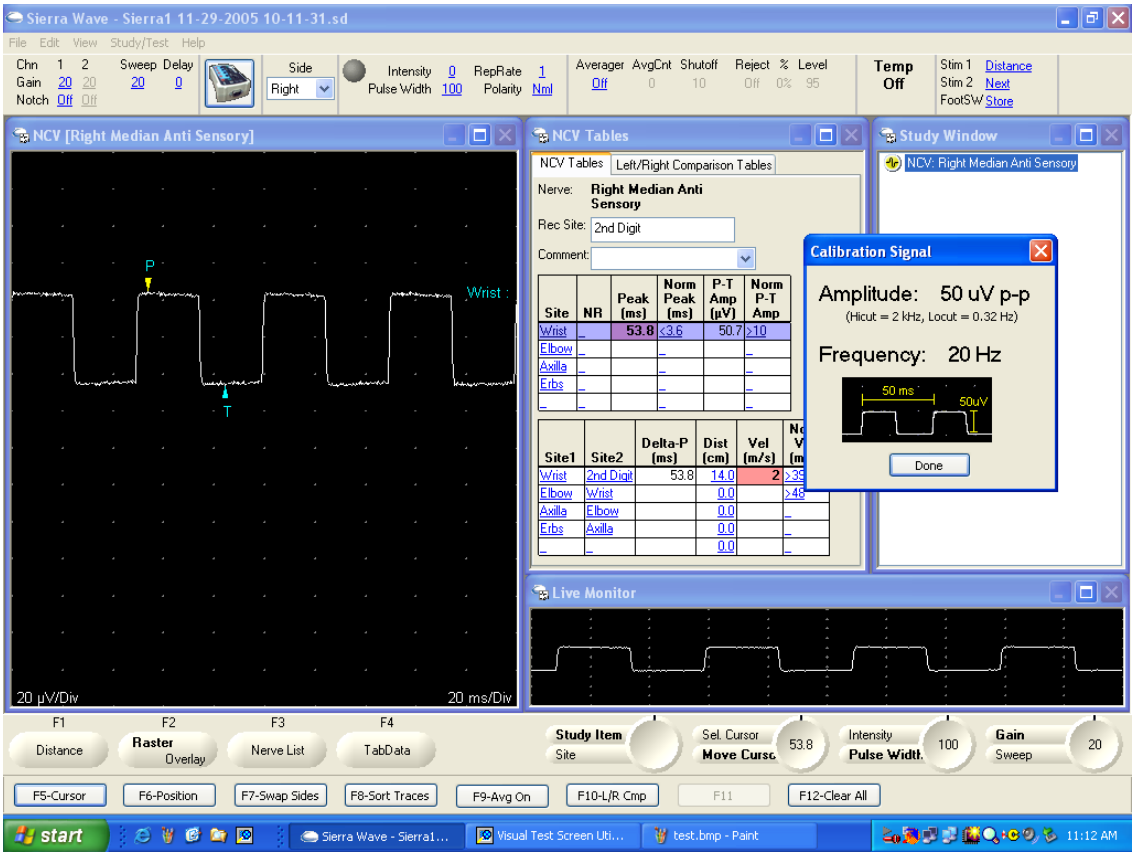
If the Calibration Signal is enabled without the necessary amplifier modification the peak-to-peak voltage of the calibration signal will not be accurate and will fluctuate between 45 and 50 uV.

To view the Calibration Signal:

1. Start the Sierra Wave program.
2. Select a test protocol from the Study/Test menu. A **sensory nerve conduction** test protocol works well for recording and measuring the calibration signal.
3. From the **View** menu, select **Calibration Signal**.
4. The **Calibration Signal** window will be displayed.



5. To **optimize the signal for measurement purposes**, do the following:
   - **Disconnect all electrodes** from the amplifier.
   - Set the **Gain to 20 uV** per division.
   - Set the **Sweep Speed to 20 ms** per division.
   - Set the **Hicut filter to 2 kHz**.
   - Set the **Locut filter to 0.32 Hz**.
6. Press the **Single** button on the Sierra Wave base unit to record the calibration signal. The amplitude of the square wave should be 50 uV *(+/-* 1.0 uV) peak-to-peak. The interval from the onset of one square wave to the next should be 50 ms, which is equivalent to 20 Hz.



Calibration Signal displayed in the sensory NCV test protocol.

7. Print the results by selecting **Print Screen** from the **File** menu.
8. Turn off the calibration signal by clicking the **Done** button in the Calibration Signal window.

The **Time & Amplitude Markers** can be used to measure the calibration signal. Right click on the trace area to enable them.

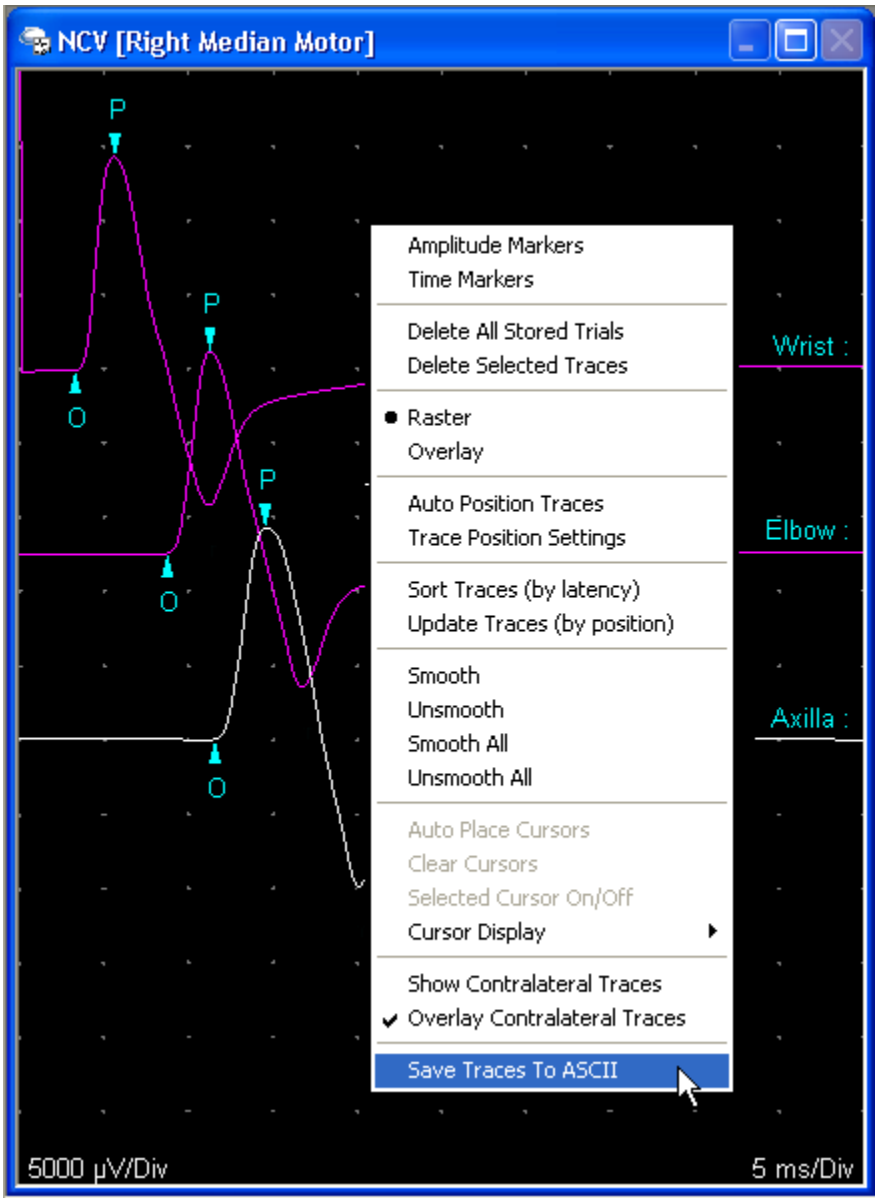
The Calibration Signal can be enabled in all test protocols.

Ascii Output

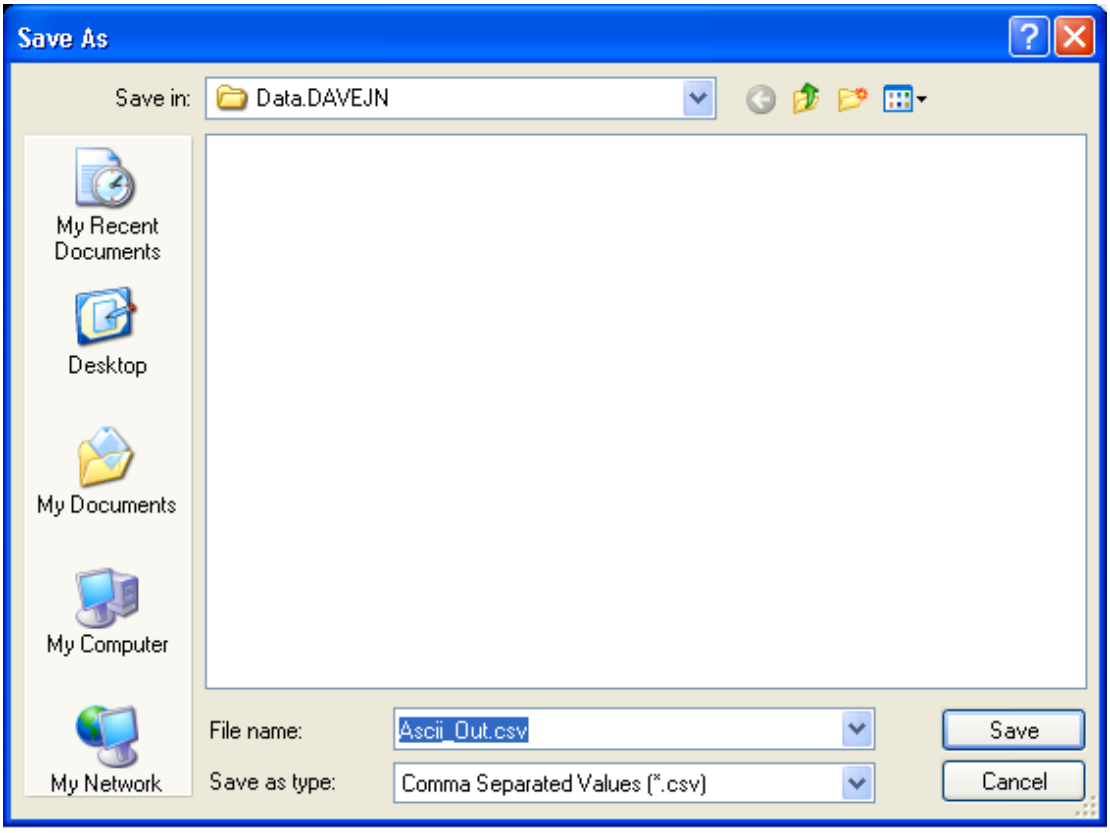
In all test protocols, the trace data can be output to an ASCII file by selecting “Save Traces to ASCII” from the right-click menu of the Trace window. The program allows you to specify the location where the ASCII file will be saved. The ASCII file is saved as a ‘comma separated values’ file; this means it can be opened easily with a spreadsheet or analysis program.

To perform Ascii output of the trace data:

1. **Right click** over the **Trace** window.
2. Select the option **Save Traces to ASCII** from the pop-up menu.



3. A standard **Save As** window will be displayed. If necessary, you can change the **Save In** location and the **Filename**.



4. Click the **Save** button.

Formatting of the Ascii Output File

The following example shows the Ascii file opened using Microsoft Excel.

	A	B	C	D	E	F	G
1	Test Name	NCV					
2	Test Item	Right Median Motor					
3	Patient Name	Data Demo					
4	Patient ID						
5	Test Date	9/11/2003					
6	Trace Label	Wrist :		Elbow :		Axilla :	
7	Sensitivity (µV/Div)	5000		5000		5000	
8	Hicut	10000		10000		10000	
9	Locut	10		10		10	
10	ms/Sample	0.1563		0.1563		0.1563	
11	Samples	640		640		640	
12	Trace Data (µV)	-24999.23706		58.74634		-41.1987	
13		244.9035645		-34.3323		-107.574	
14		296.0205078		-28.9917		-19.0735	
15		220.489502		-39.6729		-41.1987	
16		196.0754395		-36.6211		-42.7246	
17		178.527832		-33.5693		-42.7246	
18		166.3208008		-35.8582		-38.9099	
19		170.135498		-37.384		-41.1987	
20		162.5061035		-34.3323		-44.2505	
21		160.2172852		-31.2805		-39.6729	
22		154.876709		-38.9099		-36.6211	
23		145.7214355		-39.6729		-38.147	
24		141.1437988		-35.8582		-30.5176	
25		144.9584961		-40.4358		-43.4875	
26		140.3808594		-35.8582		-39.6729	

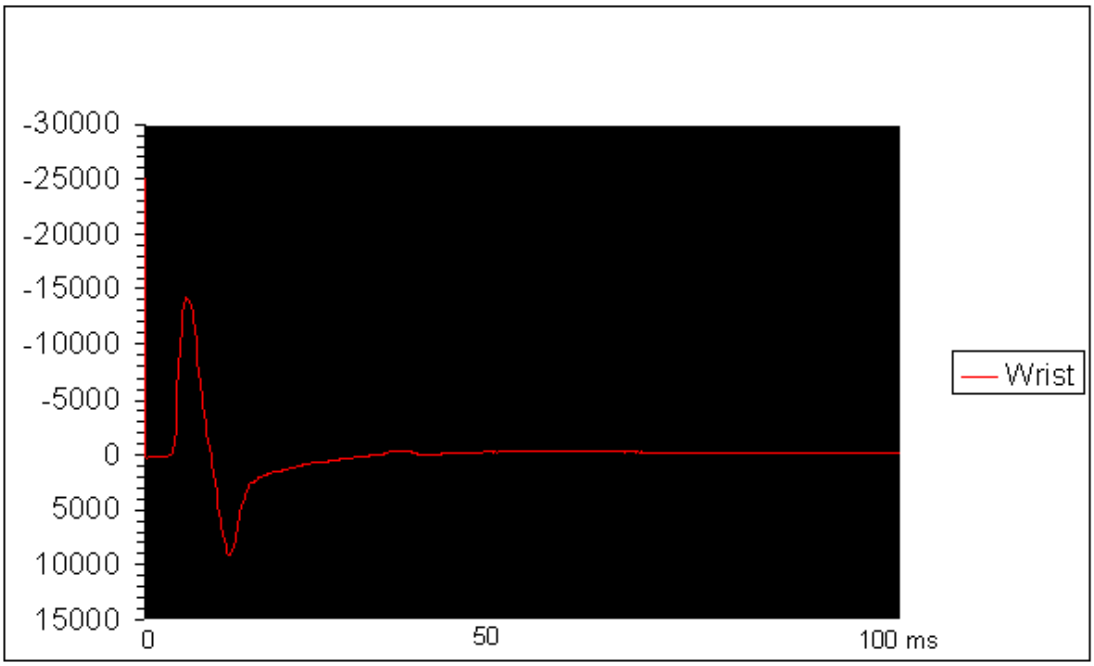
- **Test Name** - shows the name of the test protocol.
- **Test Item** - shows the name of the nerve or muscle being tested.
- **Patient Name** - shows the name of the patient.
- **Patient ID** - shows the patient's ID number.
- **Test Date** - shows the test date.
- **Trace Label** - shows the label, if any, for each trace that was present in the Trace window.
- **Sensitivity** - shows the sensitivity of each trace in microvolts per division (uV/Div).
- **Hicut** - shows the hicut filter setting for each trace in hertz (Hz).
- **Locut** - shows the locut filter setting for each trace in hertz (Hz).
- **ms/Sample** - shows the horizontal time resolution of each data point. All tests, except EMG, have 640 data points for each trace. The EMG protocol has variable data points depending on the sweep speed of the EMG test.

- **Samples** - shows the number of data points for the trace.
- **Trace Data (uV)** - shows a column of data points for each trace. The data is scaled in microvolts (uV). Negative values reflect upward deviations from the baseline, positive numbers reflect downward deflections from the baseline.

If you graph the data points in a spreadsheet, in order to get the correct polarity you will need to invert the Y-axis so that negative values are above the baseline (or zero point), and positive values are below the baseline.

Example of Ascii Data converted to a graph using Microsoft Excel

The following picture is an example of a Median Motor (Wrist trace) graphed in Microsoft Excel.



EMG to AVI Converter

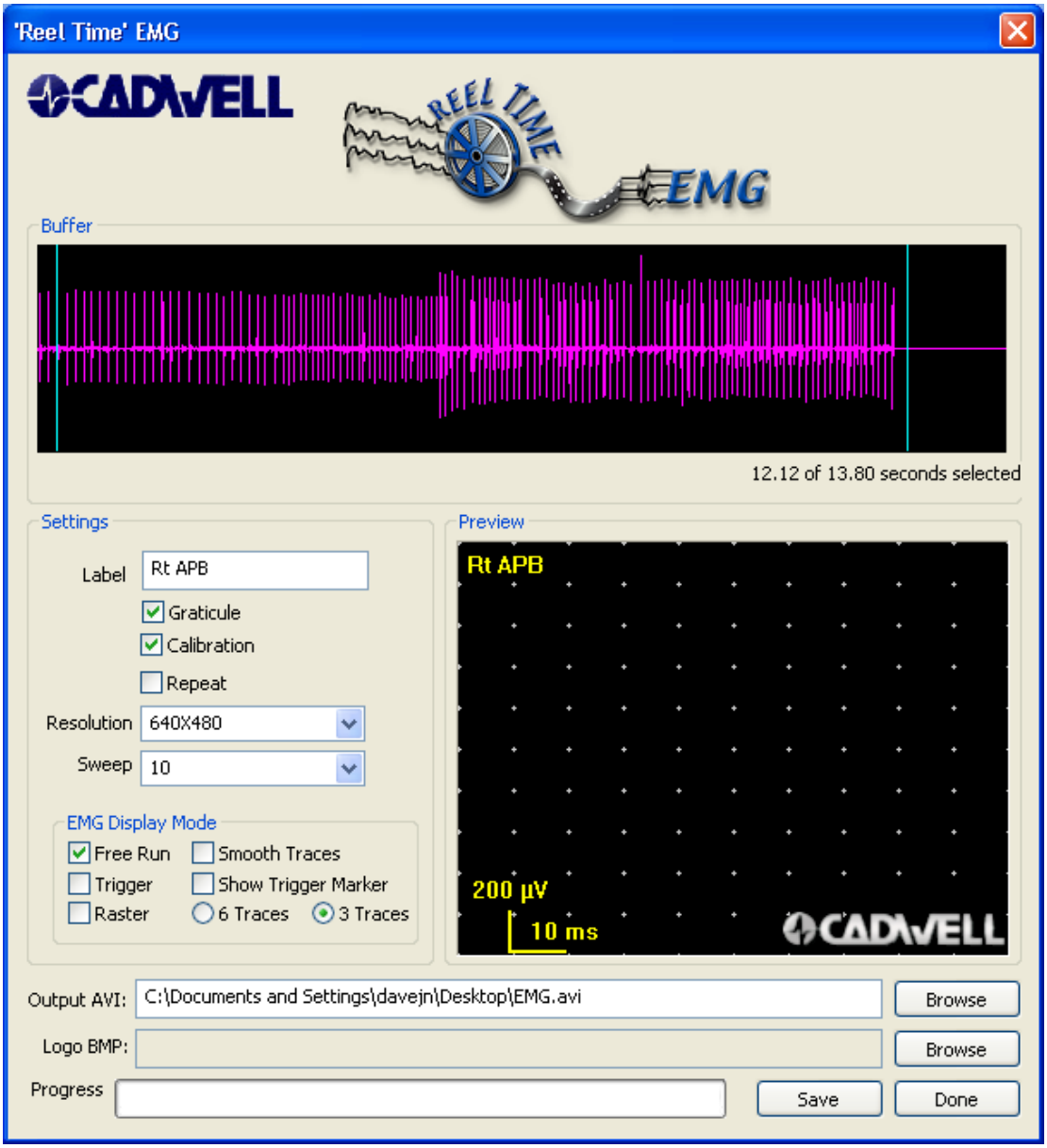
This utility allows an EMG buffer to be converted to an AVI file.

An AVI file is a sound and motion picture file that conforms to the Microsoft Windows Resource Interchange File Format (RIFF) specification. AVI files (which end with an 'avi' extension) can be played using the Windows Media Player or Apple Quick Time Player.

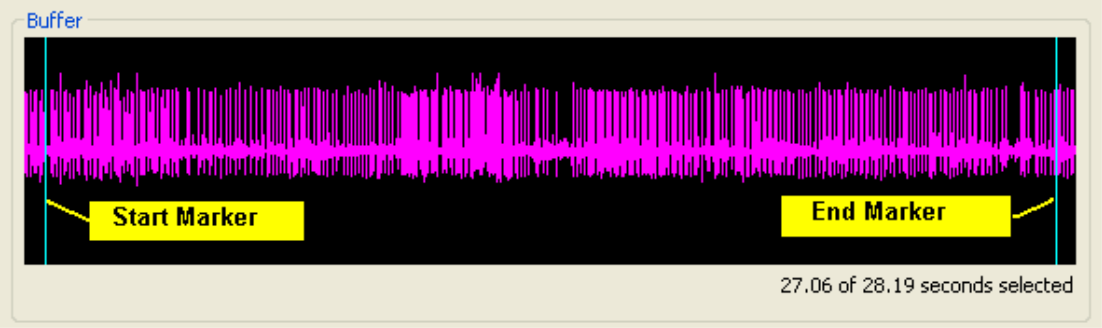
Some of the potential uses for the EMG to AVI Converter Utility are; **1)** you can send an EMG recording to someone who doesn't have Sierra Wave software and they can view and hear the recording, **2)** you can include EMG recordings in presentations made with Microsoft PowerPoint, and **3)** you can build a library of EMG examples for use as teaching cases.

To Create an AVI file:

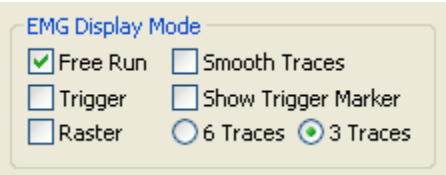
1. Record a new buffer of EMG or select a previously stored EMG Buffer from the Study window.
2. **Right-click** over the Trace window and select **Convert EMG to AVI** from the pop-up menu.
3. The 'Reel Time' EMG window is displayed.



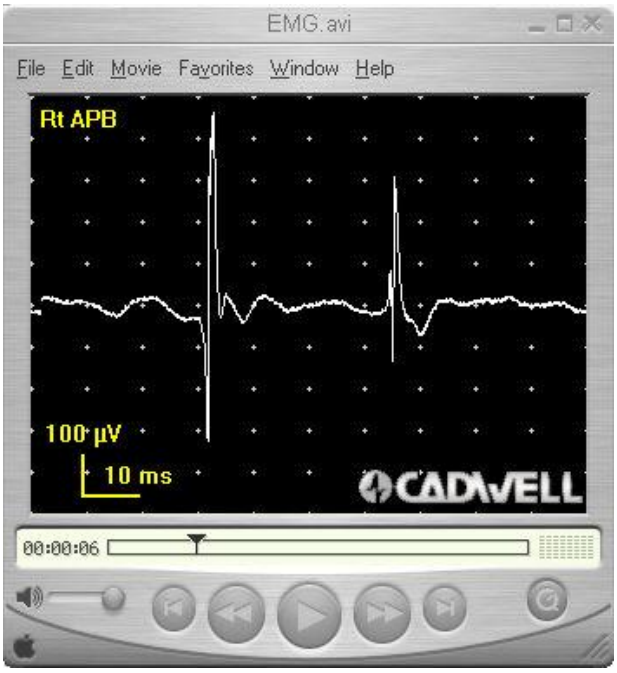
4. Select the amount of the buffer to be converted by positioning the start and end markers.



5. Enter a **Label** (optional). The label will appear above the EMG trace when the AVI file is played.
6. Select **Graticule**, **Calibration**, and **Repeat** options.
   - Graticule Check this box to display the graticule dots during playback.
   - Calibration Check this box to display the horizontal & vertical calibration scale.
   - Repeat Check this box if you want the AVI to repeat the selected buffer with a 5 second delay in between.
7. Select the desired **Resolution** of the AVI file. Choices are 320x240, 640x480, 800x600, 1024x768, 1280x1024, and 1600x1200.
8. Select the **Sweep Speed** for the AVI file. The sweep speed can be set slower or faster than the original EMG Buffer.
9. Select the appropriate **EMG Display Mode** options.

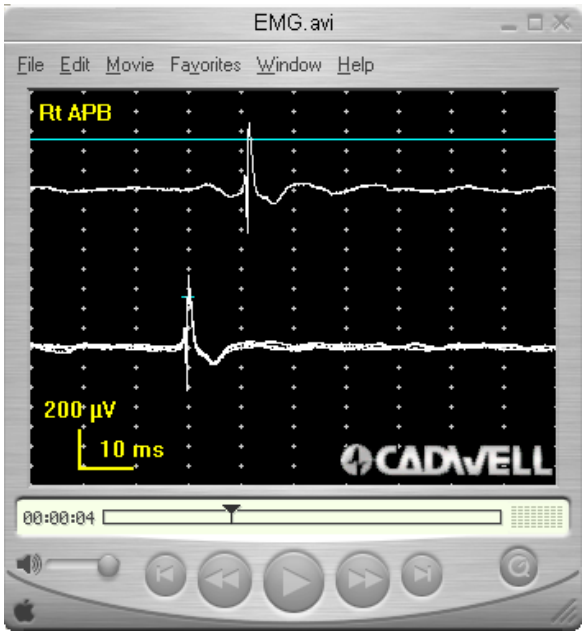


   - **Free Run** - during playback the AVI will show a free-run EMG trace.



Free-run EMG playback.

- **Trigger** - during playback the AVI will show a triggered EMG trace. When this option is selected a trigger line is displayed in the buffer area, this trigger line can be moved up/down to set the appropriate trigger level.



Triggered EMG playback (trigger marker enabled, raster is disabled).

  - **Show Trigger Marker** - causes a trigger level marker to be displayed during AVI playback (see above picture).

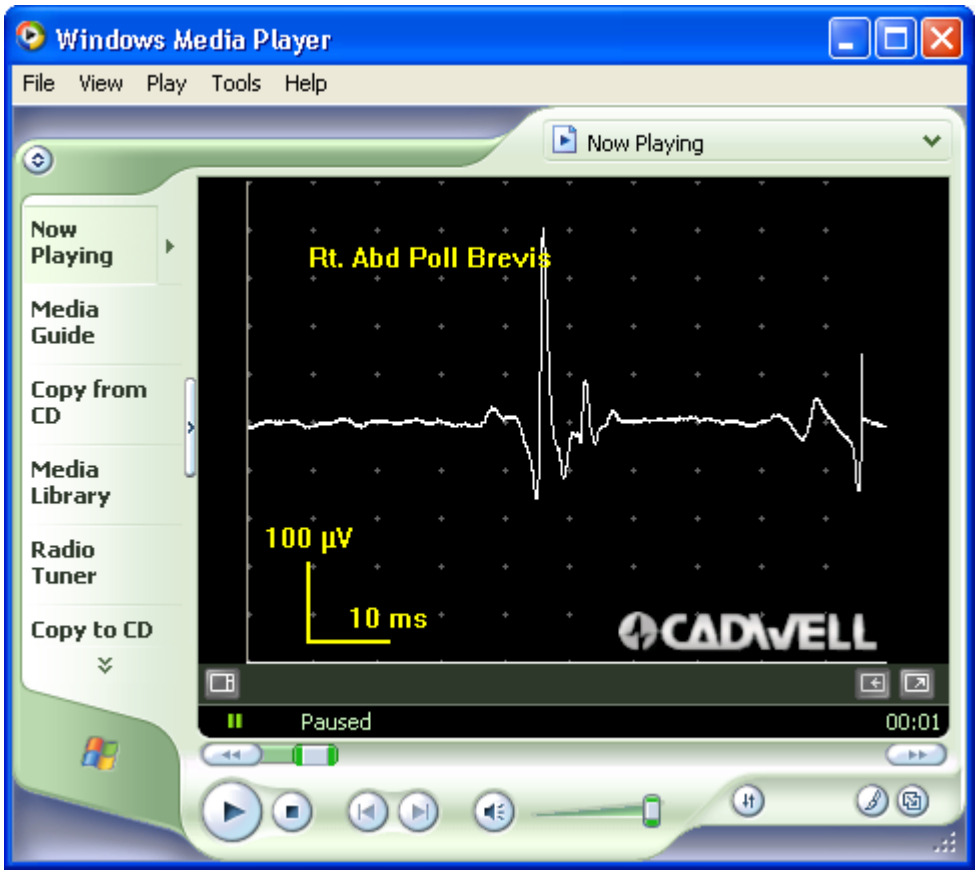
- **Raster** - the AVI will show rastered EMG traces when this box is checked. Choose to raster 3 or 6 traces.
- **Smooth Traces** - for large resolution outputs, this setting helps to smooth the appearance of the traces.

10. Verify that the **Output path** and filename are correct. The program defaults to the user's data folder. Use the **Browse** button to change the file storage location. The default AVI filename is 'EMG.avi'.
11. Select an **optional Logo or Signature**, this must be a bitmap (.bmp) file. This will appear at the bottom-center of the AVI when it is played back. This option is only available when the output resolution is 640 x 480 or higher.
12. Click the **Save** button. A green progress bar indicates the progress of the conversion and an animation occurs in the EMG area.
    - It takes about 15 seconds to convert a 30 second EMG Buffer to AVI.
    - A 30 second (320x240) buffer is about 14 Mb in size.

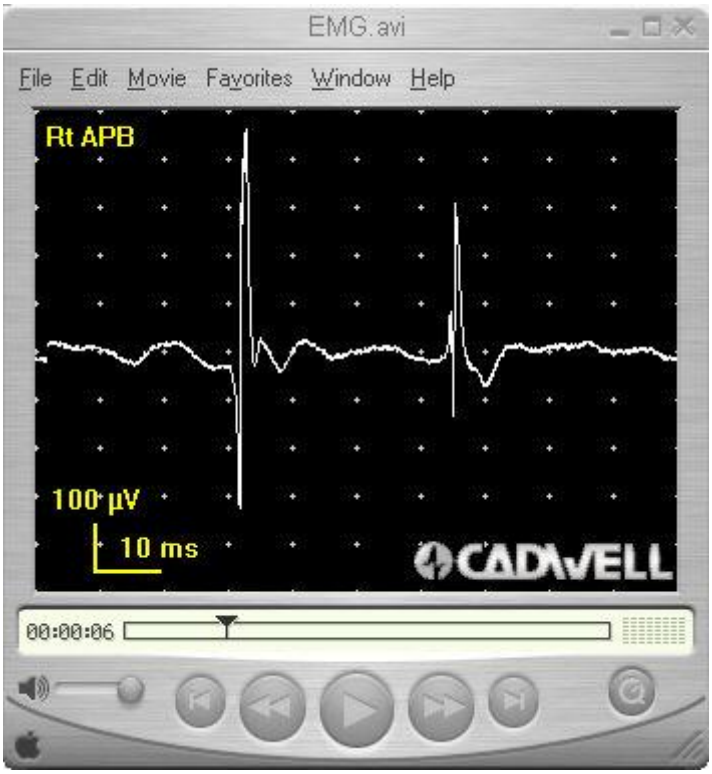
12. Click the **Done** button when finished.

To Play an AVI file:

Use Windows Explorer to go to the folder where the AVI file is stored. Double click on the AVI file. It should open in your default media player and the file should start playing automatically.



Windows Media Player



Quick Time Player

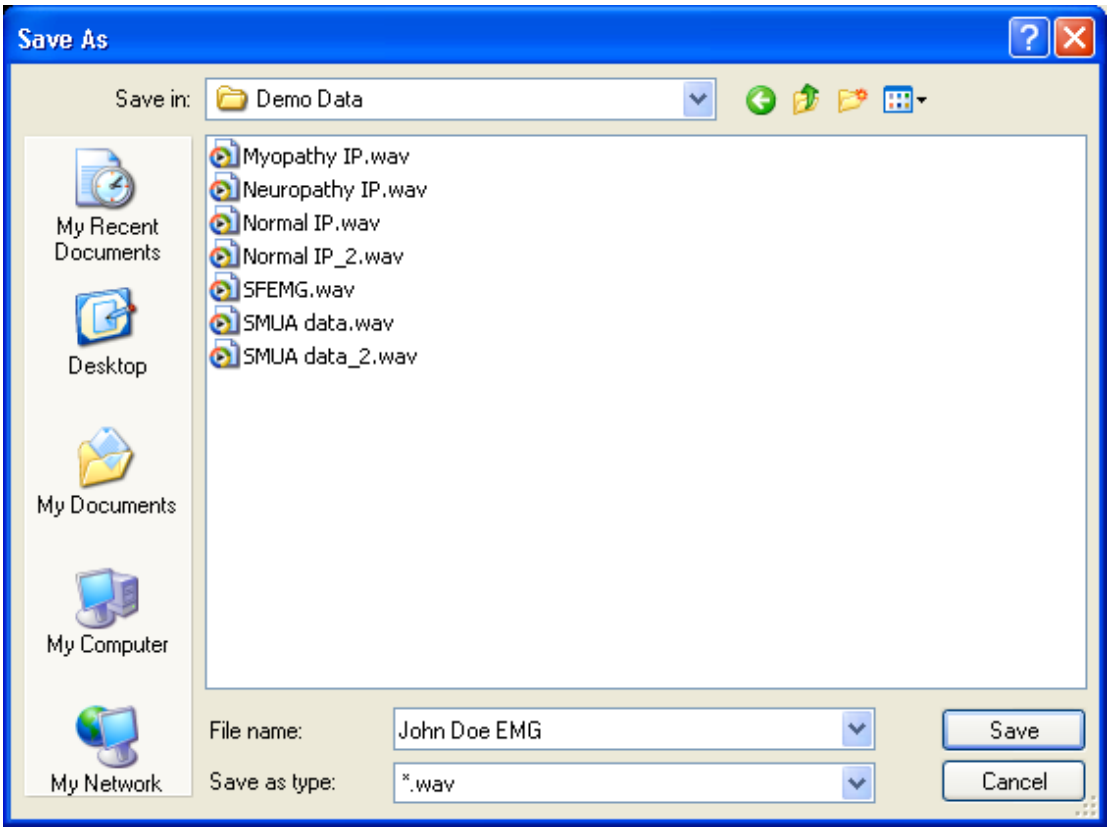
EMG to WAV Converter

This utility allows an EMG buffer to be converted to a type of audio file called a WAV.

A Wave file is an audio file format, created by Microsoft, that has become a standard PC audio file format for everything from system and game sounds to CD-quality audio. A Wave file is identified by a file name extension of WAV (.wav). Used primarily in PCs, the Wave file format has been accepted as a viable interchange medium for other computer platforms, such as Macintosh. This allows content developers to freely move audio files between platforms for processing, for example.

To Create an WAV file:

1. Record a new buffer of EMG or select a previously stored EMG Buffer from the Study window.
2. **Right-click** over the Trace window and select **Save Live Buffer To File** from the pop-up menu.
3. A standard **Save As** window will be displayed with the file type set to ***.wav**.



4. Enter a **File Name** for the audio file.
5. If necessary, change the **Save In location** to the folder where you would like the audio file to be placed.
6. Click the **Save** button.

To Play a WAV file:

Use Windows Explorer to go to the folder where the WAV file is stored. Double click on the WAV file. It should open in your default media player, which in most cases is Windows Media Player. The file should start playing automatically.

Reader Station Configuration

On systems that are only used for data review, you can disable the "communication error" message that is displayed when launching the Sierra Wave program.

To disable the communication error message:

1. Open **My Computer**.

2. Go to the **C:\Cadwell\Sierra Wave** folder.

3. Locate the file **"ReaderStationOn.reg"** and double-click on it.

4. Answer **Yes** and **OK** to the displayed messages.

HL7 Interface

The Cadwell HL7 interface can be used with the Sierra Wave EMG/EP instrument. The interface allows the Sierra Wave program to be launched using the patient information (i.e., demographics) provided by an order message from the hospital/office EMR system. The interface also supports the sending of results messages back to the hospital/office EMR at the conclusion of testing; this 'results' message tells the EMR where the patient's report document (.doc, .rtf, or .pdf) is located on the network. The hospital/office EMR is responsible to obtain the report document and to incorporate or link it into the patient's electronic medical record (by whatever means are supported by the EMR software).

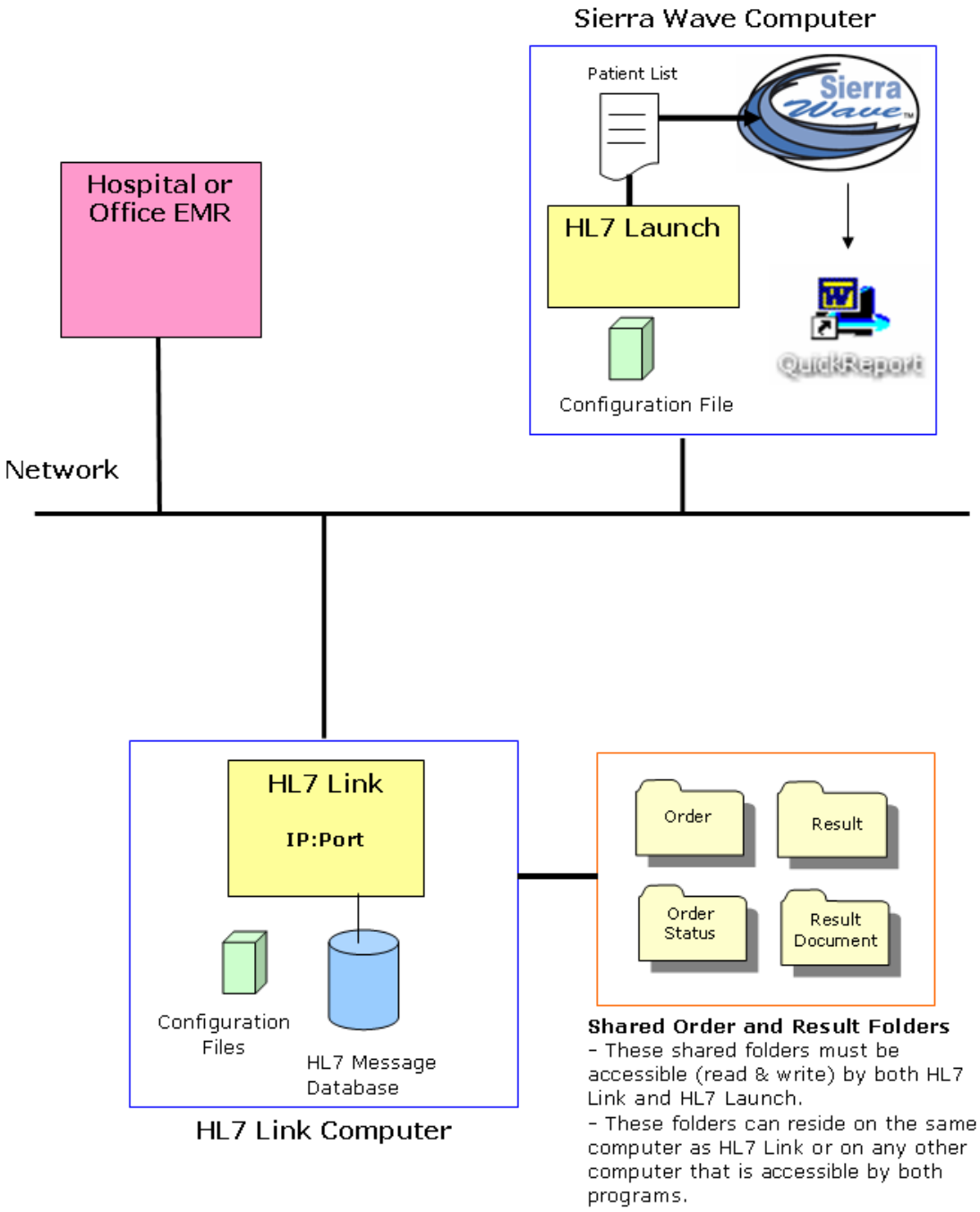
The Cadwell HL7 interface is comprised of the following two components:

- **HL7 Link** - this is a data exchange module that can be run on the hospital server or on any Windows XP computer that is always 'on-line' with the hospital/office network. HL7 order messages (ORM^O01) from the hospital/office EMR are routed to this program's IP/Port address for queuing of service requests. This program also manages the sending of results messages (ORU^R01) back to the hospital/office EMR.
- **HL7 Launch** - this is a program that resides on the desktop of the Cadwell Sierra Wave computer. When launched it picks up service requests from the HL7 Link module and displays a list of patients for selection. On selection, the Sierra Wave program is launched and the patient information window is automatically populated with the pertinent patient demographics. At the completion of testing a report is generated and saved, this triggers a results message to be generated and queued; this results message is then picked up by the HL7 Link module and sent to the hospital/office EMR.

HL7 Link and HL7 Launch use a common set of shared network folders for queuing of order and results messages.

Setup information is used by both HL7 Link and HL7 Launch to configure IP addresses and Port numbers, to specify HL7 field usage, and to specify preferred operating modes. Editing this setup information allows for customization at different installation sites.

Shown below is a conceptual diagram of the interface:



Please contact Cadwell Laboratories for more information on the HL7 Interface Module.

Data Interface Toolkit

Sierra Wave now supports **real-time data output to third-party applications**. A data interface toolkit is available for researchers interested in this capability. The data interface toolkit consists of C# (C-sharp) code and an example client program that demonstrates the functions and methods supported by the interface. Trace data, instrument status, patient demographics, and minimal control functions are supported by the interface.

The first application to utilize this new interface is a program called **DQEMG**.

What is DQEMG?

Decomposition based **Q**uantitative **E**lectro**M**yo**G**raphy (DQEMG) is a program designed to provide quantitative information on motor-unit potential (MUP) train analysis.

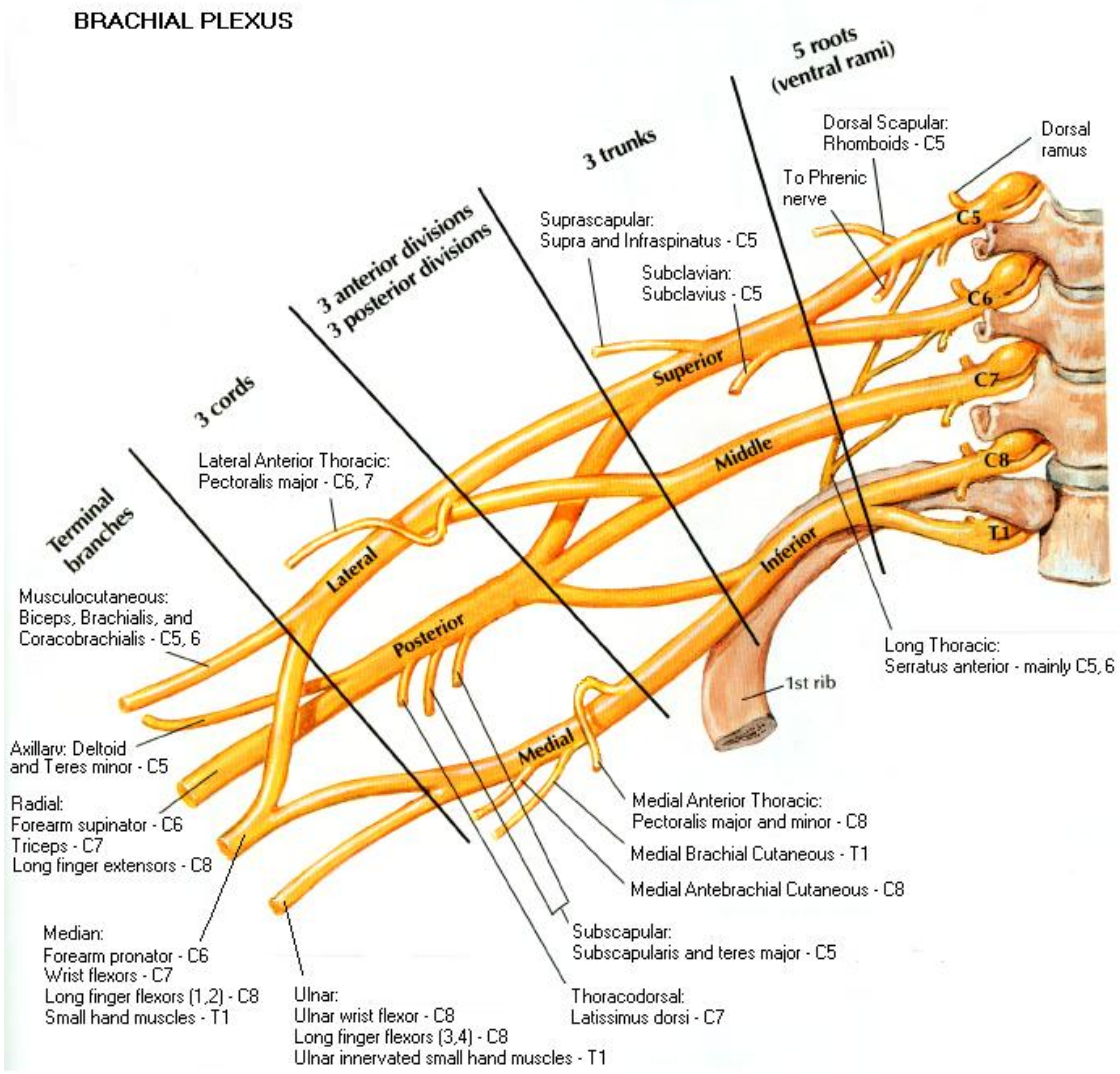
This program has been developed by Dr. Daniel W. Stashuk over a period of several years, including recent versions with collaboration with Dr. Andrew Hamilton-Wright.

The program and acquisition support software is available at the following website; http://www.qemg.org/Sierra

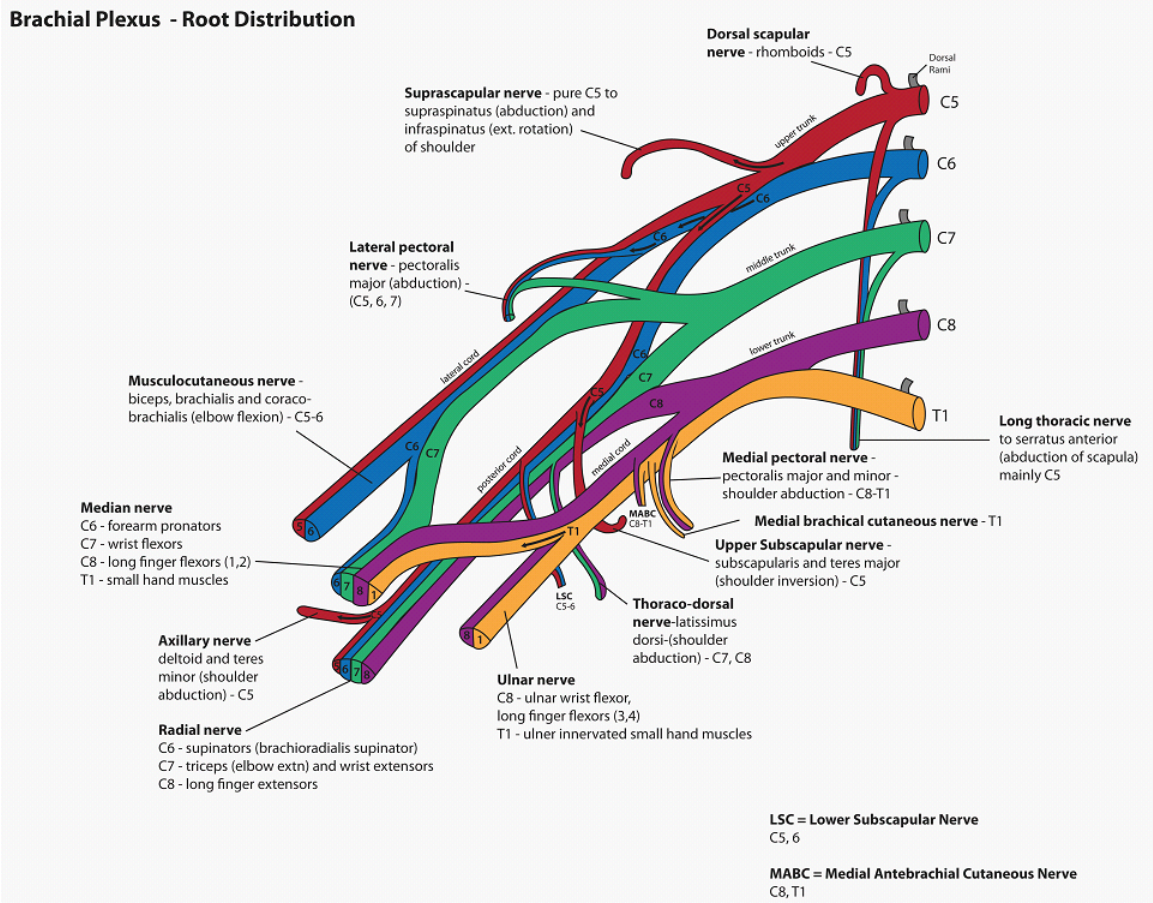
 For additional information on the **Data Interface Toolkit**, please contact the **Application Support Department**.

Reference Guides

Brachial Plexus



Brachial Plexus Root Distribution



Brachial Plexus Studies

Brachial Plexus Protocol

General Approach when Diffuse Plexus Involvement Suspected

	Common Studies	Additional Considerations
Motor Nerve Studies	Median (APB) Ulnar (ADM) Radial (EDC) Musculocutaneous (Biceps) Spinal Accessory (Trapezius)	Perform conduction studies in all nerves that have a clinical deficit (any weakness or sensory loss).
Sensory Nerve Studies	Median (2nd Digit) Ulnar (5th Digit) Radial (Thumb) Lateral Antebrachial Cutaneous	Consider performing sensory and/or motor studies on opposite side for comparison if the findings are borderline.
Needle EMG Studies	Cervical Paraspinal (two levels) Biceps (MC, C5-6, both heads) Triceps (R, C5-6, both lateral and medial heads) First Dorsal Interosseous (U, C8-T1)	If weakness in **Upper Trunk**, test additional C5-6 muscles: Rhomboid (DSc) Infraspinatus (SScap) Deltoid (Ax) Brachioradialis (R) If weakness in **Middle Trunk**, test additional C7 muscles: Pronator Teres (M) Extensor Carpi Radialis (R) Extensor Dig Communis (R) If there is weakness in **Lower Trunk**, test additional C8 muscles: Extensor Carpi Ulnaris (R) Extensor Indicis Proprius (R) Flexor Pollicis Longus (M) Flexor Carpi Ulnaris (U) Flexor Pollicis Longus (M)

MC = musculocutaneous n., R = radial n., M = median n., U = ulnar n., DSc = dorsal scapular n., SScap – suprascapular n., Ax = axillary n.

Segments of the Brachial Plexus tested by specific nerve conduction studies

	Upper Trunk (C5-6)	Middle Trunk (C6-7-8)	Lower Trunk (C8-T1)
	Suprascapular (Supraspinatus)		
Lateral Cord	Lateral Antebrachial Cutaneous Median sensory to Thumb Median sensory to 2nd Digit Musculocutaneous motor (Biceps)	Median sensory to 2nd Digit Median sensory to 3rd Digit	
Posterior Cord	Radial sensory Axillary motor (Deltoid)	Radial sensory Radial motor (EDC)	
Medial Cord			Ulnar sensory to 5th Digit Dorsal Ulnar Cutaneous Medial Antebrachial Cutaneous Median motor (APB) Ulnar motor (ADM, FDI)

Brachial Plexus Muscle Innervation

	Upper Trunk (C5-6)	Middle Trunk (C6-7-8)	Lower Trunk (C8-T1)
	Supraspinatus (SScap) Infraspinatus (SScap)		
Lateral Cord	Biceps (MC) Brachialis (MC) Coracobrachialis (MC)	Pronator Teres (M) Flexor Carpi Radialis (M)	
Posterior Cord	Brachioradialis (R) Supinator (R) Deltoid (Ax) Teres Minor (Ax) Triceps (R)	Triceps (R) Anconenus (R) Extensor Carpi Radialis (R) Extensor Dig Communis (R) Extensor Carpi Ulnaris (R)	Extensor Indicis Proprius (R) Extensor Carpi Ulnaris (R)
Medial Cord			Abductor Pollicis Brevis (M) First Dorsal Interosseous (U) Abductor Digiti Minimi (U) Flexor Carpi Ulnaris (U) Flexor Digitorum Profundus (U) Flexor Pollicis Longus (M)

SScap= Suprascapular nerve
MC = Musculocutaneous nerve
Ax = Axillary nerve
R = Radial nerve
M = Median nerve
U = Ulnar nerve

<table>
<tr><th colspan="4">Upper Trunk Assessment
(C5-6)</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Median to 2nd Digit
Median to Thumb
Radial to Dorsum & Thumb
Lateral Antebrachial Cutaneous</td><td>Ulnar to 5th Digit</td><td rowspan="3">Supraspinatus
Infraspinatus
Deltoid
Teres Minor
Biceps
Brachioradialis
Brachialis
Supinator
Pronator Teres
Extensor Carpi Radialis
Flexor Carpi Radialis</td><td rowspan="3">Rhomboid Major
Serratus Anterior
Triceps
First Dorsal Interosseous
Upper Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Axillary (Deltoid)
Musculocutaneous (Biceps)
Suprascapular (Infraspinatus)</td><td>Median (APB)
Ulnar (ADM)</td></tr>
<tr><td colspan="4">Clinical Presentation:
Weakness in nearly all C5-6 innervated muscles; most affected are Supraspinatus, Infraspinatus, Deltoid, and Brachioradialis.

Sensory loss in lateral arm, lateral forearm, lateral hand and thumb.

Reflexes: Biceps and Brachioradialis are depressed or absent. Triceps reflex is normal.</td></tr>
</table>

<table>
<tr><th colspan="4">Middle Trunk Assessment
(C7)</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Median to 2nd Digit
Median to 3rd Digit
Radial to Thumb</td><td>Median to Thumb
Ulnar to 5th Digit</td><td rowspan="3">Pronator Teres
Flexor Carpi Radialis
Triceps
Anconeus
Extensor Digitorum Com</td><td rowspan="3">Deltoid
Biceps
Brachioradialis
First Doral Interosseous
Mid Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Radial (EIP or EDC)</td><td>Median (APB)
Ulnar (ADM)</td></tr>
<tr><td colspan="4">Clinical Presentation:
Middle Trunk injuries are very rare, they mimic C7 radiculopathy.

Weakness is seen primarily in the Pronator Teres, Flexor Carpi Radialis, and Triceps.

Sensory loss in middle finger and posterior forearm.

Reflexes: Only Triceps is abnormal.</td></tr>
</table>

<table>
<tr><th colspan="4">Lower Trunk Assessment
(C8, T1)</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Ulnar to 5th Digit
Medial Antebrachial Cutaneous
Dorsal Ulnar Cutaneous</td><td>Median to 2nd Digit
Radial to Thumb</td><td rowspan="3">Abductor Digiti Minimi
First Dorsal Interrosseous
APB
Flexor Pollicis Longus
Extensor Indicis Proprius
Flexor Carpi Ulnaris
Flexor Digitorum Profundus

*Basically all Ulnar innervated muscles, and C8-T1 Median innervated muscles (APB, FPL, PQ), and C8 Radial innervated muscles (EIP, EPB)</td><td rowspan="3">Deltoid
Biceps
Brachioradialis
First Doral Interosseous
Mid Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Median (APB)
Ulnar (ADM)</td><td></td></tr>
<tr><td colspan="4">Clinical Presentation:
Middle Trunk injuries are very rare, they mimic C7 radiculopathy.

Weakness is seen primarily in the Pronator Teres, Flexor Carpi Radialis, and Triceps.

Sensory loss in middle finger and posterior forearm.

Reflexes: Only Triceps is abnormal.</td></tr>
</table>

<table>
<tr><th colspan="4">Posterior Cord Assessment
(Radial, Axillary, Thoracodorsal)</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Radial to Thumb</td><td>Median to 2nd Digit
Ulnar to 5th Digit</td><td rowspan="3">Deltoid
Teres Minor
Brachioradialis
Supinator
Triceps
Extensor Carpi Radialis
Extensor Digitorum Com
Extensor Indicis Proprius</td><td rowspan="3">Biceps
Pronator Teres
First Dorsal Interosseous
Mid Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Radial (EIP and EDC)
Axillary (Deltoid)</td><td>Median (APB)
Ulnar (ADM)</td></tr>
<tr><td colspan="4">Clinical Presentation:
Radial palsies (wrist drop and finger drop), weakness of arm extension, weakness of shoulder abduction, and adduction.

Sensory loss involves lateral arm, posterior arm and forearm, and radial innervated dorsal portion of hand.

Reflexes: Triceps and Brachioradialis reflexes are abnormal. Biceps is normal.</td></tr>
</table>

<table>
<tr><th colspan="4">Lateral Cord Assessment
(Musculocutaneous, C6-7 portion of Median)</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Median to Thumb
Median to 2nd Digit
Median to 3rd Digit
Lateral Antebrachial Cutaneous</td><td>Radial to Dorsum
Ulnar to 5th Digit</td><td rowspan="3">Biceps
Brachialis
Pronator Teres
Flexor Carpi Radialis</td><td rowspan="3">Infraspinatus
Supraspinatus
Brachioradialis
Supinator
Deltoid
Teres Minor
Rhomboid Major
Triceps
First Dorsal Interosseous
Upper Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Musculocutaneous (Biceps)</td><td>Median (APB)
Ulnar (ADM)</td></tr>
<tr><td colspan="4">Clinical Presentation:
Weakness of arm pronation and wrist flexion (median nerve - PT, FCR). Weakness of elbow flexion (radial nerve - biceps).

Sensory loss to the lateral forearm, lateral hand, and first 3 fingers.

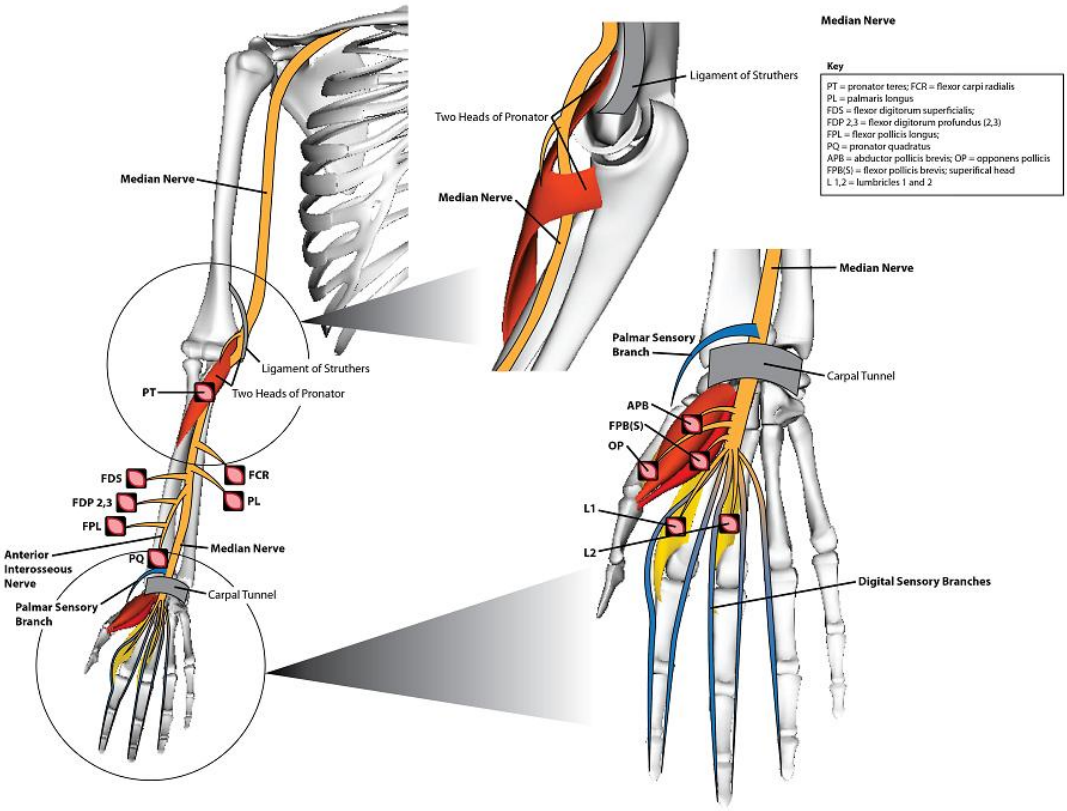
Reflexes: Biceps reflex is abnormal.</td></tr>
</table>

<table>
<tr><th colspan="4">Medial Cord Assessment
(C8-T1 Median, Ulnar)
- Nearly identical to Lower Trunk plexopathy, except for intact C8 Radial fibers</th></tr>
<tr><th colspan="2">Nerve Conduction Studies</th><th colspan="2">Needle EMG</th></tr>
<tr><td>Abnormal Sensory</td><td>Normal Sensory</td><td>Abnormal</td><td>Normal</td></tr>
<tr><td>Ulnar to 5th Digit
Medial Antebrachial Cutaneous</td><td>Radial to Dorsum
Median to 2nd Digit</td><td rowspan="3">First Dorsal Interosseous
Abductor Pollicis Brevis
Flexor Pollicis Longus
Flexor Carpi Ulnaris
Flexor Digitorum Profundus</td><td rowspan="3">Deltoid
Biceps
Pronator Teres
Triceps
Extensor Carpi Ulnaris
Extensor Indicis Proprius
Mid Cervical Paraspinals</td></tr>
<tr><td>Abnormal Motor</td><td>Normal Motor</td></tr>
<tr><td>Median (APB)
Ulnar (ADM)</td><td></td></tr>
<tr><td colspan="4">Clinical Presentation:
Weakness of all ulnar innervated muscles and C8-T1 median innervated muscles (APB, FPL, FDP). The finger extensors (radial) are spared.

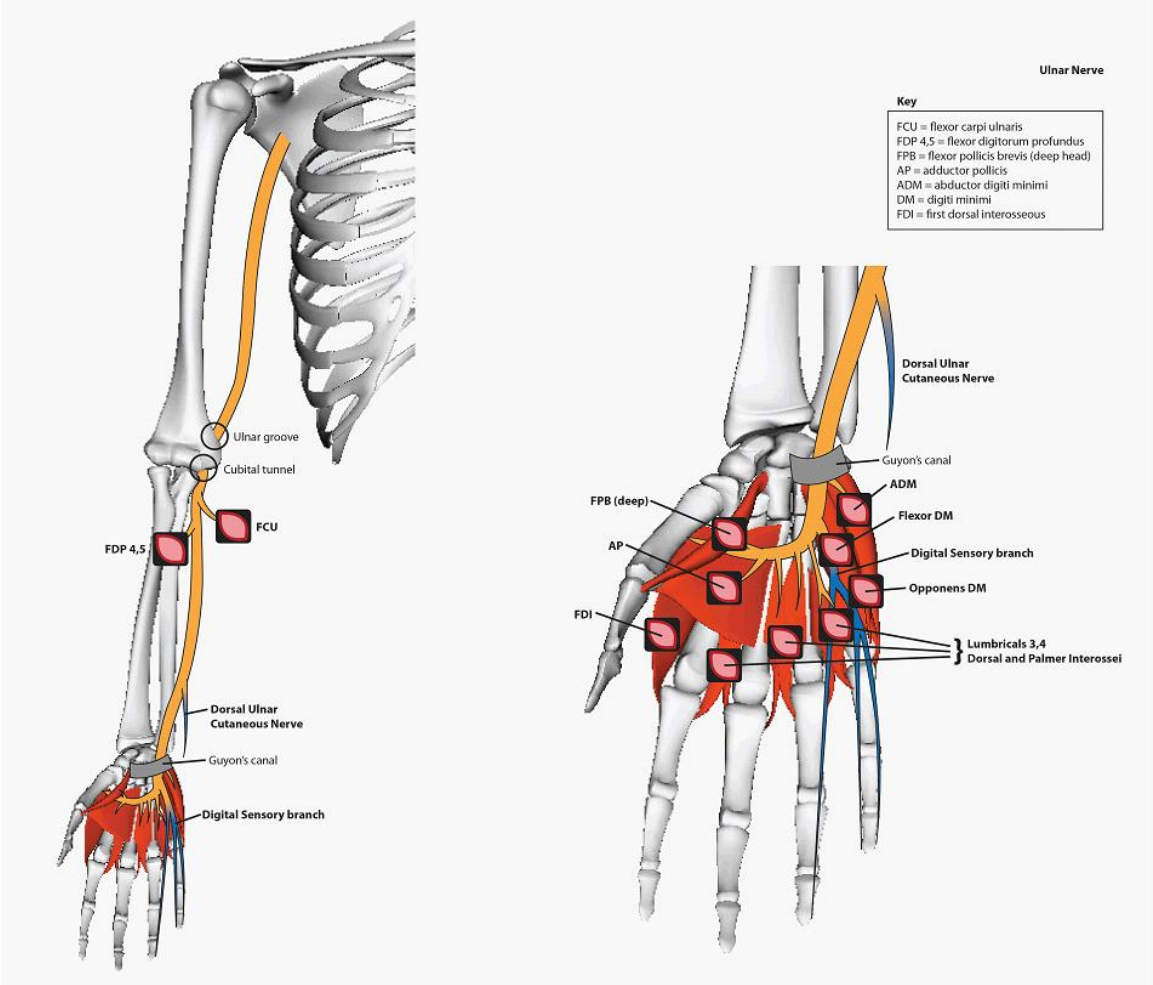
Sensory loss in medial arm, medial forearm, medial hand, and 4th and 5th fingers.

Reflexes: All normal.</td></tr>
</table>

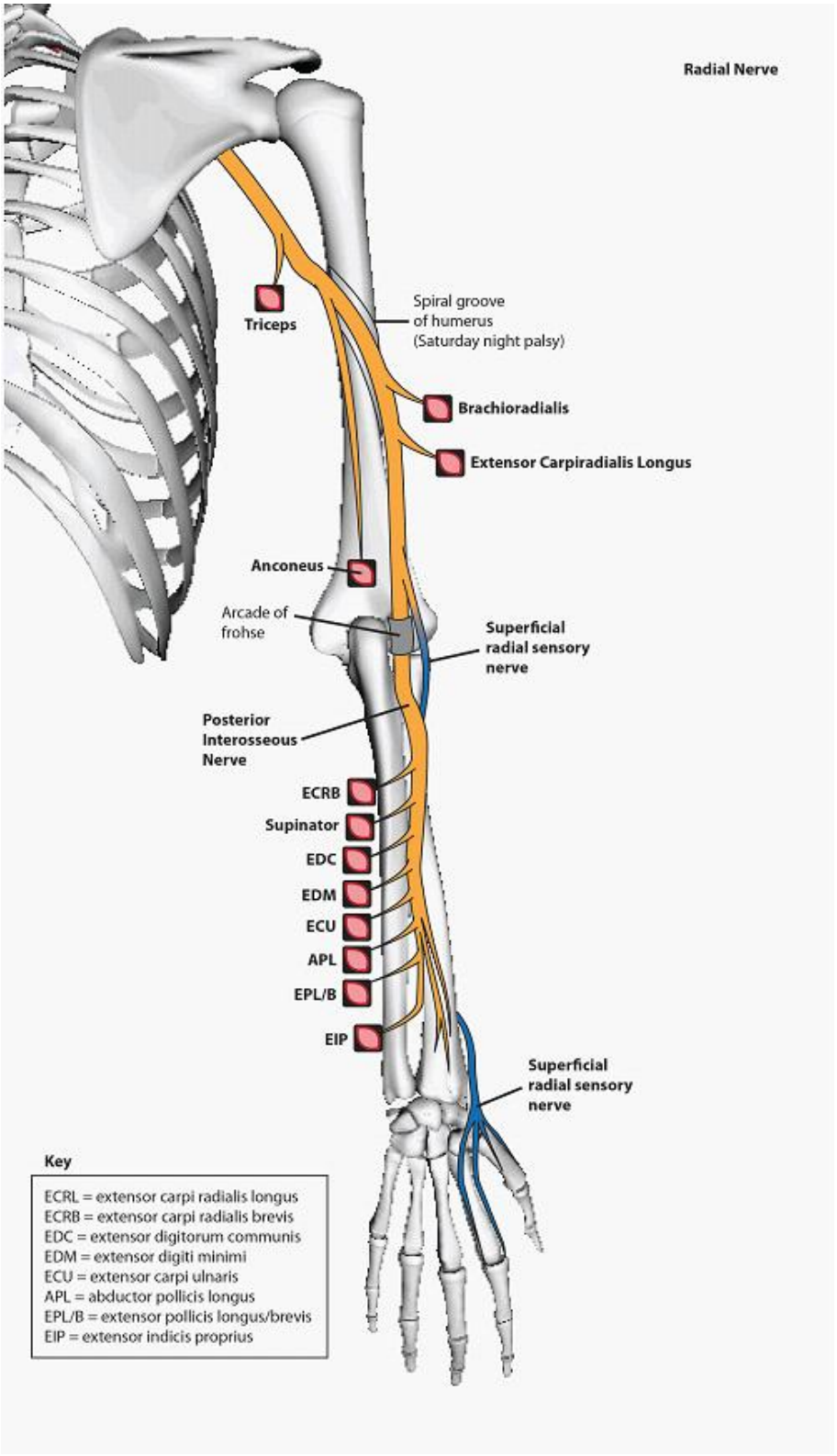
Median Nerve Diagram



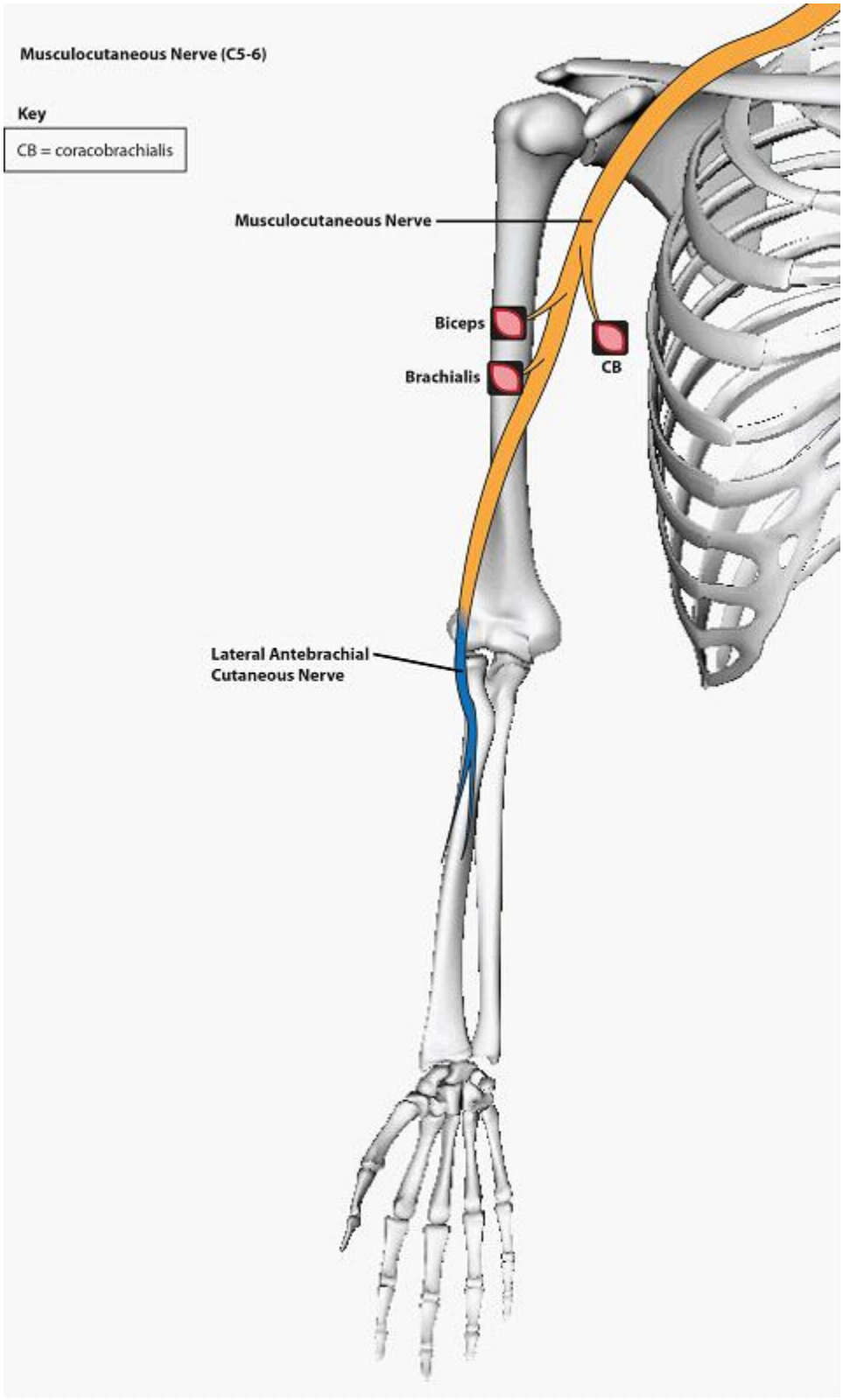
Ulnar Nerve Diagram



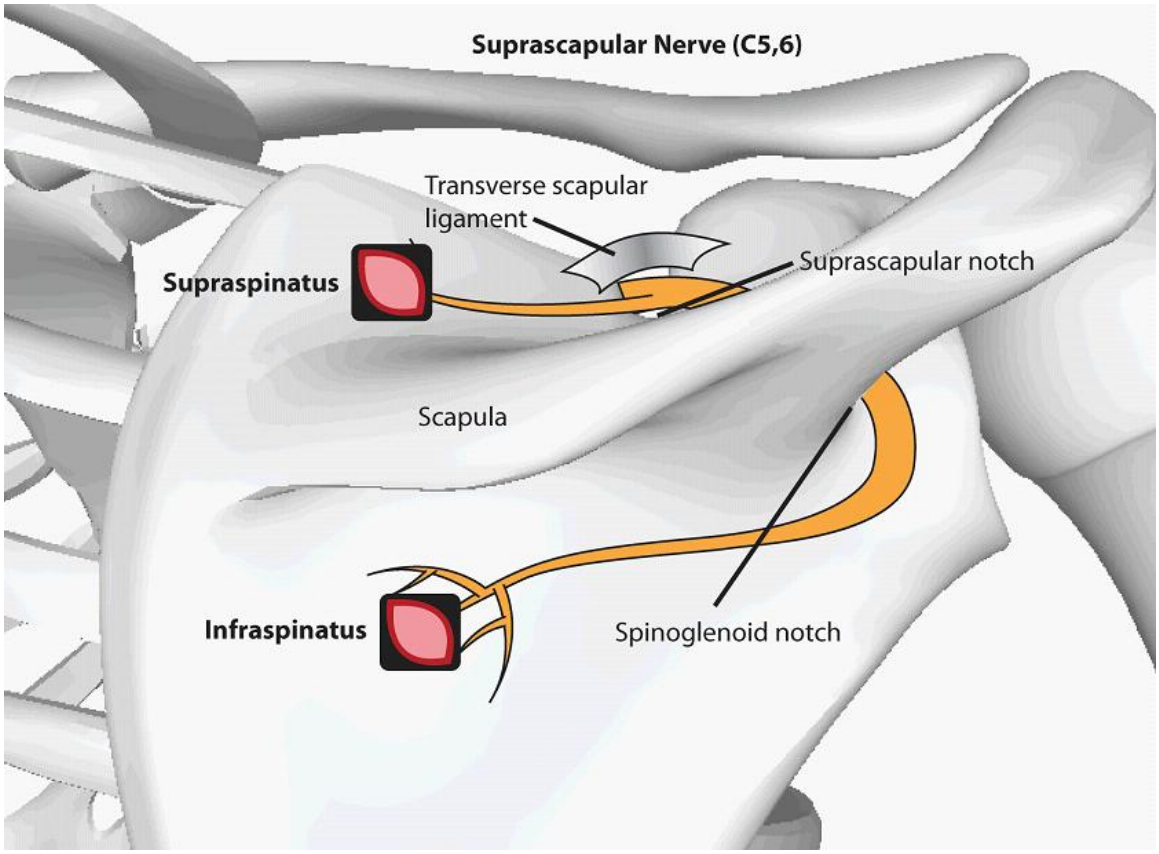
Radial Nerve Diagram



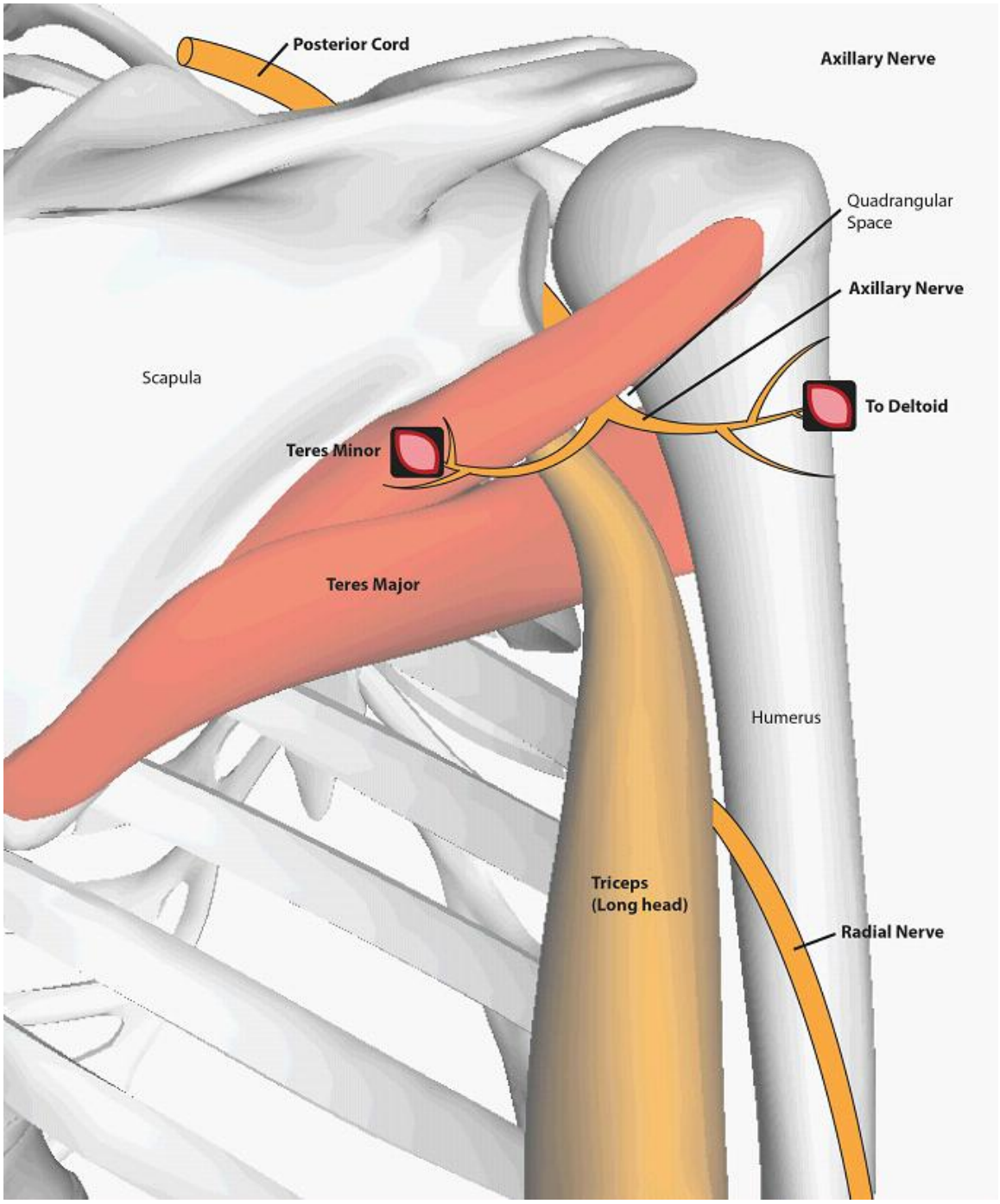
Musculocutaneous Nerve Diagram



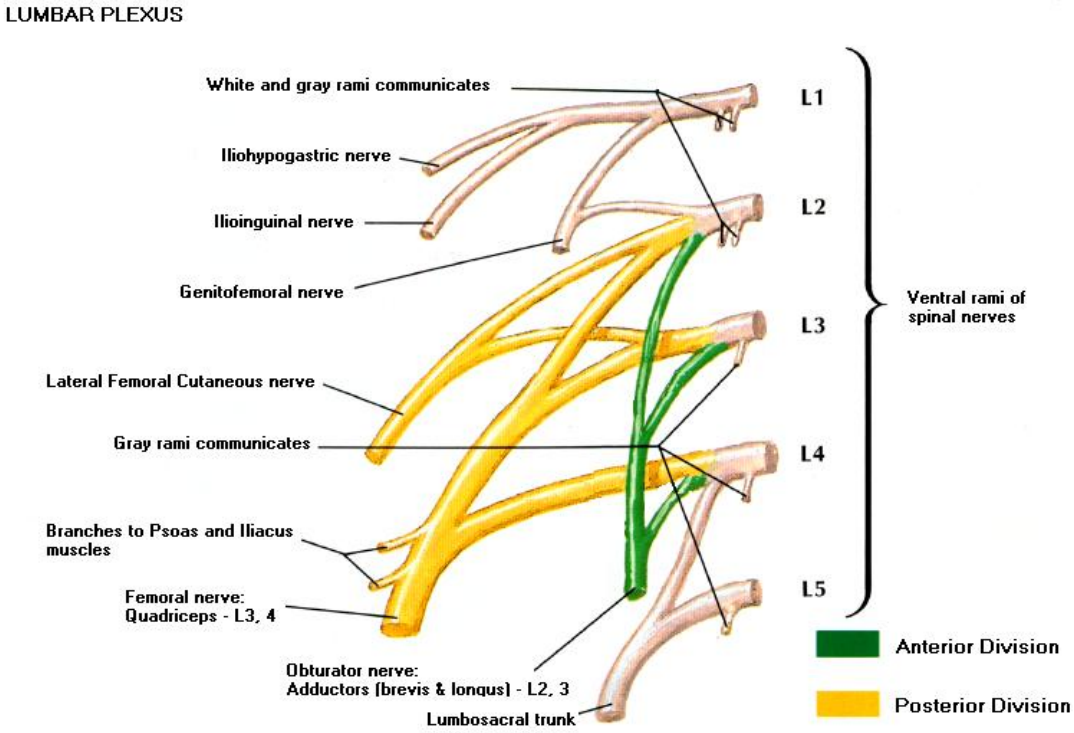
Suprascapular Nerve Diagram



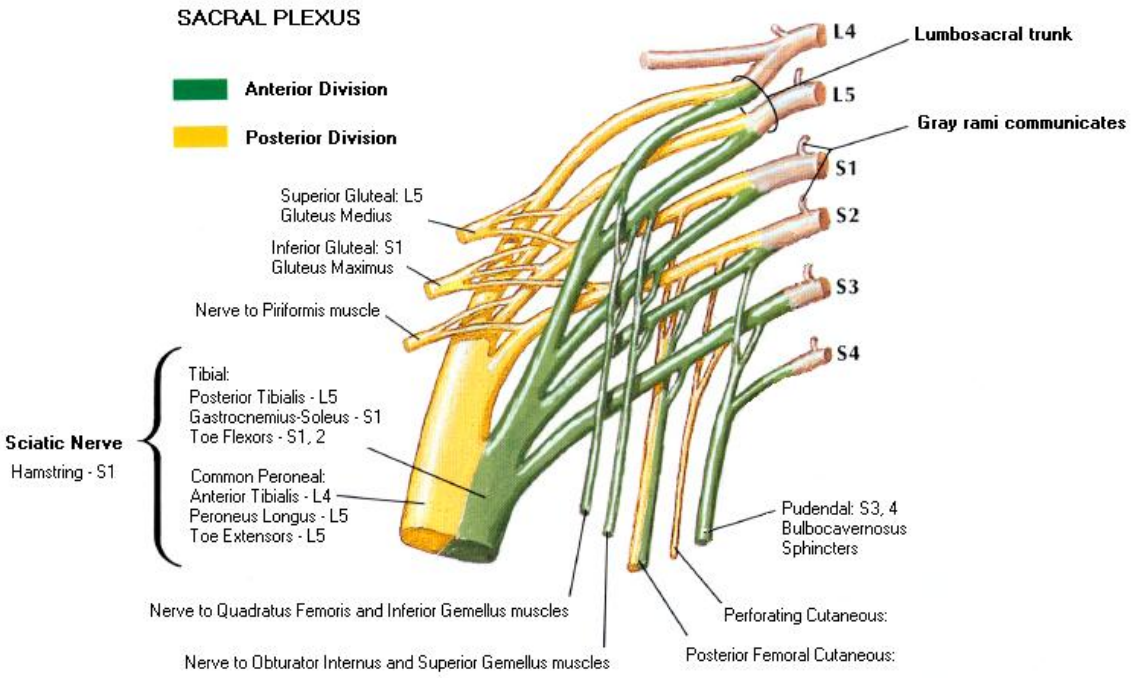
Axillary Nerve Diagram



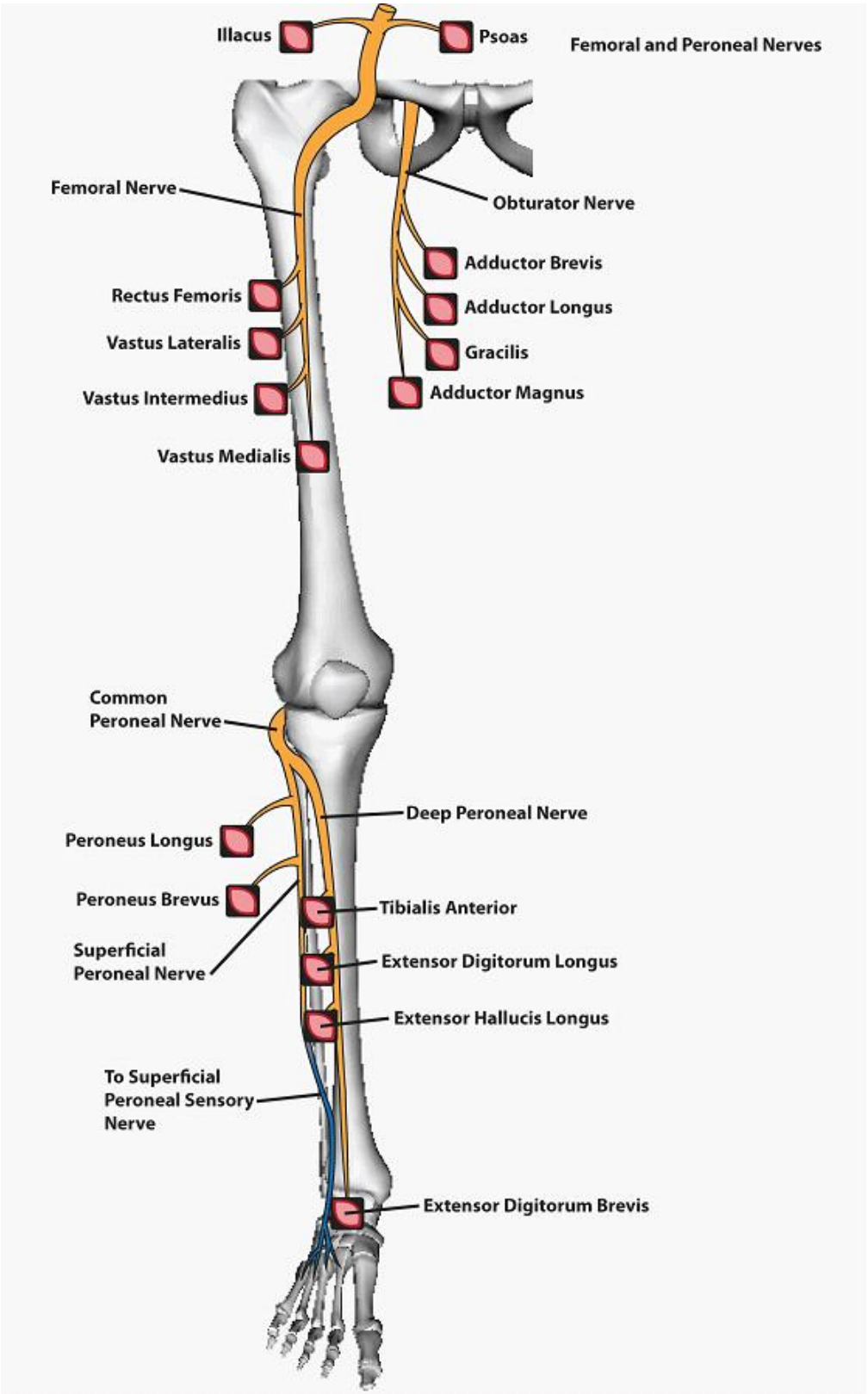
Lumbar Plexus



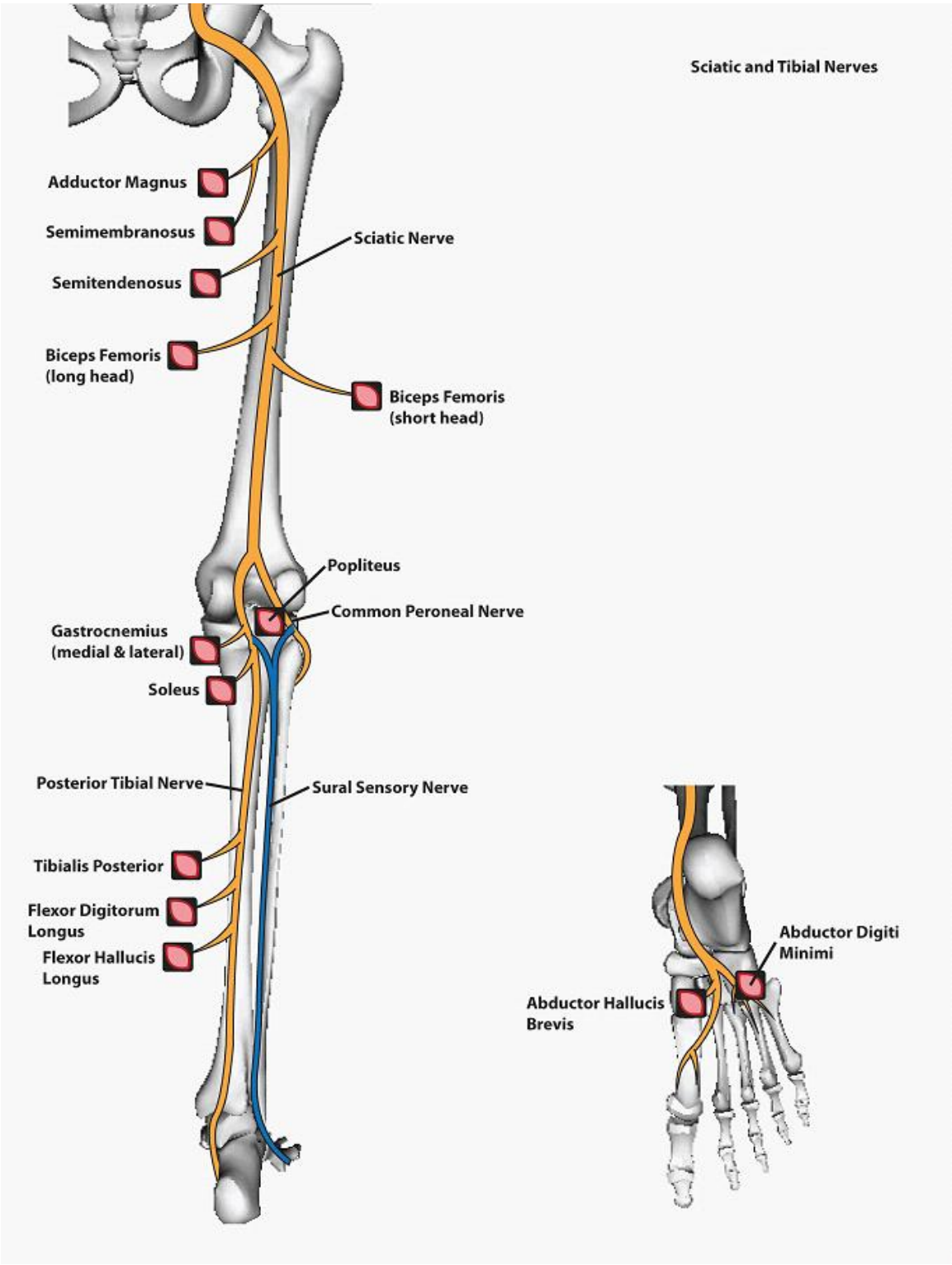
Sacral Plexus



Femoral and Peroneal Nerve Diagram



Sciatic and Tibial Nerve Diagram



NCV Setups

NCV Index

Upper Limb Motor Nerves

Median

Ulnar

Ulnar Inching Across Elbow

Radial

Musculocutaneous

Axillary

Suprascapular

Lower Limb Motor Nerves

Femoral

Peroneal (to Extensor Digitorum Brevis)

Peroneal (to Tibialis Anterior)

Tibial

Medial Plantar

Lateral Plantar

Upper Limb Sensory Nerves

Median Antidromic

Median Orthodromic

Median Across Palm

Median/Ulnar Comparison to 4th Digit

Median/Radial Comparison to 1st Digit

Median/Ulnar Palm Comparison to Wrist

Ulnar Orthodromic

Median Inching (across the wrist)

Dorsal Cutaneous

Medial Antebrachial Cutaneous

Lateral Antebrachial Cutaneous

Ulnar Antidromic

Radial Antidromic

Lower Limb Sensory Nerves

Sural Antidromic

Superficial Peroneal Antidromic

Saphenous Antidromic

Medial Plantar

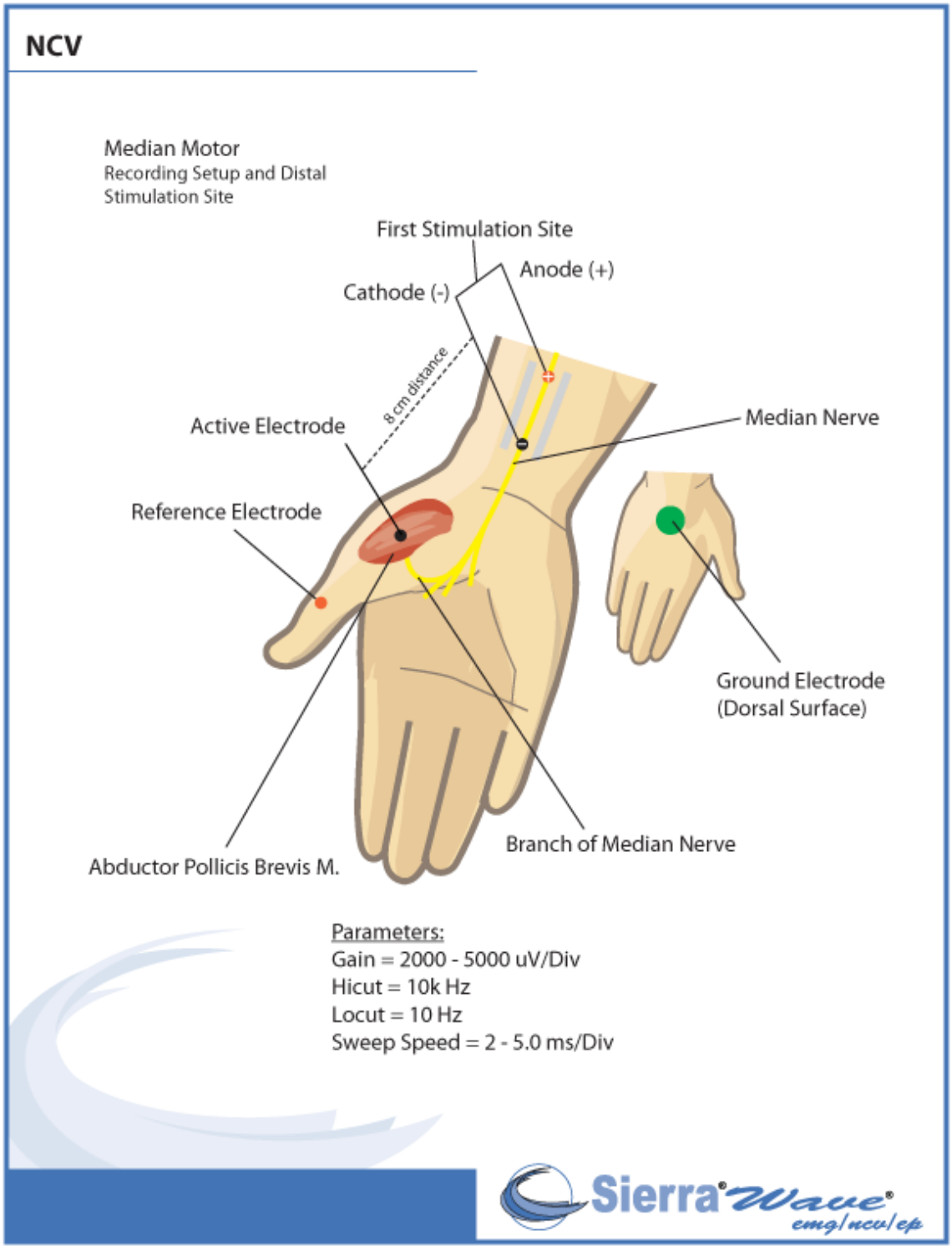
Lateral Plantar

Medial Plantar Mixed

Lateral Plantar Mixed

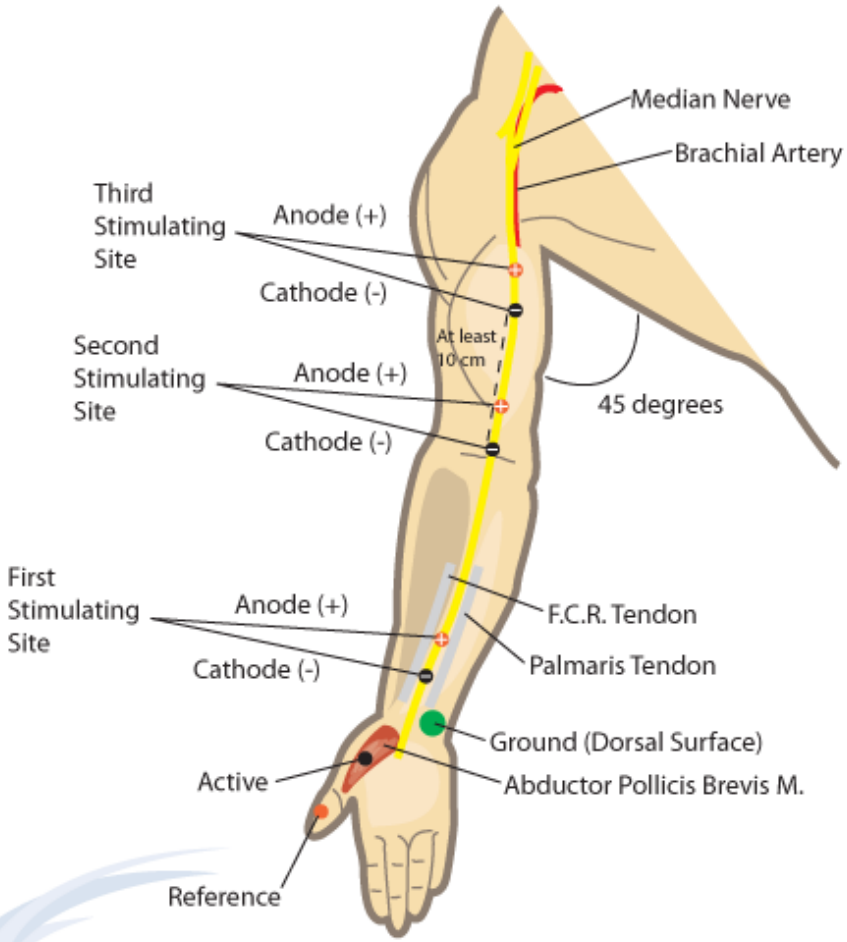
Upper Limb Motor Nerves

Median Motor



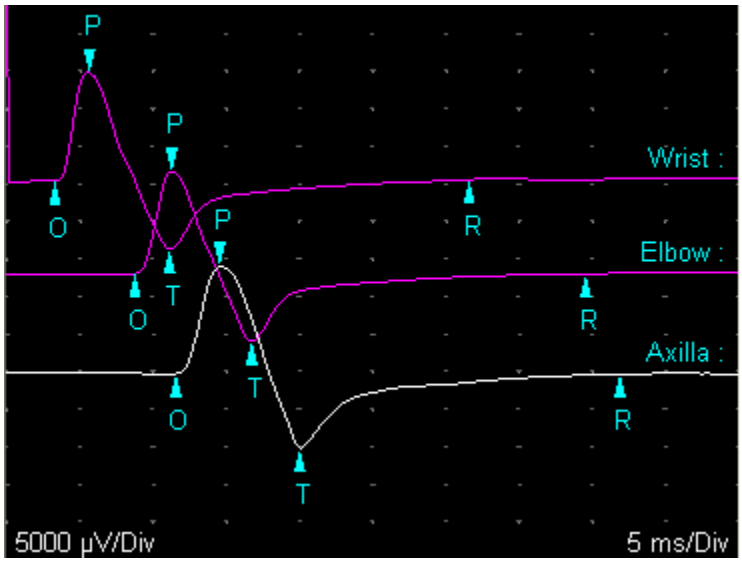
NCV

Median Motor
Proximal Stimulation Sites

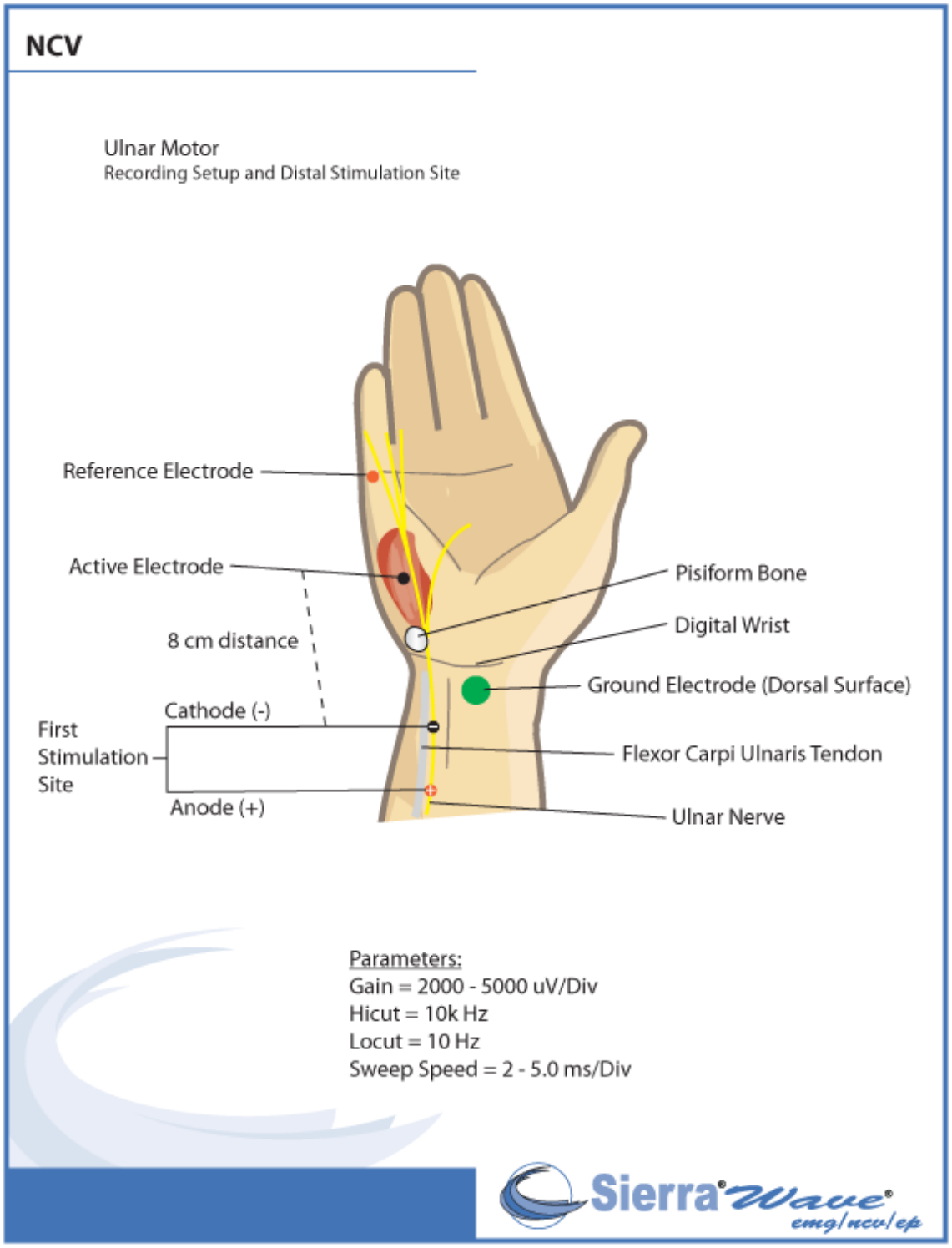


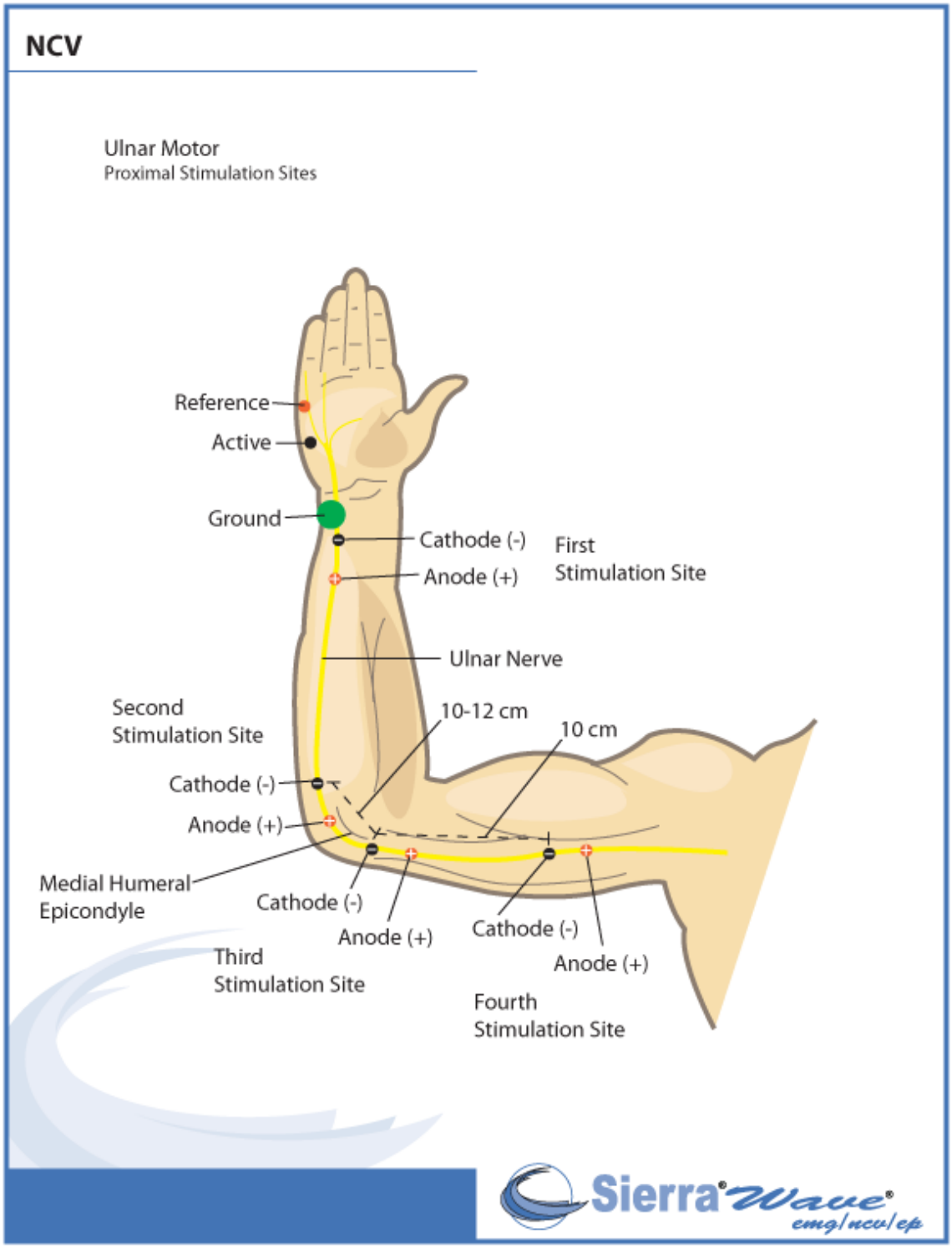
Sierra Wave emg/ncv/ep

MEDIAN MOTOR - Example Traces

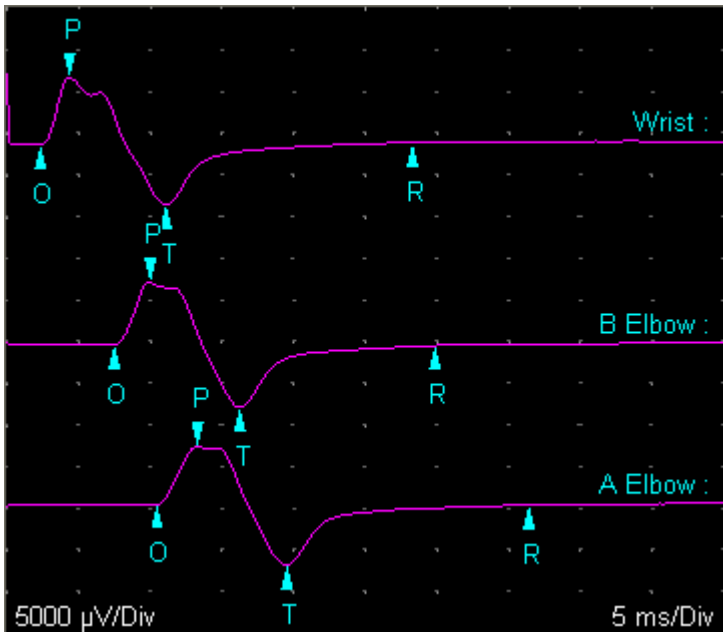


Ulnar Motor

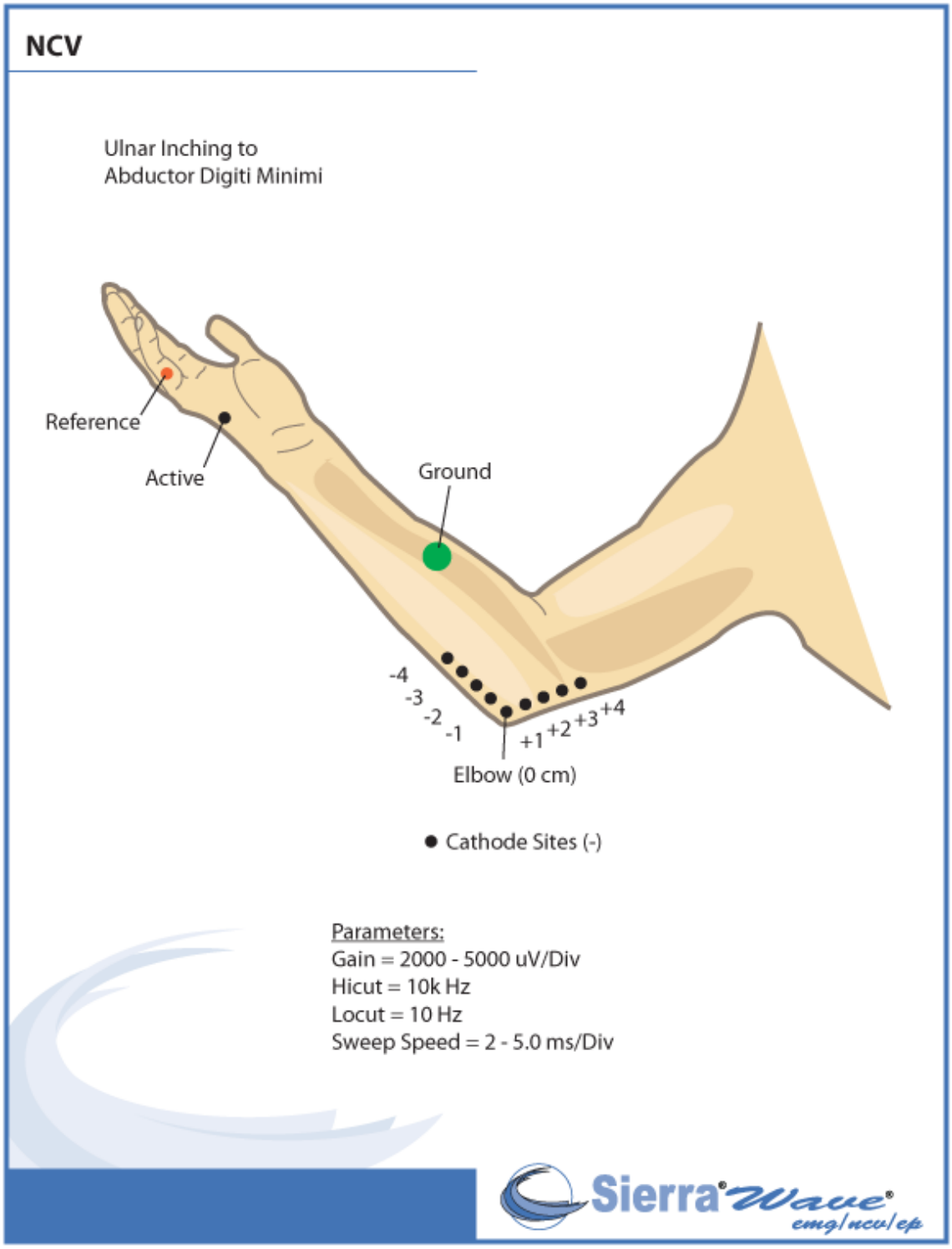

NCV
Ulnar Motor
Recording Setup and Distal Stimulation Site
Reference Electrode
Active Electrode
8 cm distance
Cathode (-)
First
Stimulation
Site
Anode (+)
Pisiform Bone
Digital Wrist
Ground Electrode (Dorsal Surface)
Flexor Carpi Ulnaris Tendon
Ulnar Nerve
Parameters:
Gain = 2000 - 5000 uV/Div
Hicut = 10k Hz
Locut = 10 Hz
Sweep Speed = 2 - 5.0 ms/Div
Sierra Wave
emg/ncv/ep


NCV
Ulnar Motor
Proximal Stimulation Sites
Reference
Active
Ground
Cathode (-)
Anode (+)
First
Stimulation Site
Ulnar Nerve
Second
Stimulation Site
10-12 cm
10 cm
Cathode (-)
Anode (+)
Medial Humeral
Epicondyle
Cathode (-)
Anode (+)
Third
Stimulation Site
Cathode (-)
Anode (+)
Fourth
Stimulation Site
Sierra Wave
emg/ncv/ep

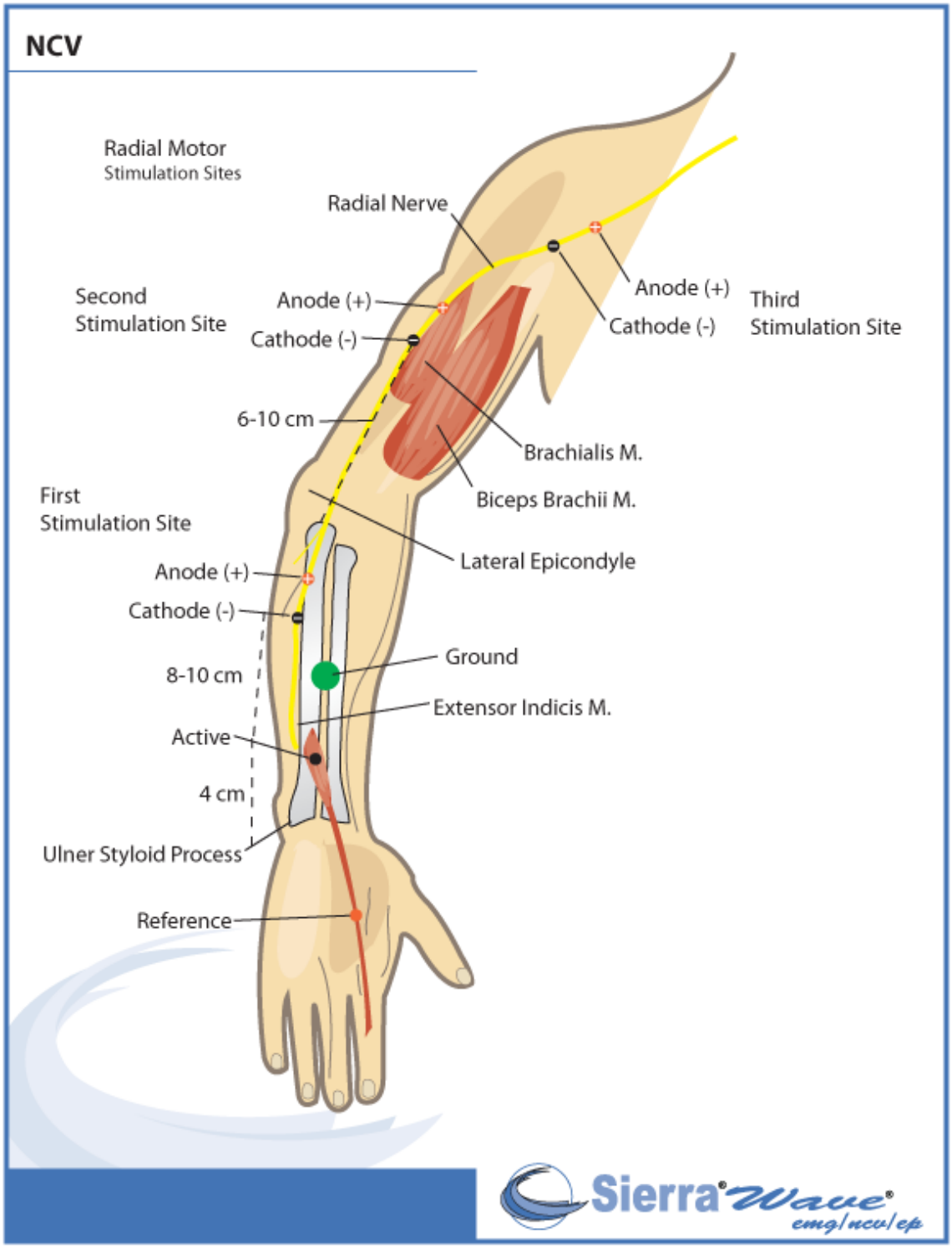
ULNAR MOTOR - Example Traces



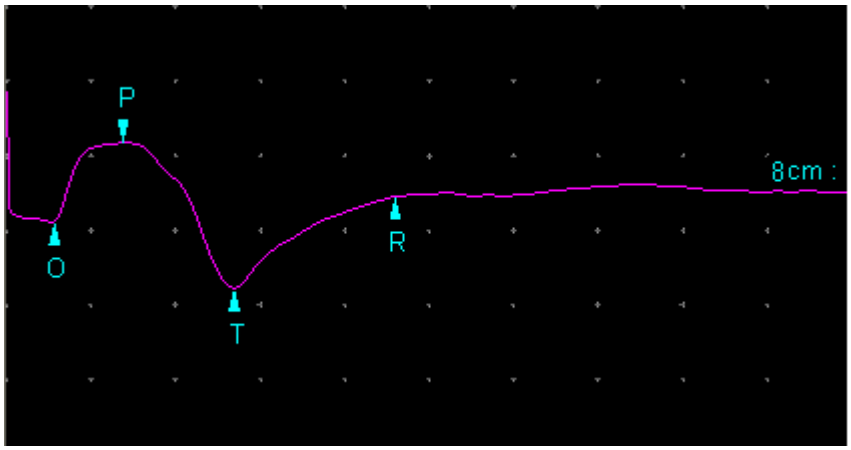
Ulnar Motor Inching Across Elbow



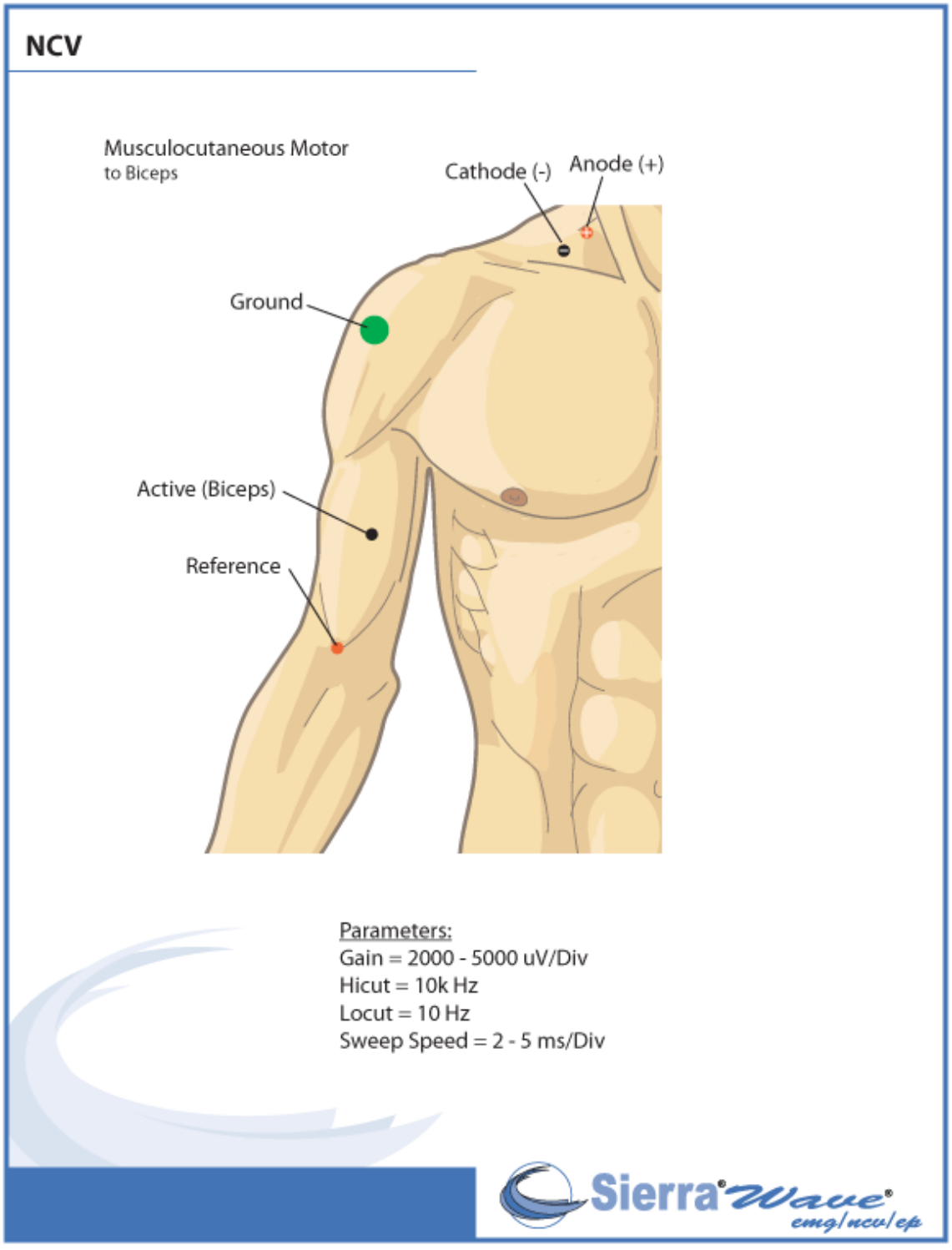
Radial Motor


NCV
Radial Motor
Stimulation Sites
Radial Nerve
Second
Stimulation Site
Anode (+)
Cathode (-)
Anode (+)
Cathode (-)
Third
Stimulation Site
6-10 cm
Brachialis M.
Biceps Brachii M.
First
Stimulation Site
Lateral Epicondyle
Anode (+)
Cathode (-)
Ground
8-10 cm
Extensor Indicis M.
Active
4 cm
Ulner Styloid Process
Reference
Sierra Wave
emg/ncv/ep

Example Trace (First Stimulation Site):



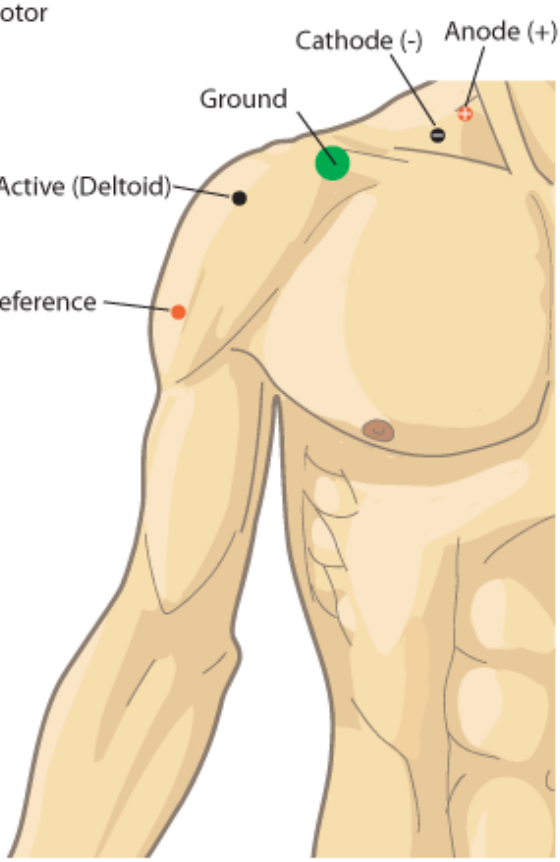
Musculocutaneous Motor



Axillary Motor

NCV

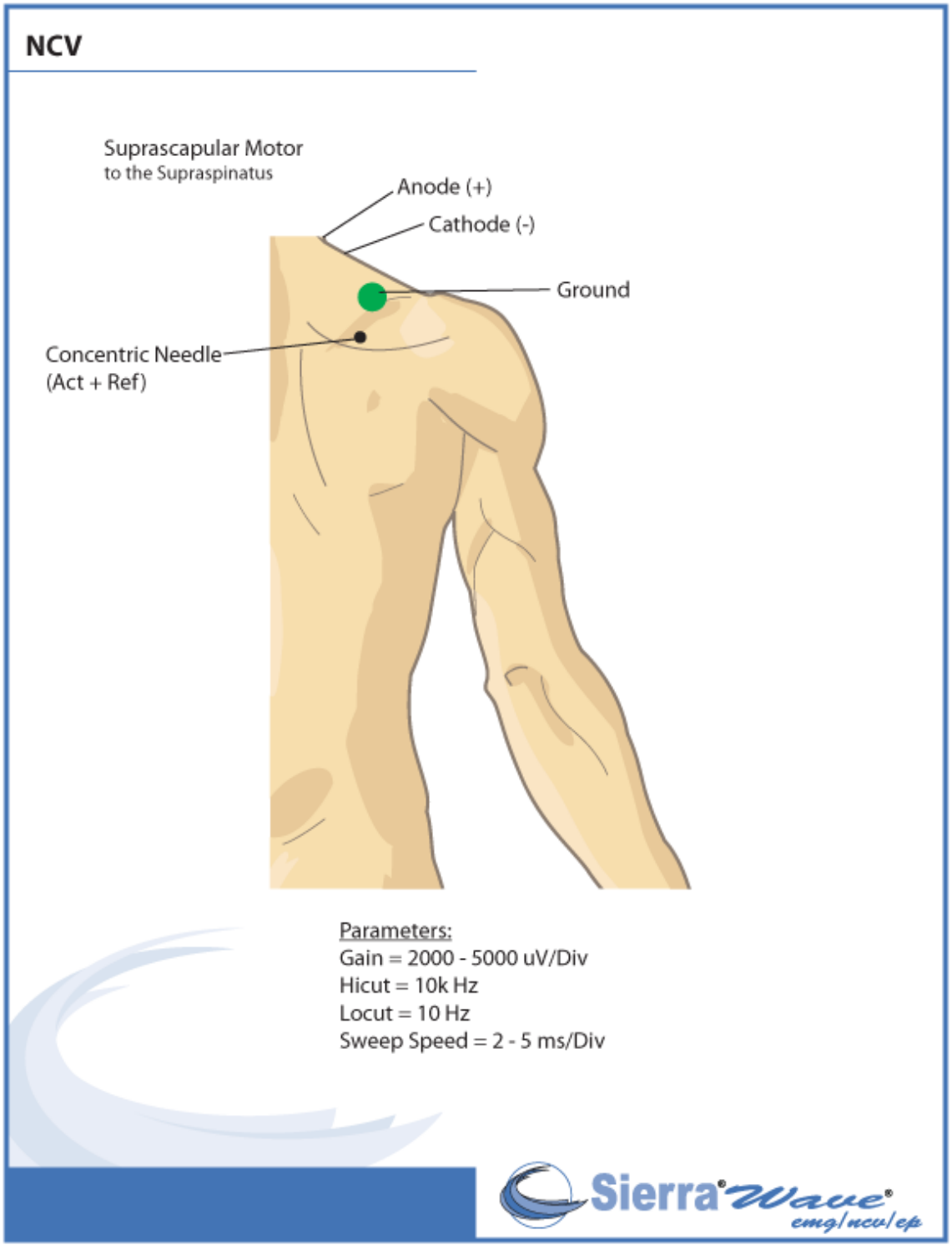
Axillary Motor
to Deltoid



Parameters:
Gain = 2000 - 5000 uV/Div
Hicut = 10k Hz
Locut = 10 Hz
Sweep Speed = 2 - 5 ms/Div

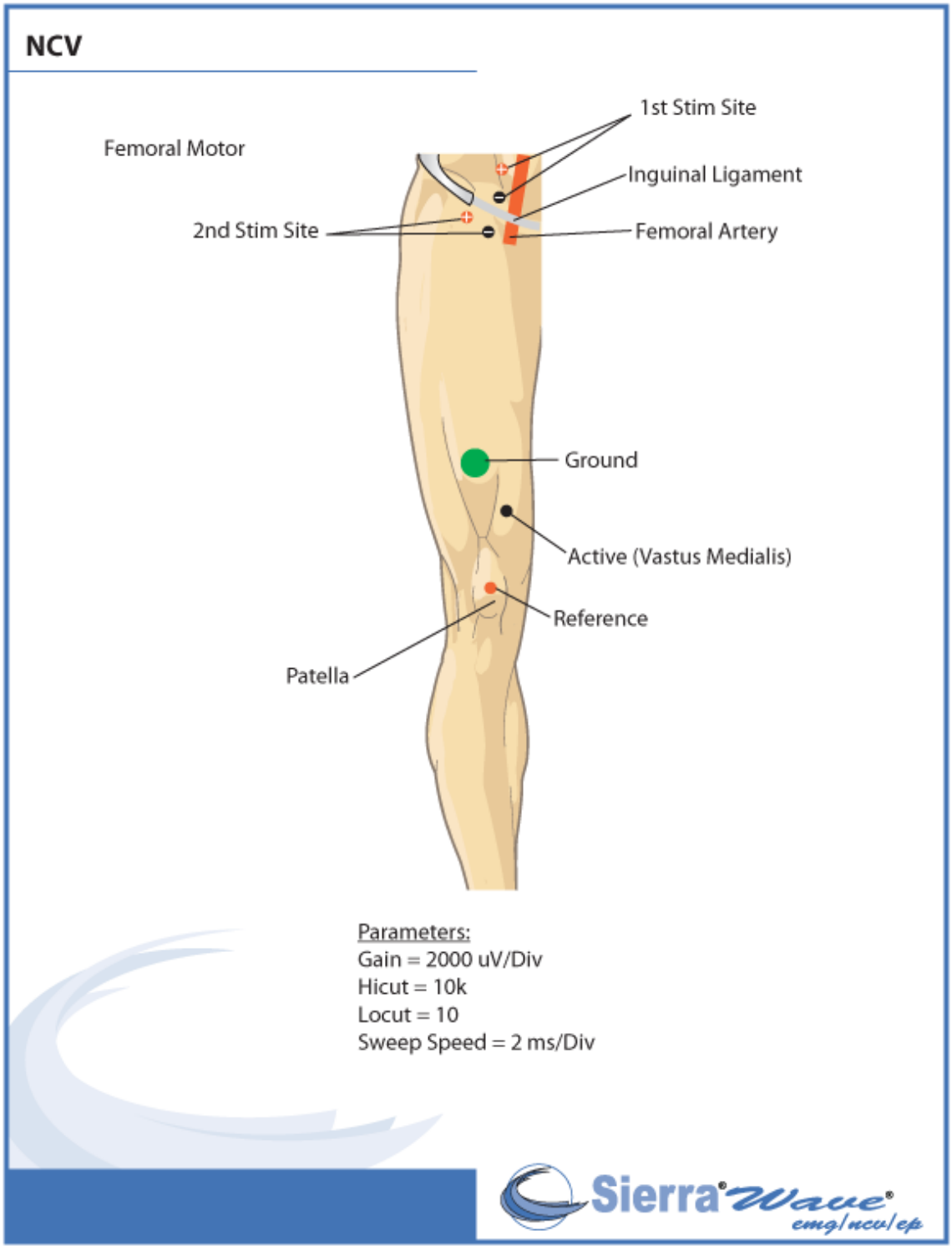
Sierra Wave emg/ncv/ep

Suprascapular Motor

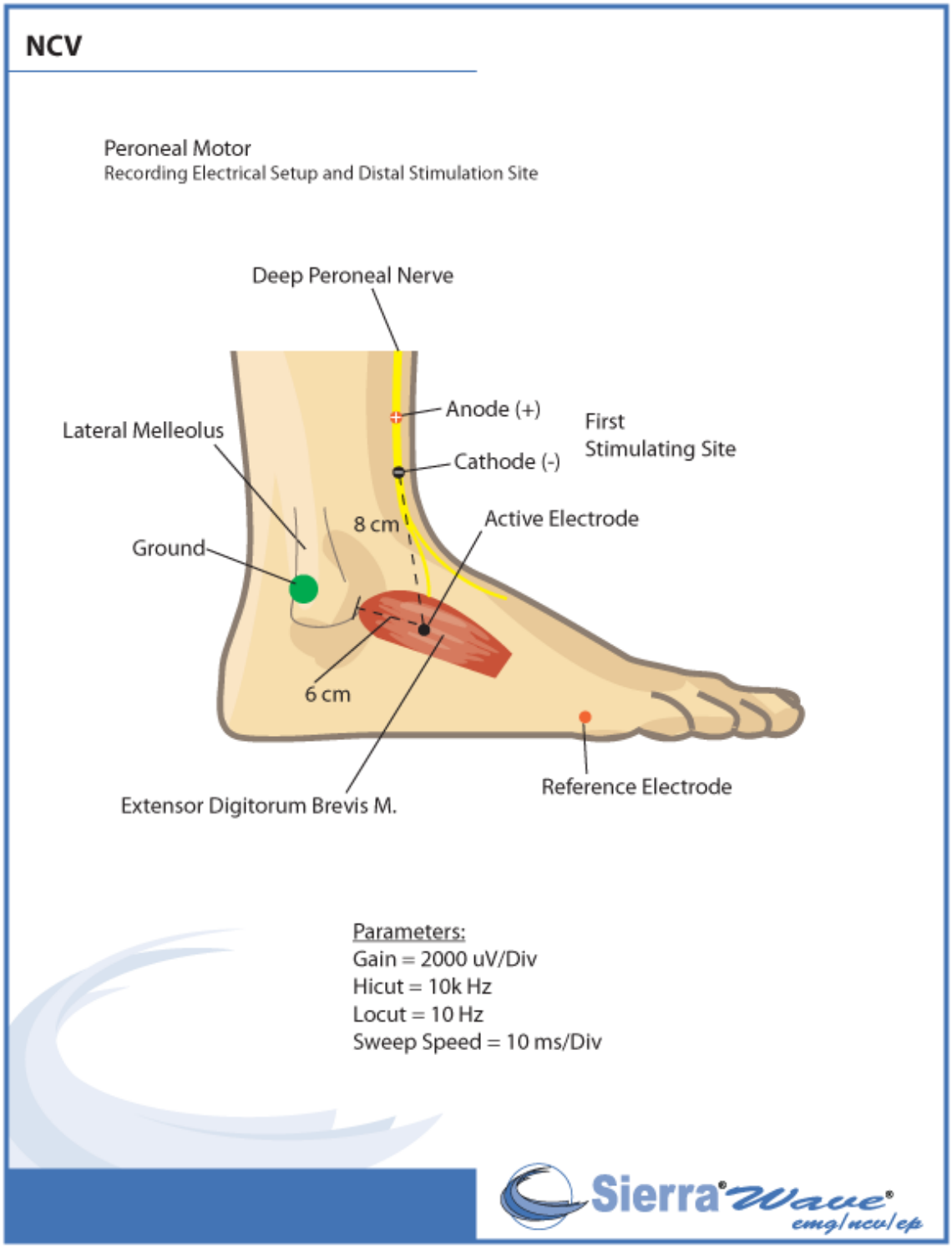


Lower Limb Motor Nerves

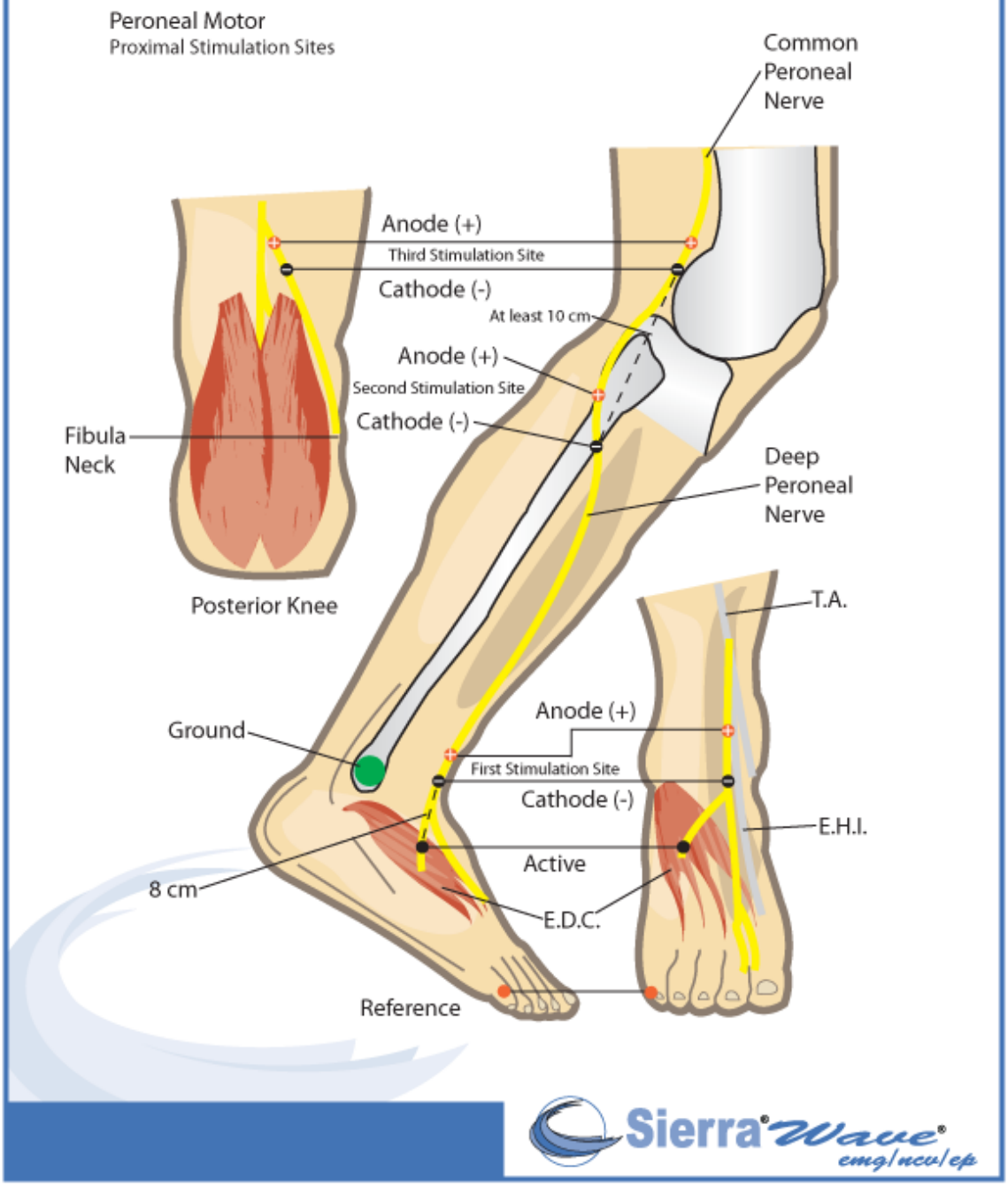
Femoral Motor



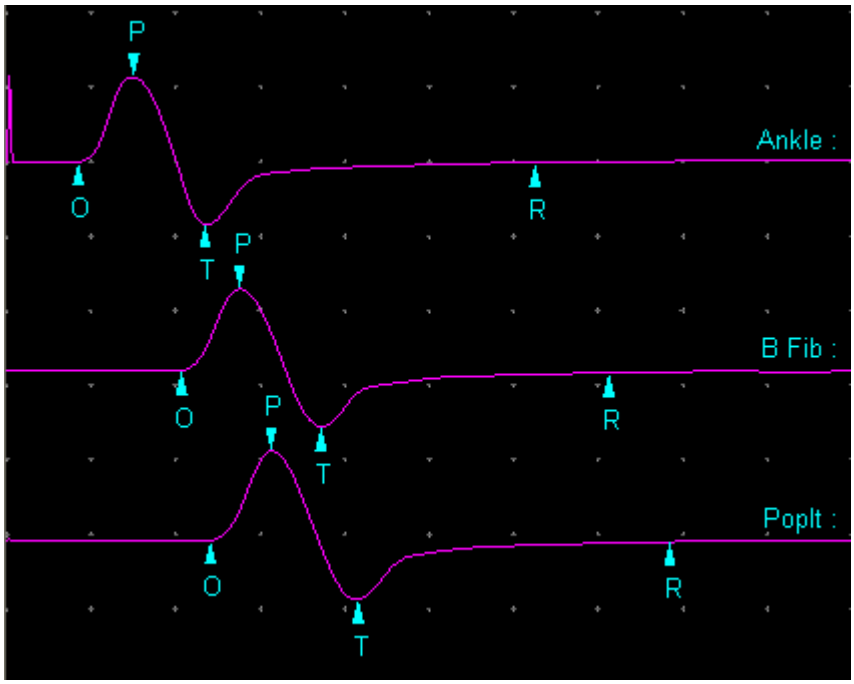
Peroneal Motor



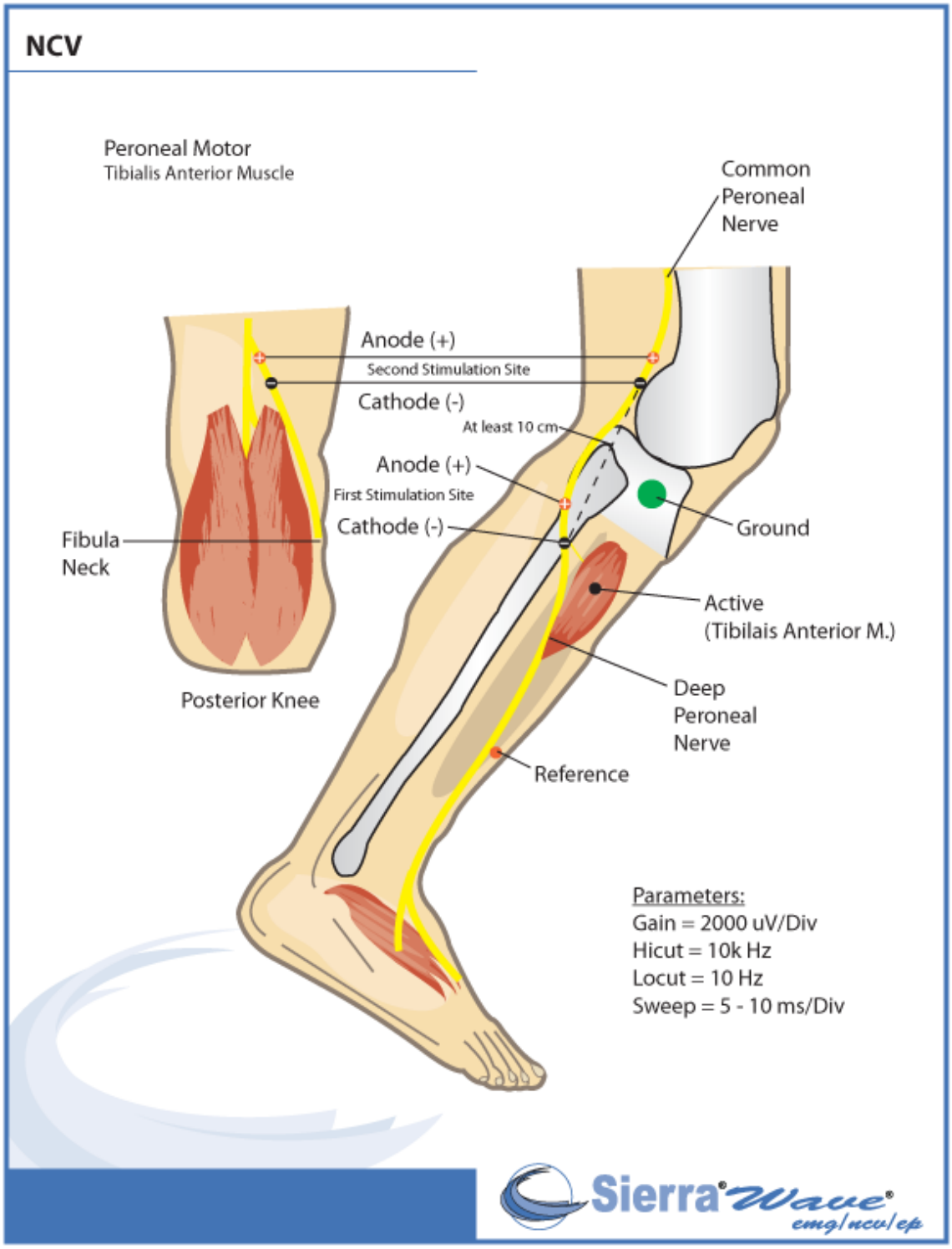
NCV


Peroneal Motor
Proximal Stimulation Sites
Common Peroneal Nerve
Anode (+)
Third Stimulation Site
Cathode (-)
At least 10 cm
Anode (+)
Second Stimulation Site
Cathode (-)
Fibula Neck
Deep Peroneal Nerve
Posterior Knee
T.A.
Ground
Anode (+)
First Stimulation Site
Cathode (-)
E.H.I.
Active
8 cm
E.D.C.
Reference
Sierra Wave emg/ncv/ep

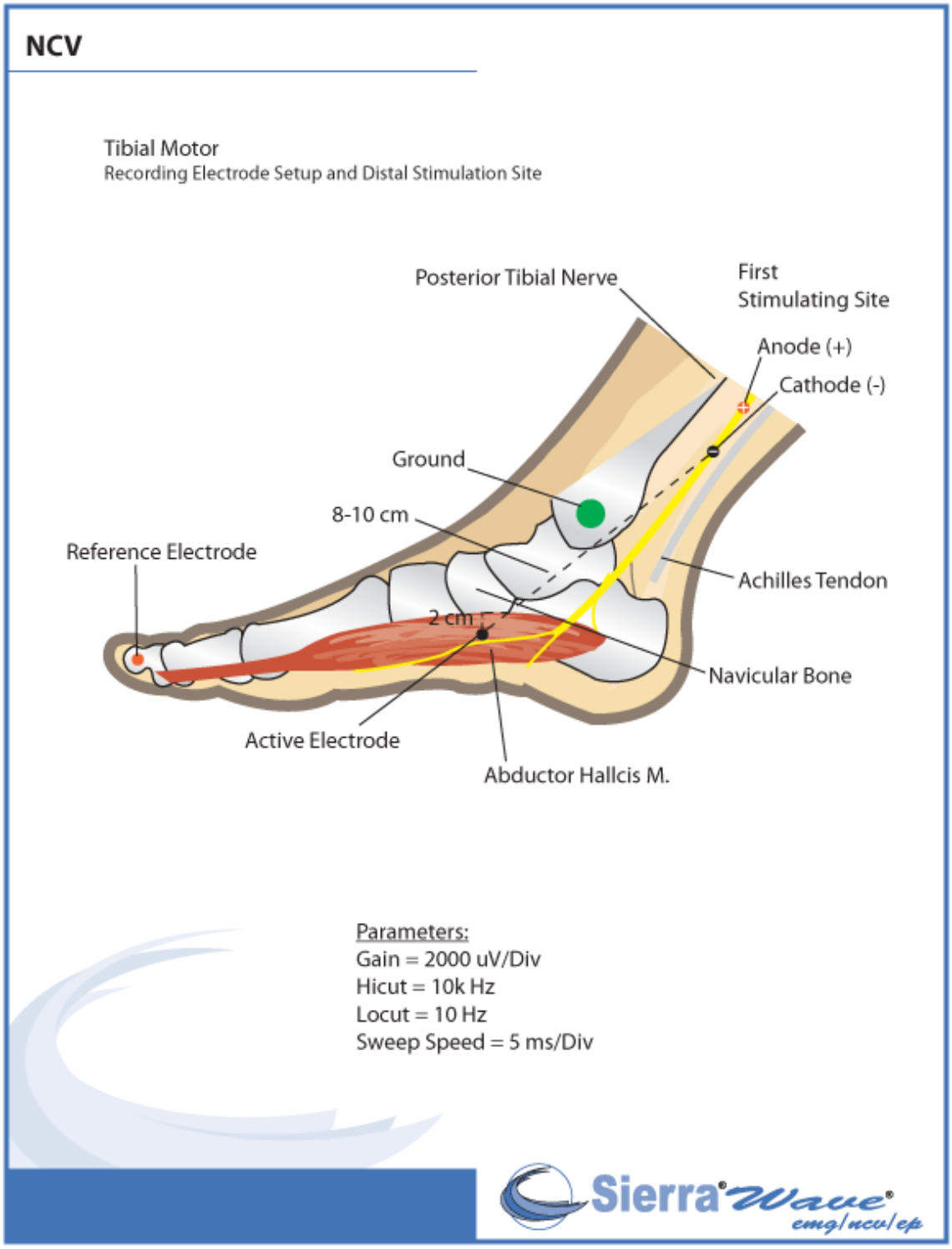
Example Traces:



Peroneal Motor (Tibialis Anterior)

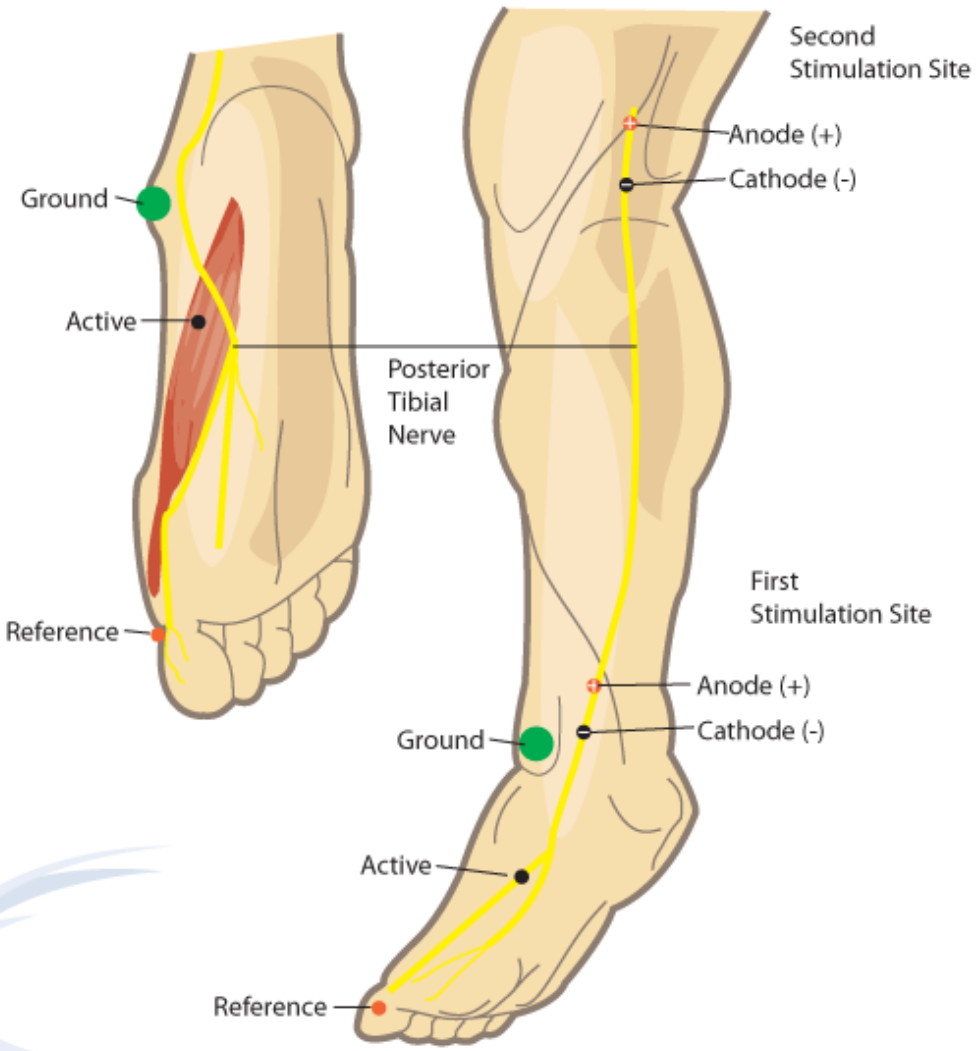


Tibial Motor



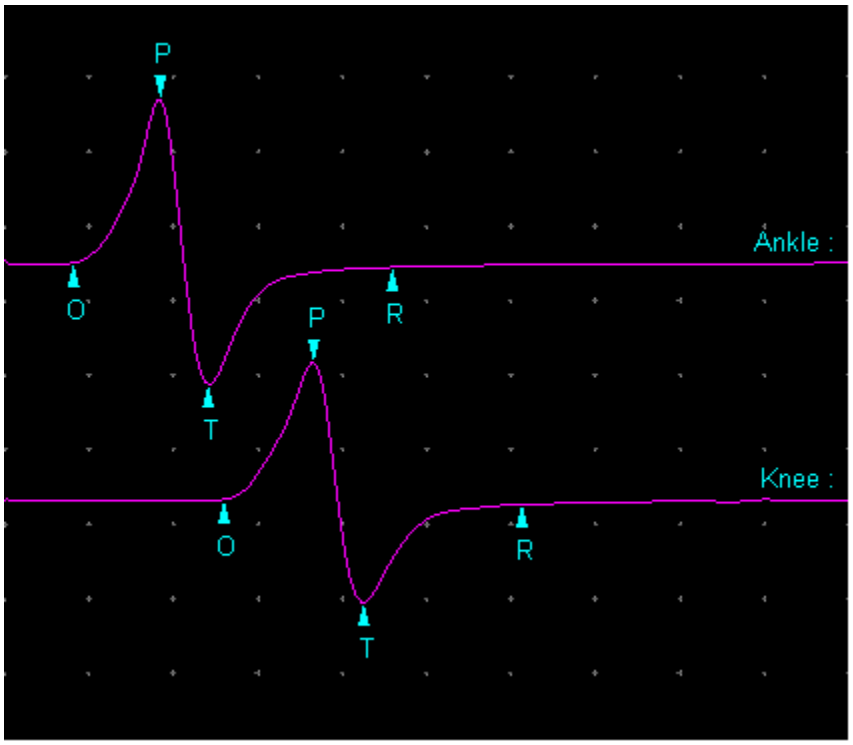
NCV

Tibial Motor
Distal and Proximal Stimulation Sites



Sierra Wave emg/ncv/ep

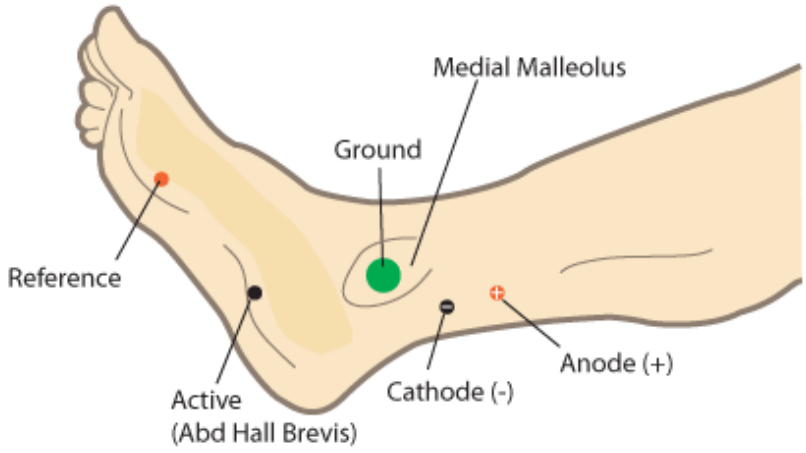
Example Traces:



Medial Plantar Motor

NCV

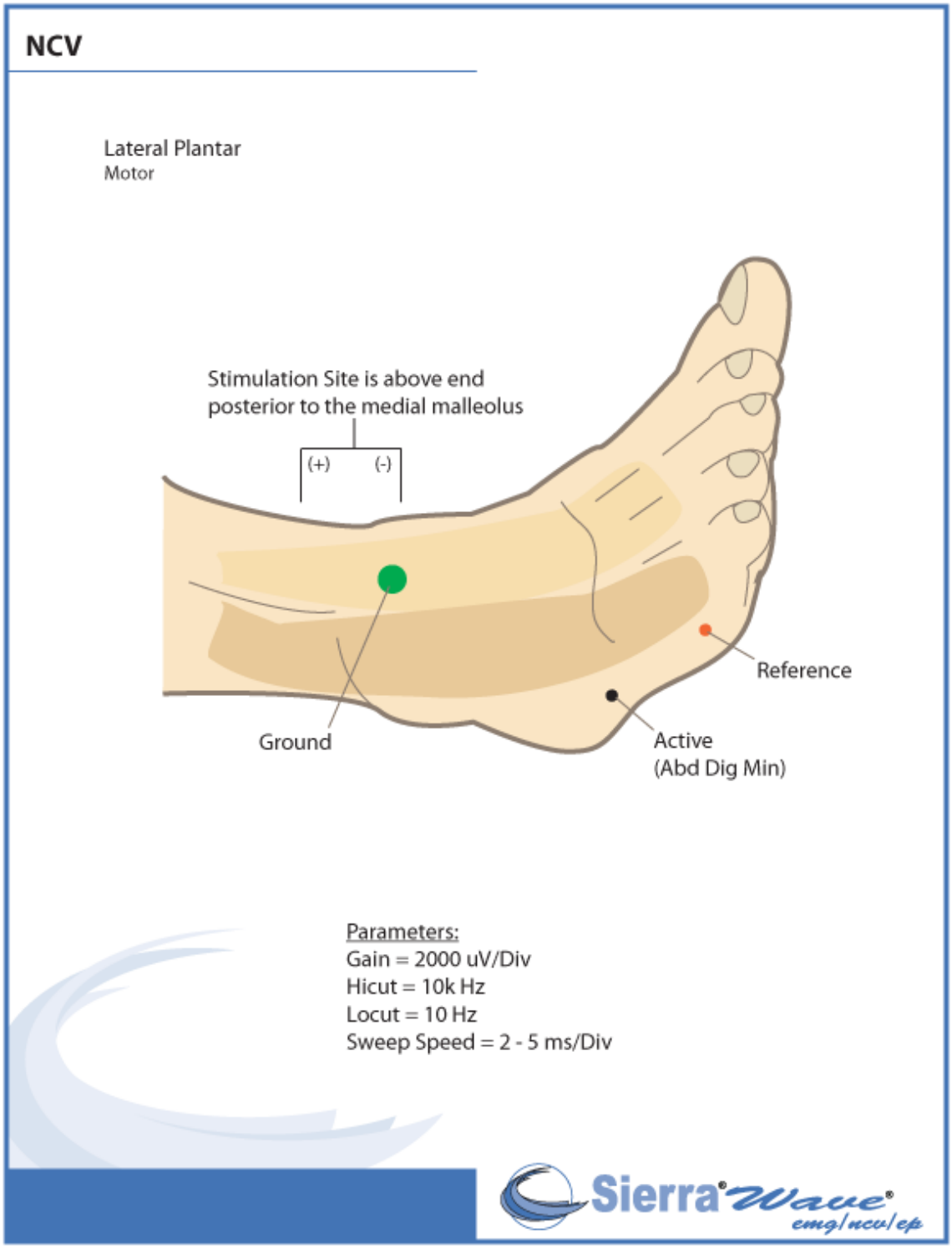
Medial Plantar
Motor



Parameters:
Gain = 2000 uV/Div
Hicut = 10k Hz
Locut = 10 Hz
Sweep Speed = 2 - 5 ms/Div

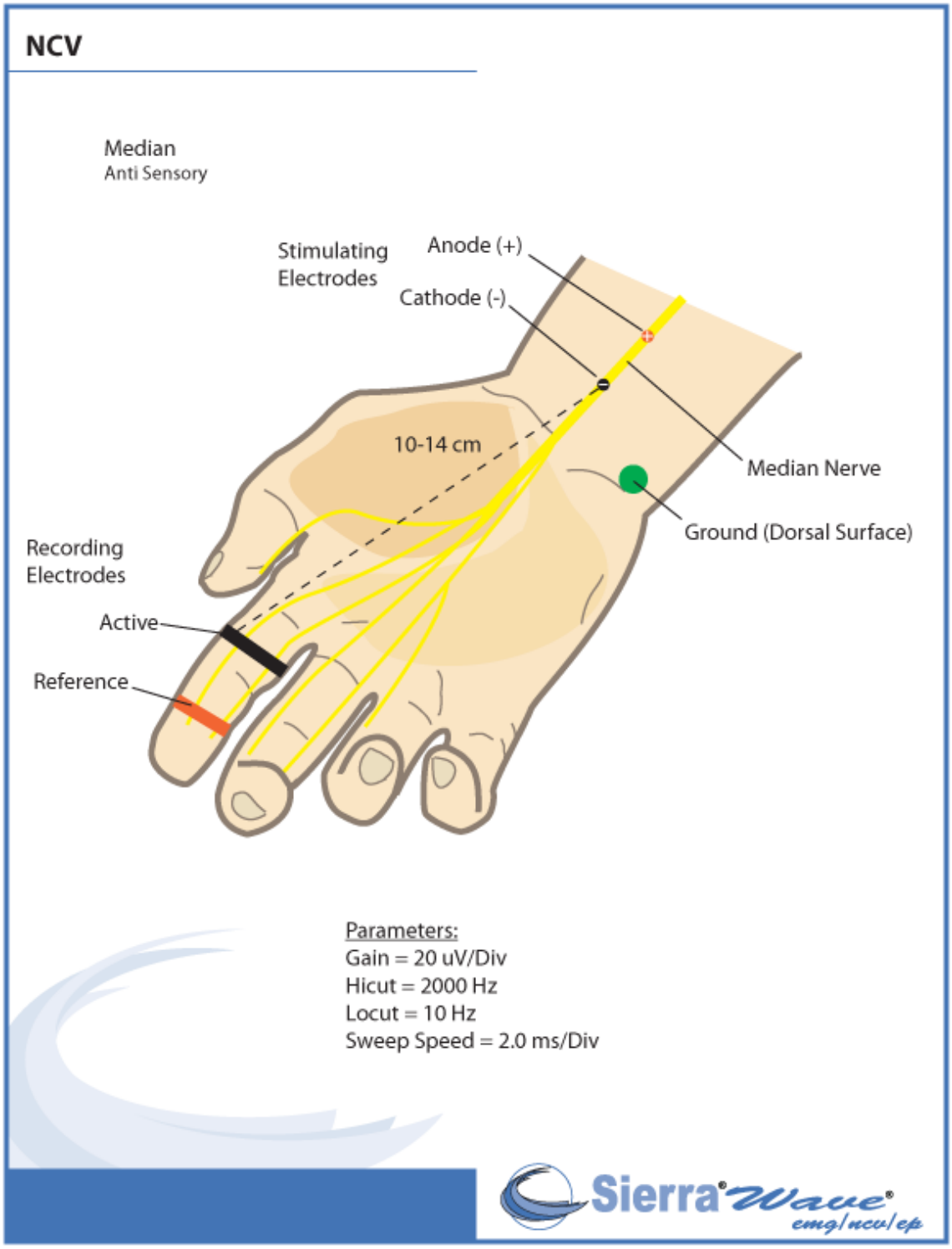
Sierra Wave emg/ncv/ep

Lateral Plantar Motor

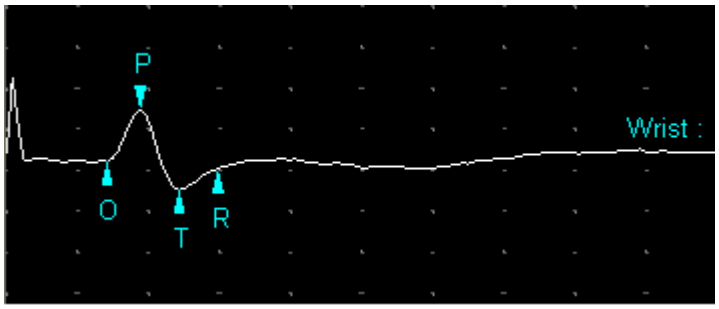


Upper Limb Sensory Nerves

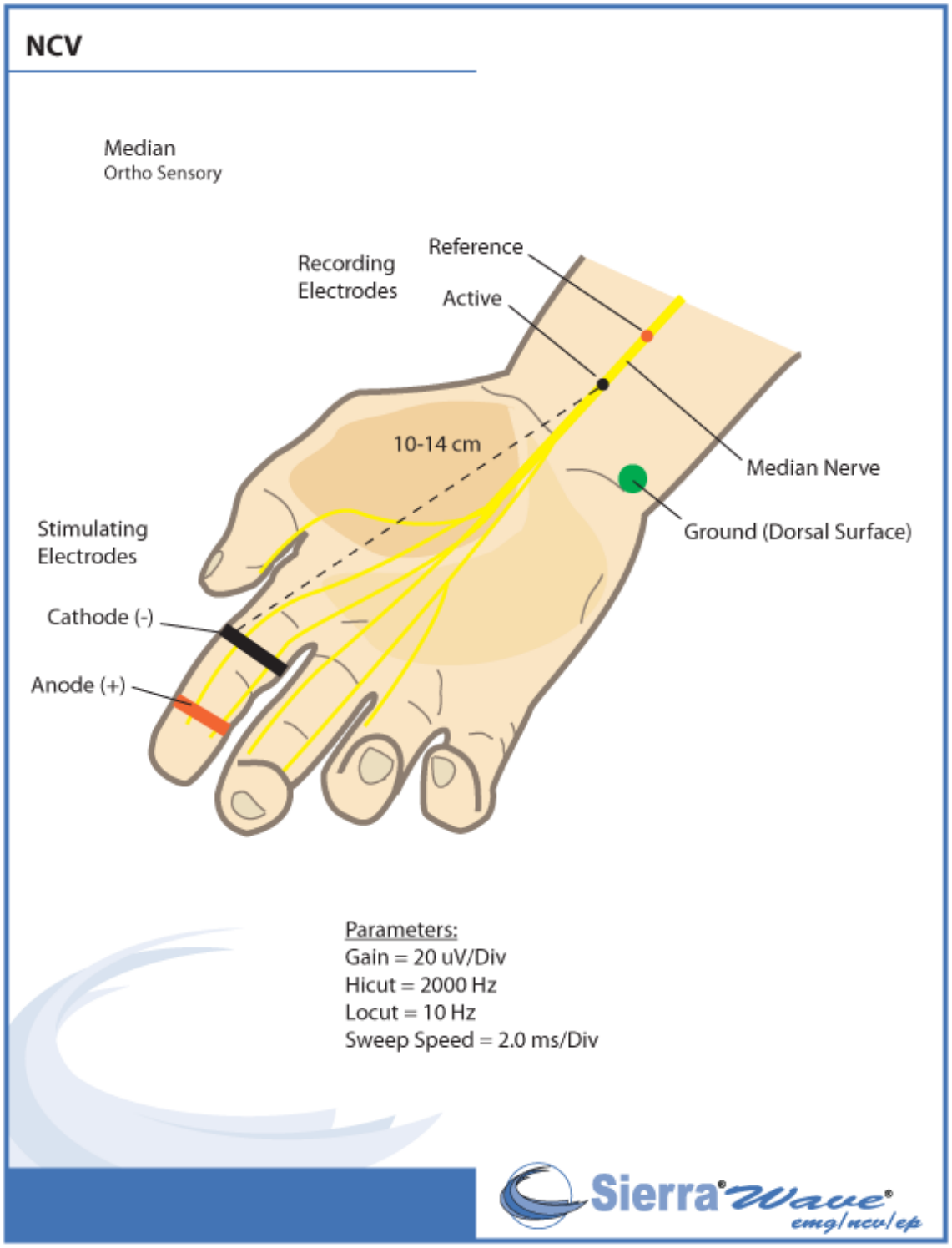
Median Antidromic Sensory



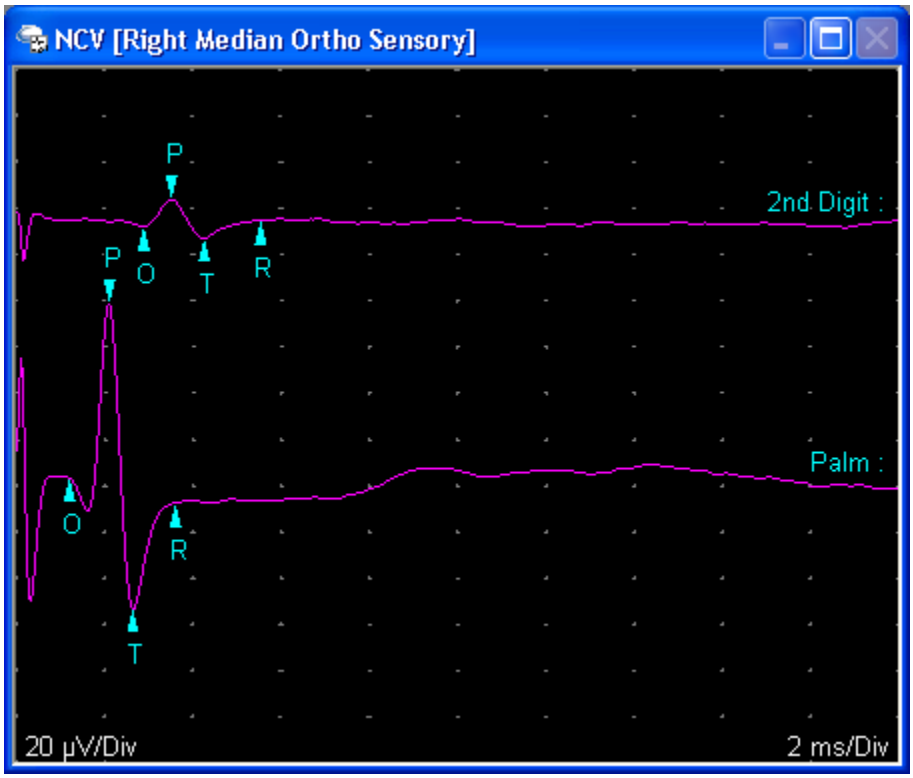
MEDIAN ANTI SENSORY - Example Trace



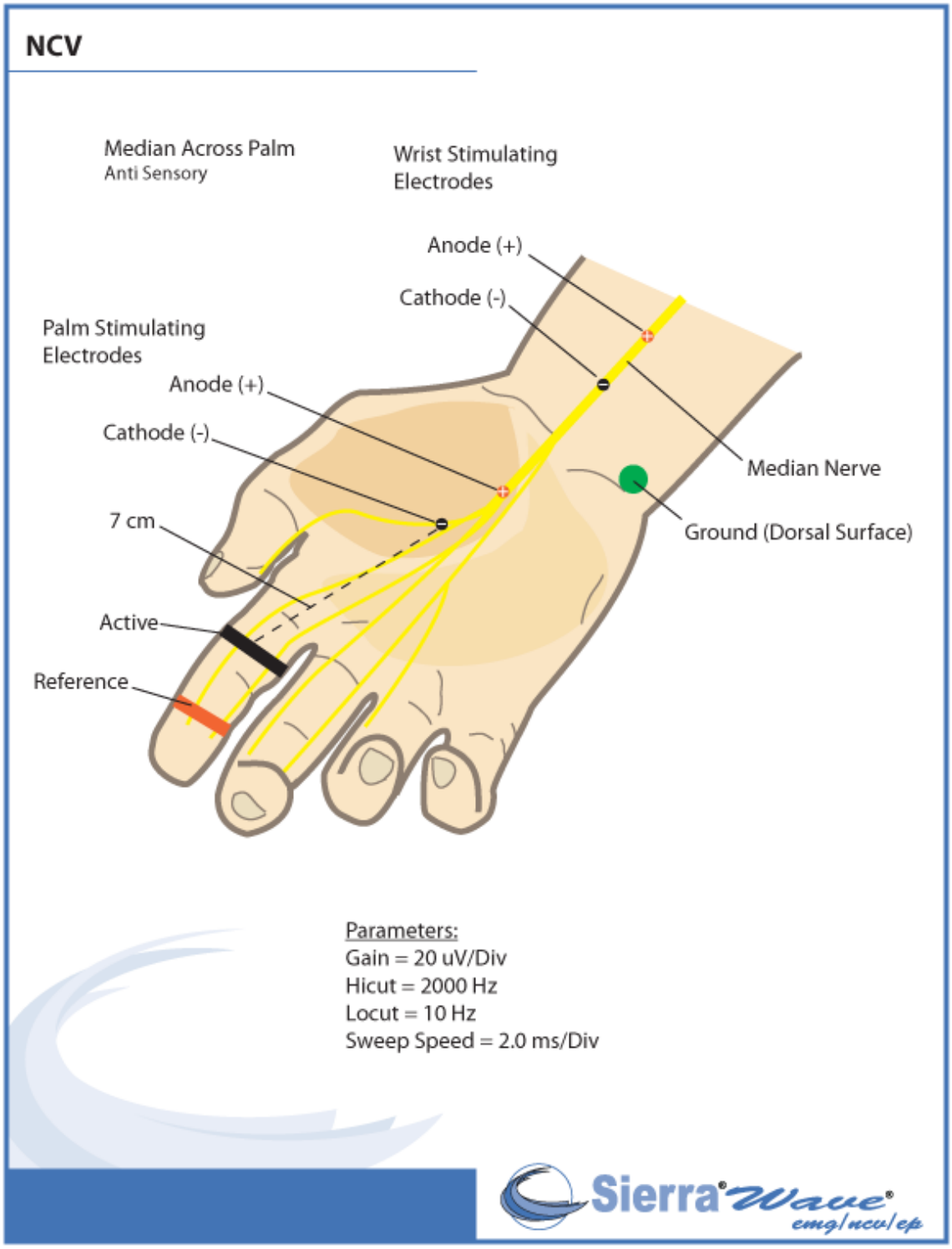
Median Orthodromic Sensory



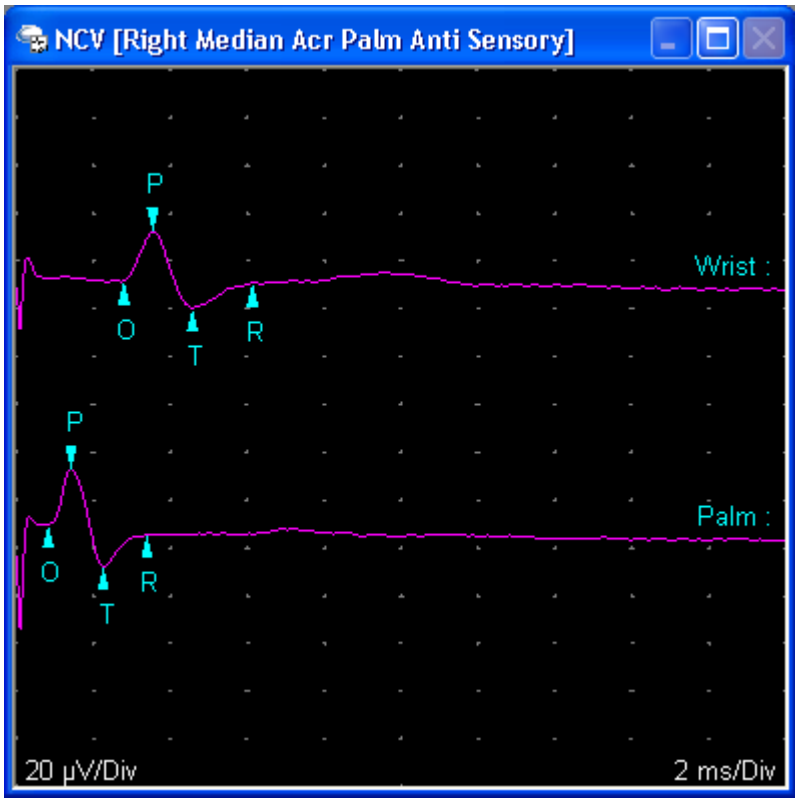
Example Traces:



Median Across Palm Sensory



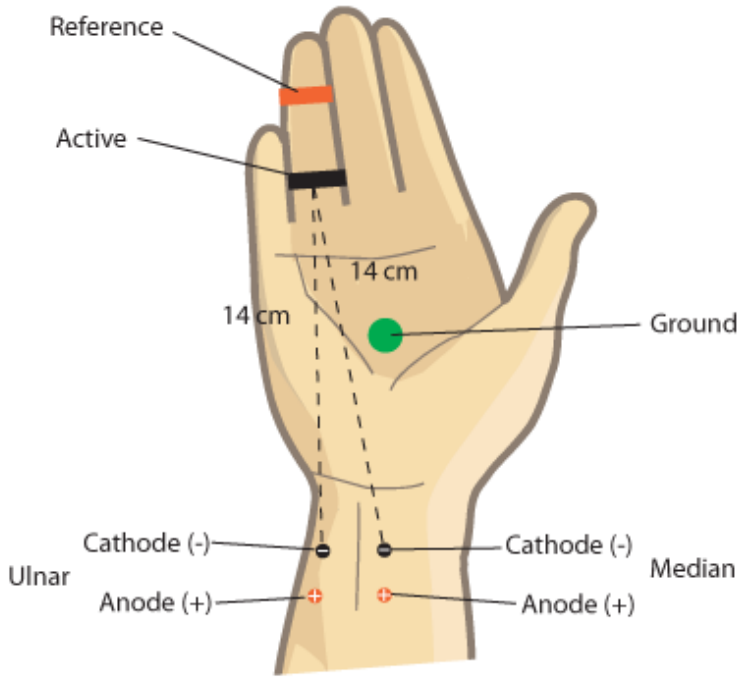
Example Traces:



Median/Ulnar Sensory Comparison to 4th Digit

NCV

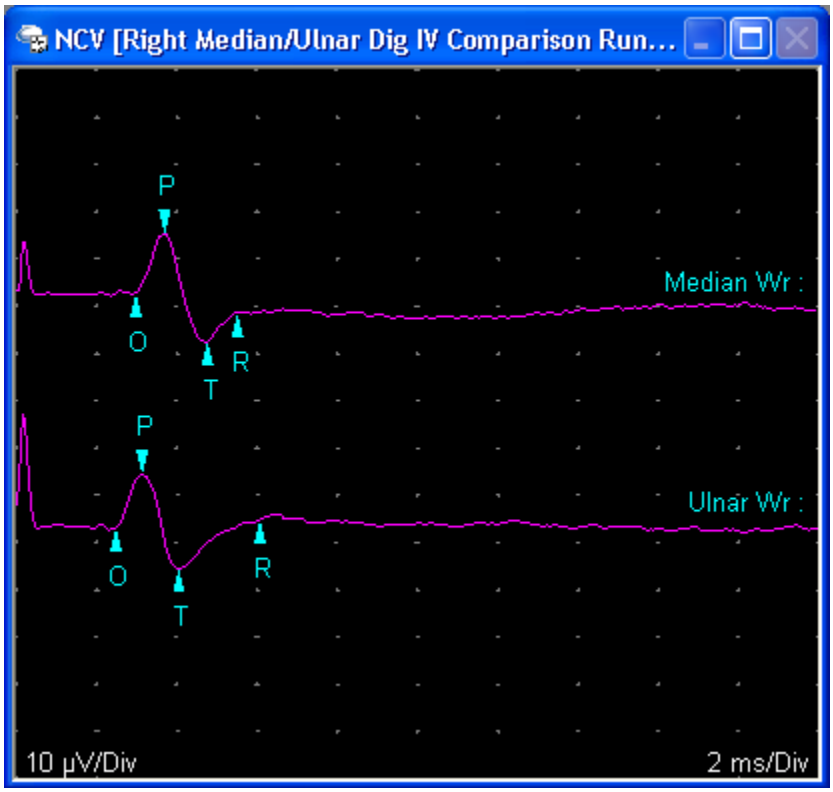
Median/Ulnar
Comparison to 4th Digit Anti-Sensory



Parameters:
Gain = 20 uV/Div
Hicut = 2000 Hz
Locut = 10 Hz
Sweep = 2.0 ms/Div

Sierra Wave emg/ncv/ep

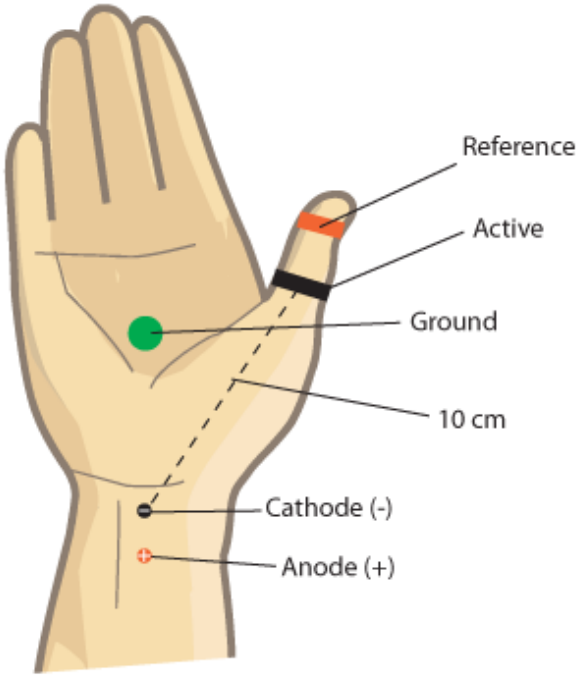
Example Traces:



Median/Radial Sensory Comparison to 1st Digit

NCV

Median Sensory
Antidromic to 1st Digit

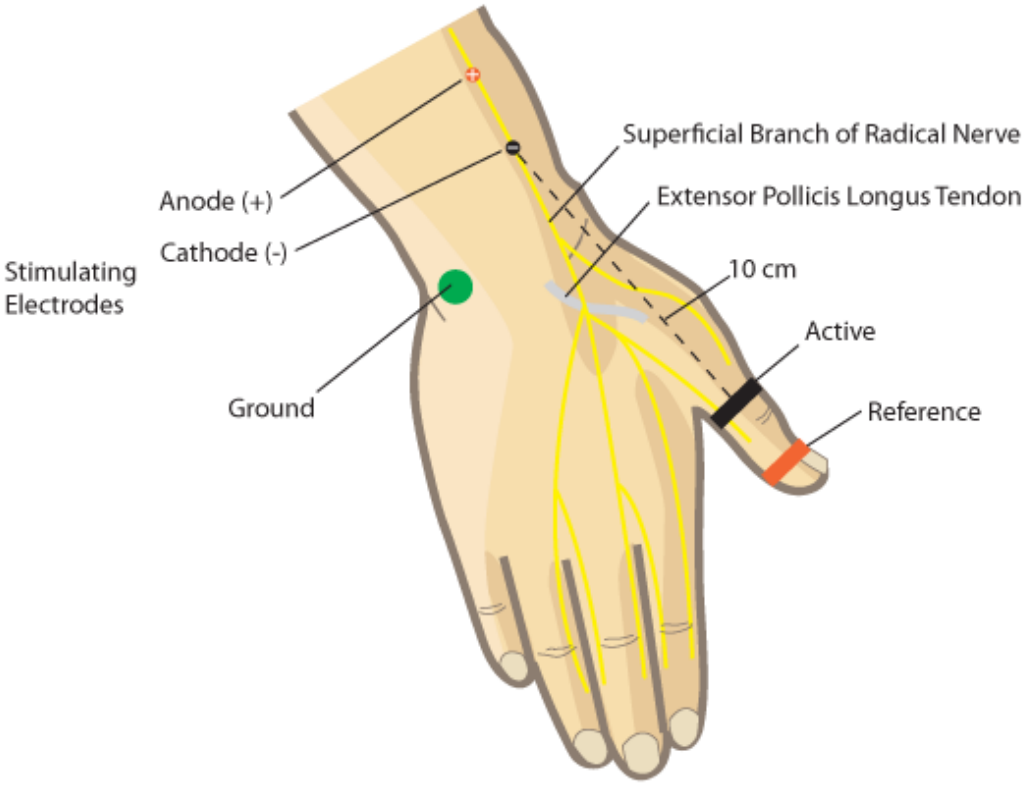


Parameters:
Gain = 20 uV/Div
Hicut = 2000 Hz
Locut = 10 Hz
Sweep = 2.0 ms/Div

Sierra Wave emg/ncv/ep

NCV

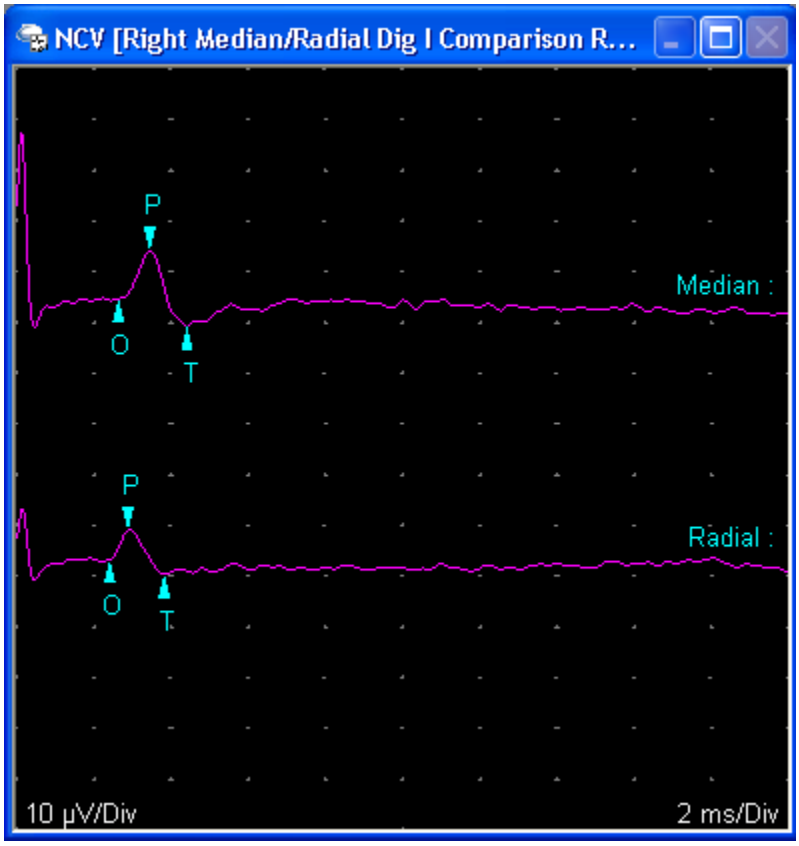
Radial Sensory
Antidromic to 1st Digit



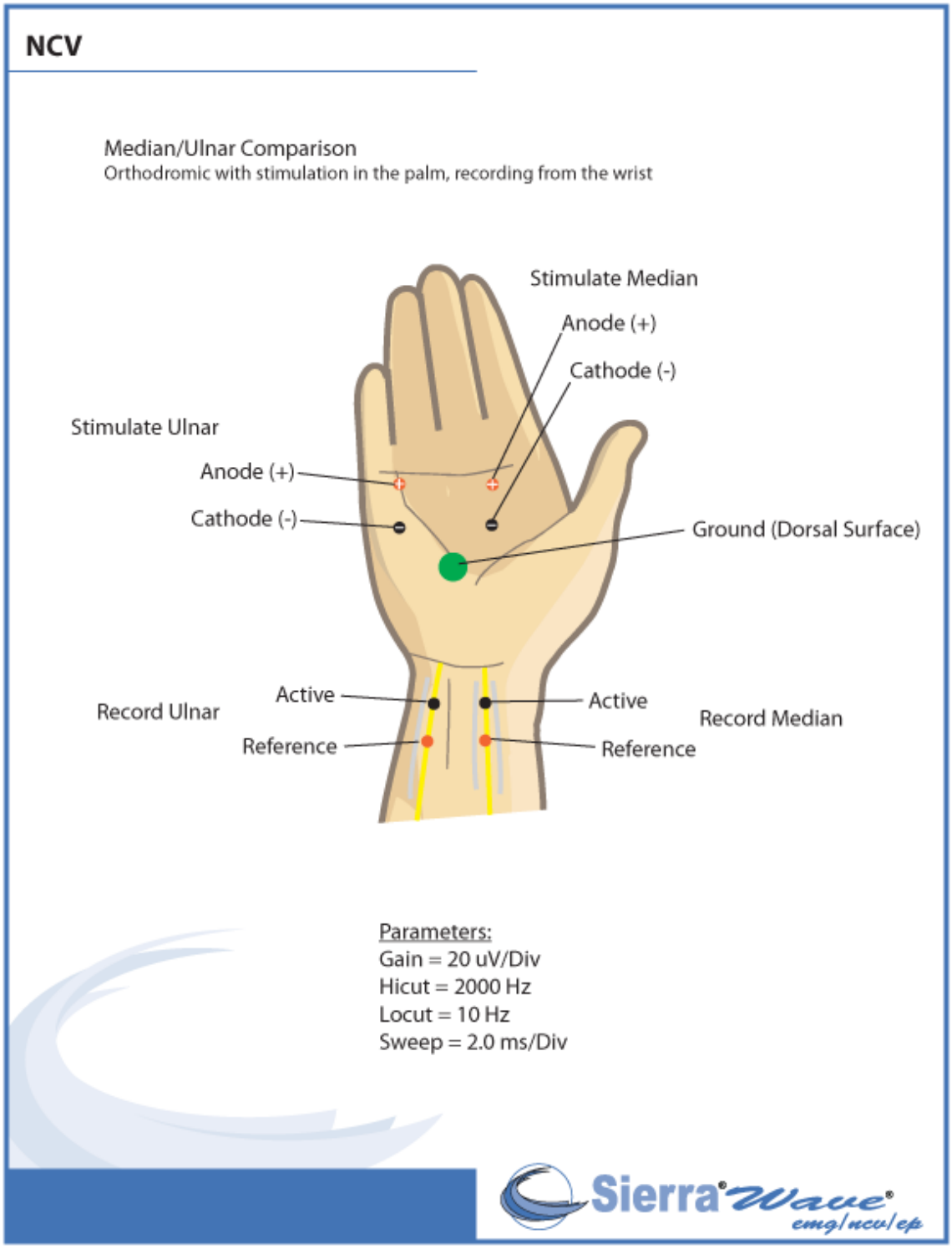
Parameters:
Gain = 10 - 20 uV/Div
Hicut = 2k Hz
Locut = 10 Hz
Sweep Speed = 1 - 2 ms/Div

Sierra Wave emg/ncv/ep

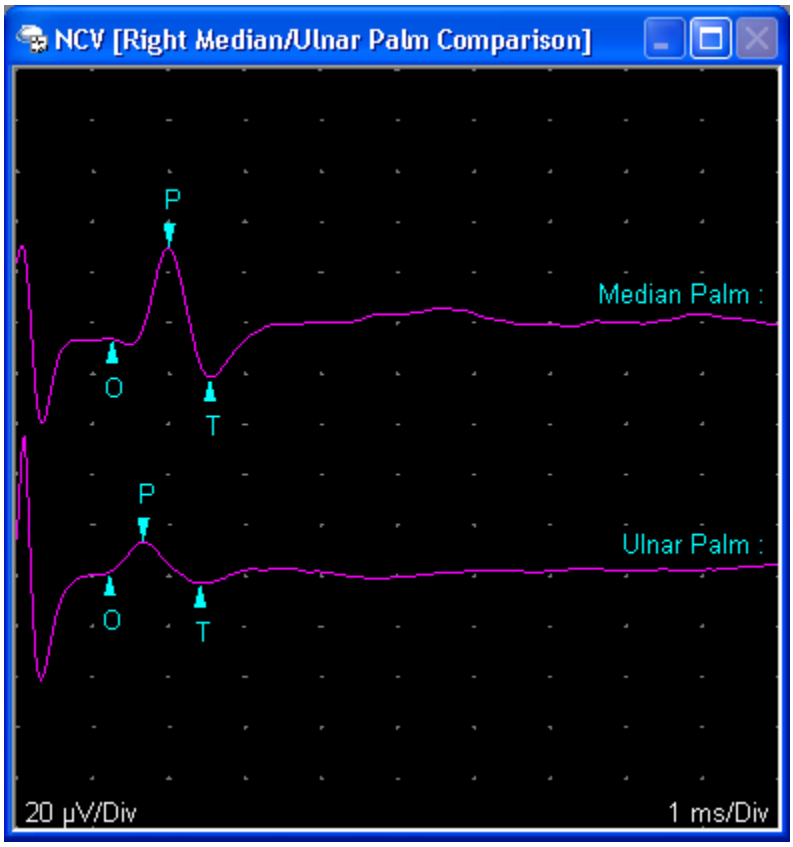
Example Traces:



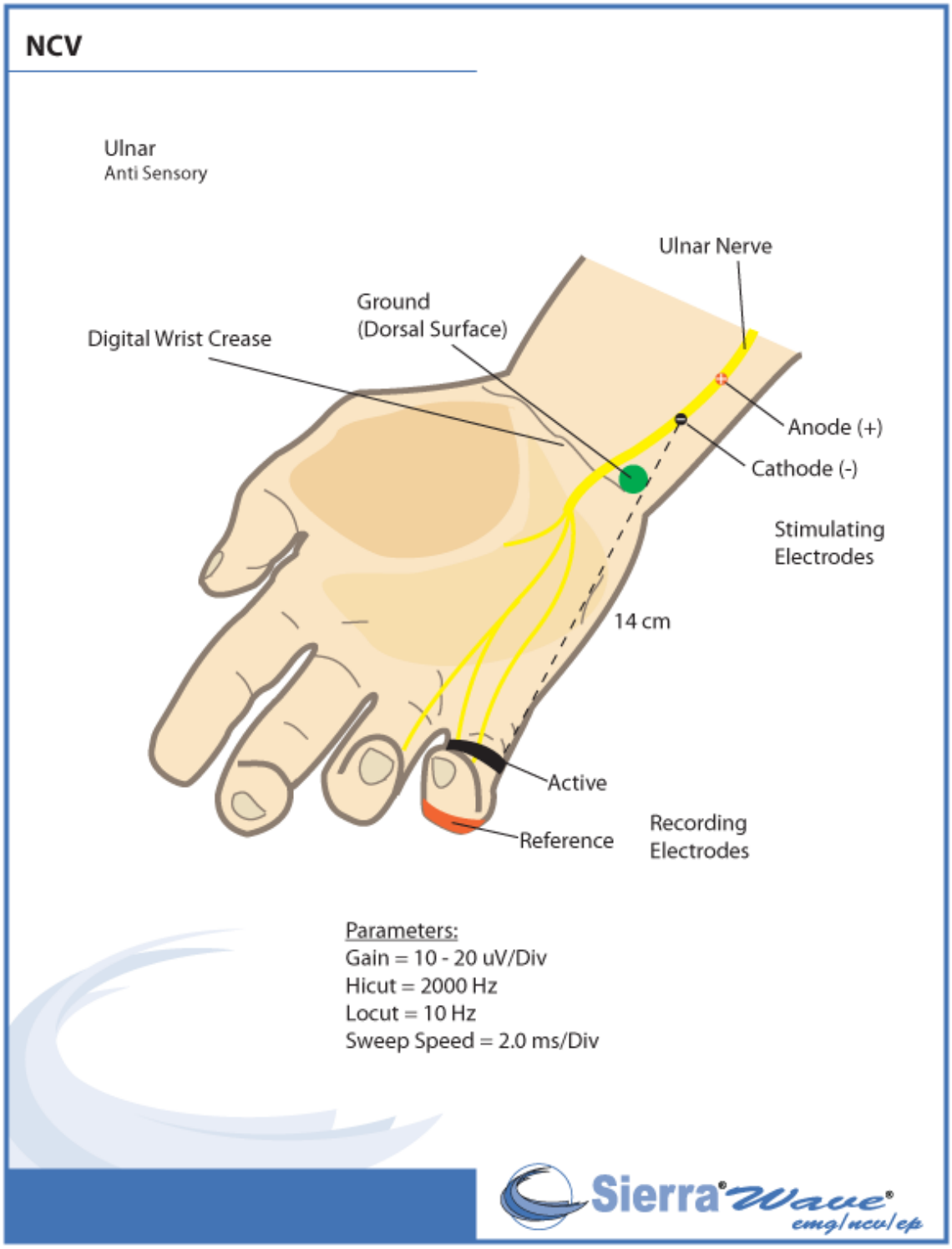
Median/Ulnar Palm Sensory Comparison to Wrist



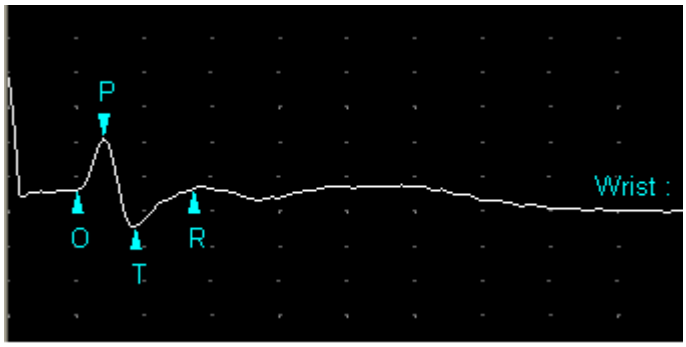
Example Traces:



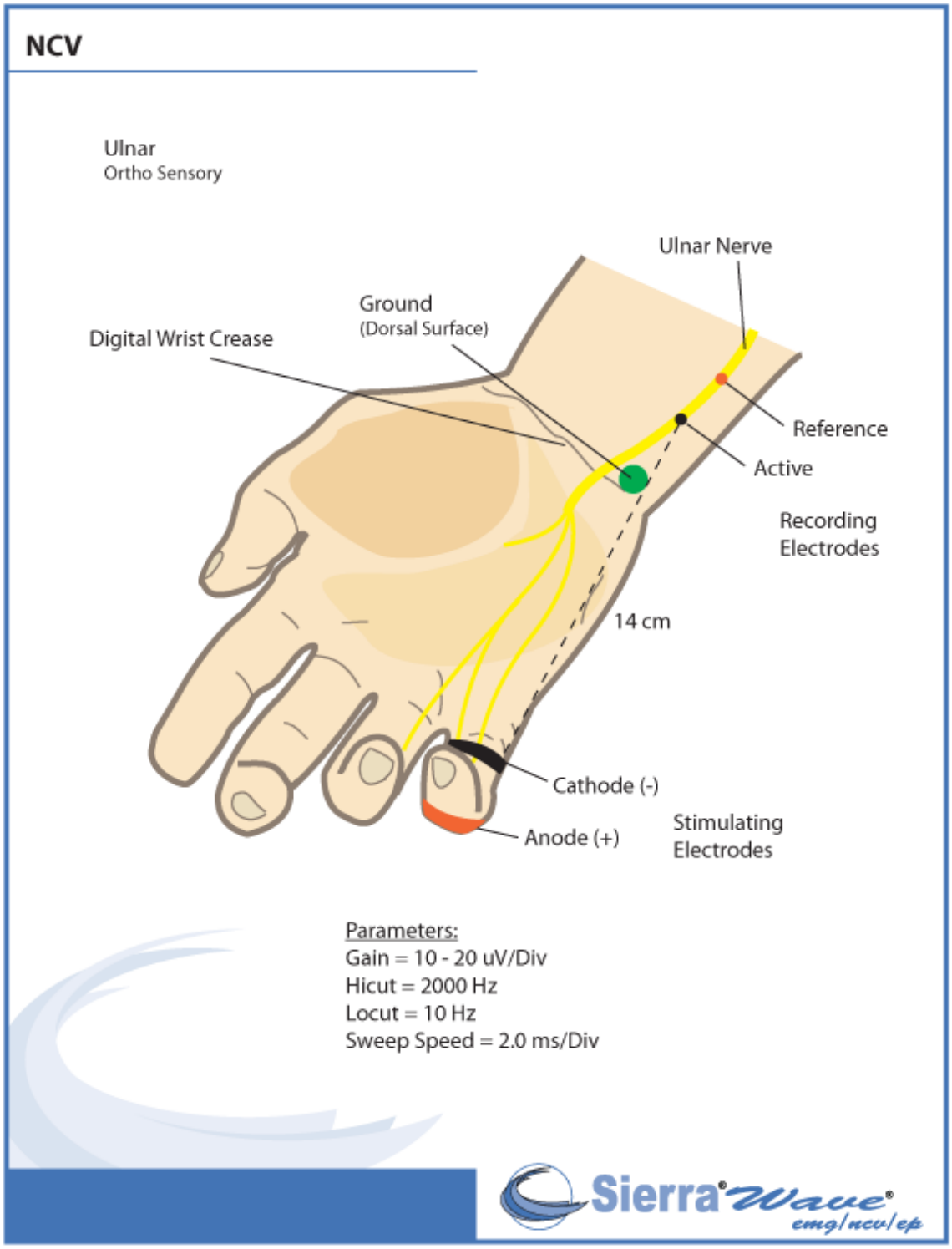
Ulnar Antidromic Sensory



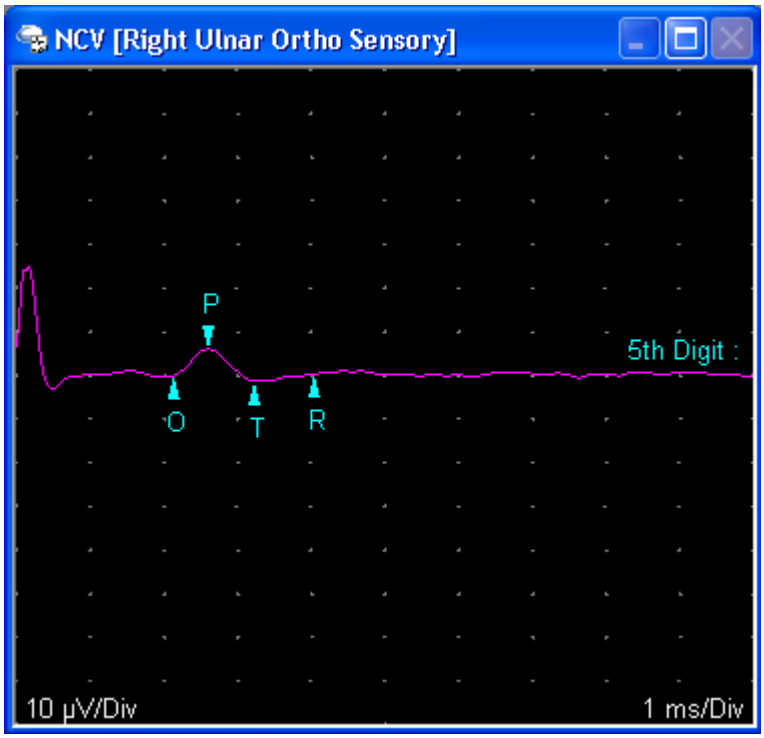
ULNAR ANTI SENSORY - Example Trace



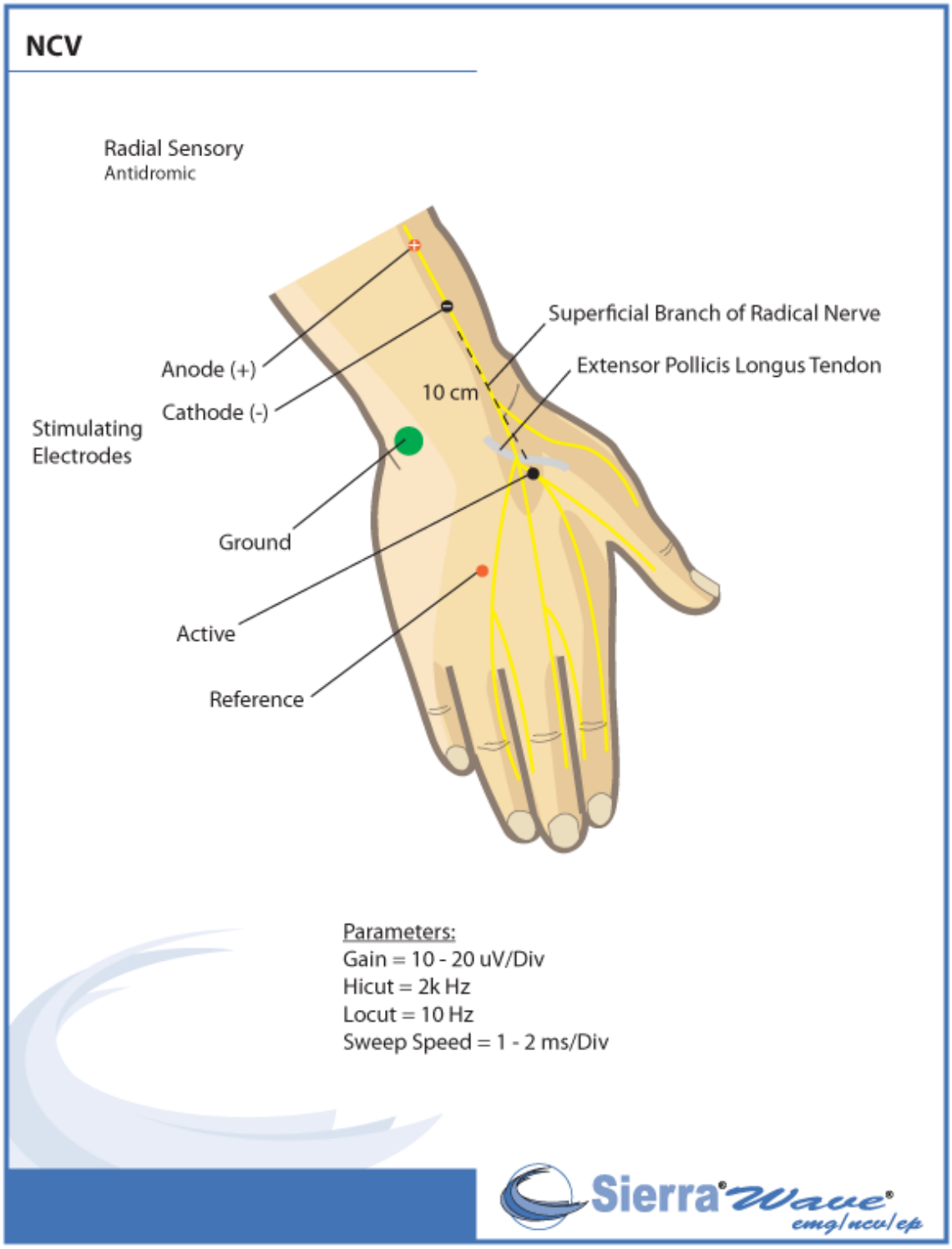
Ulnar Orthodromic Sensory



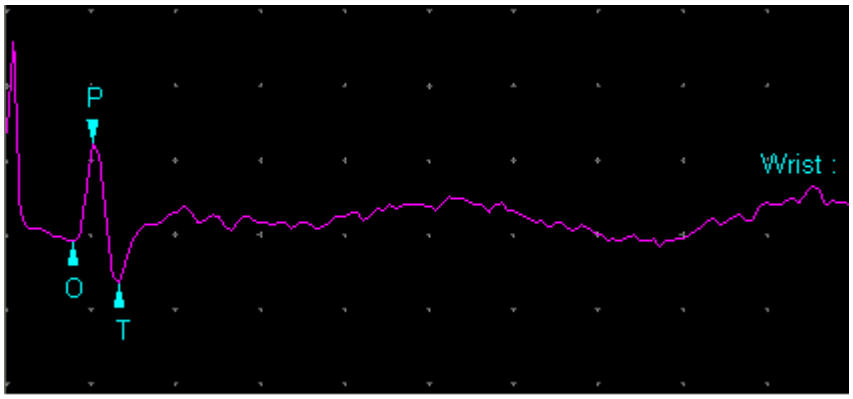
Example Trace:



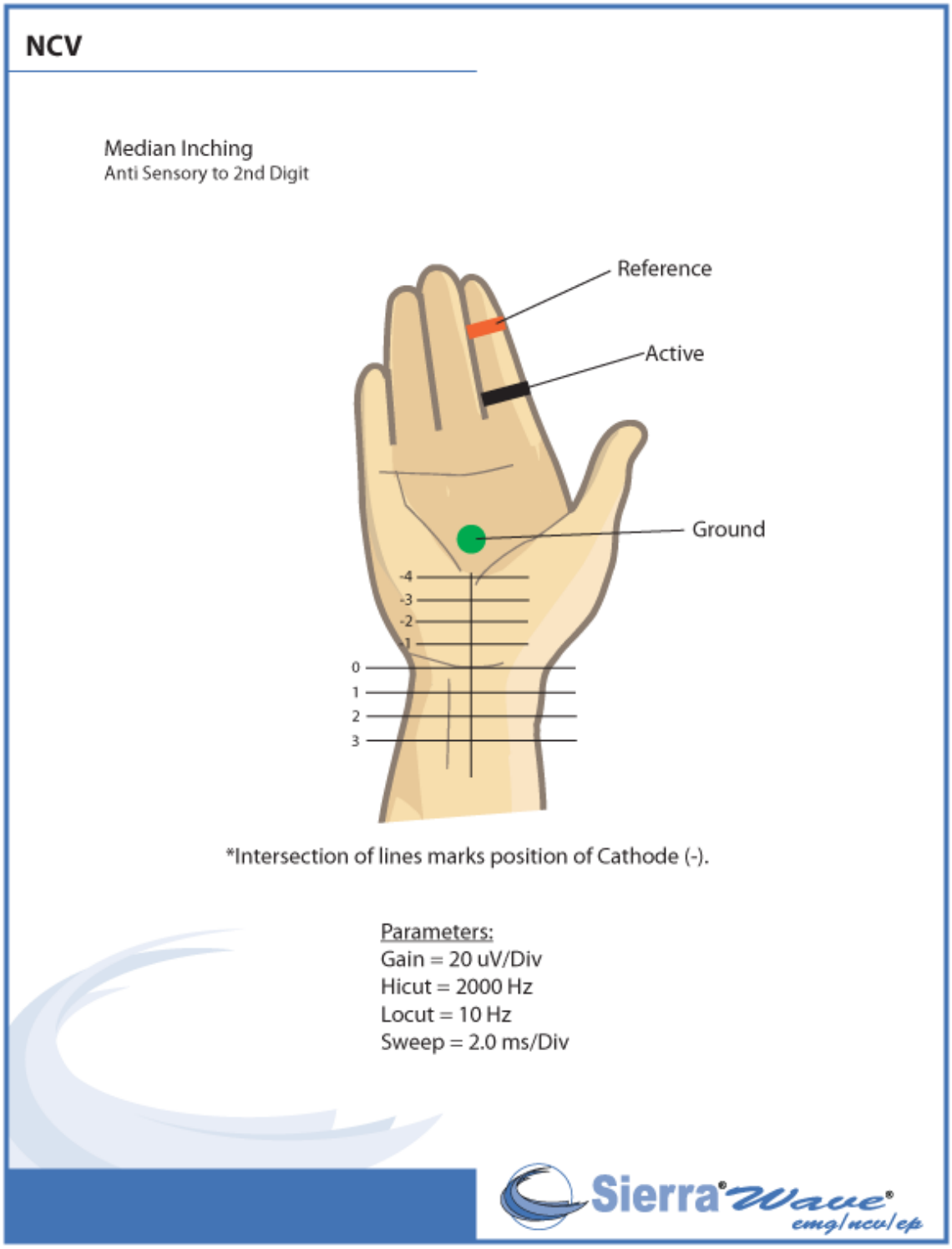
Radial Antidromic Sensory



Example Trace:

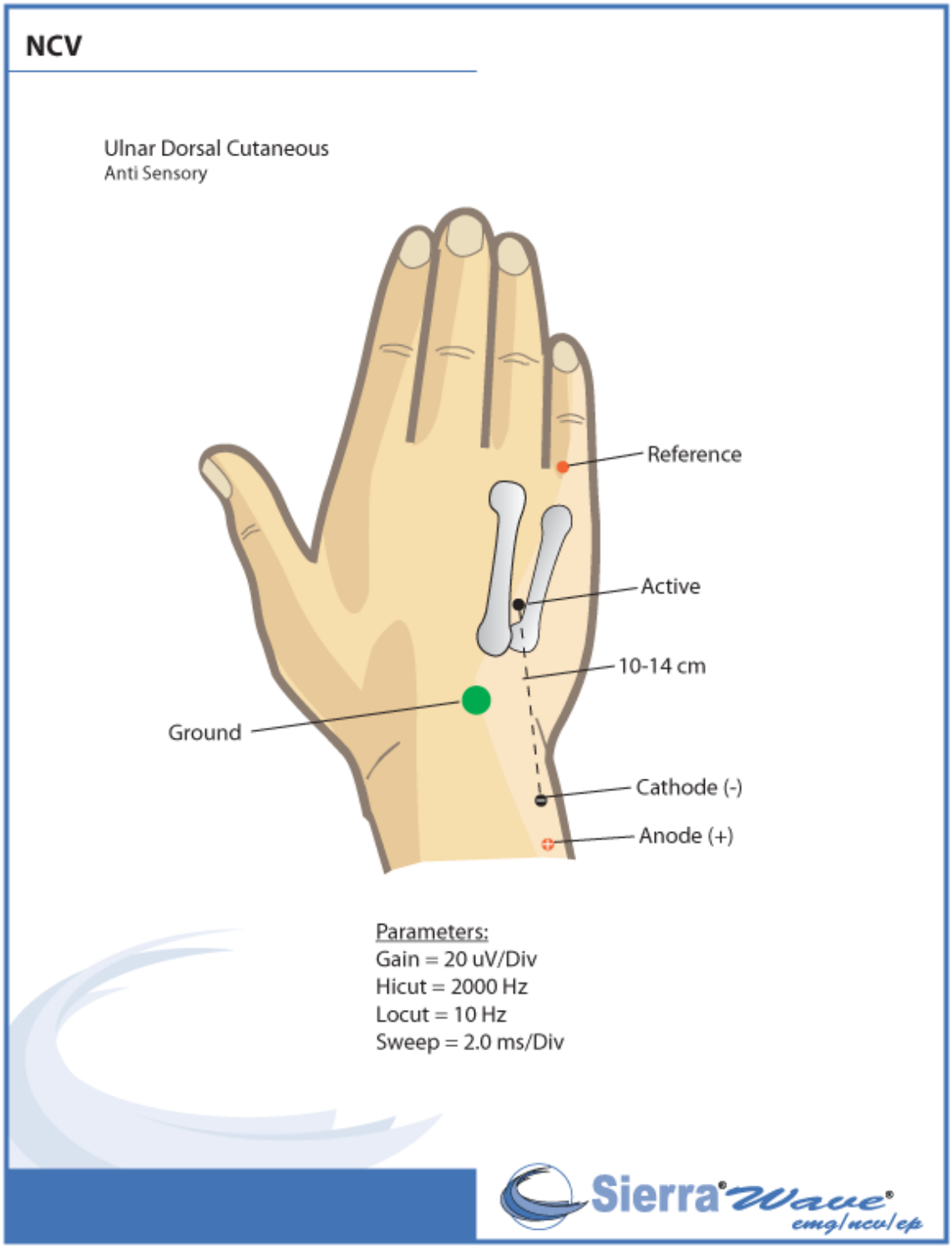


Median Inching (across the wrist)

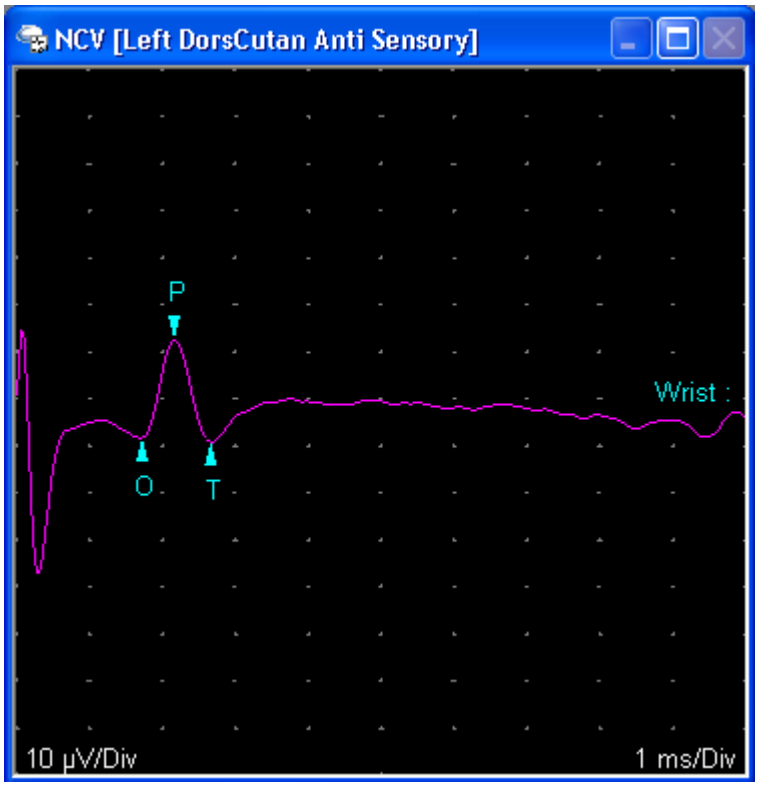


Example Traces:

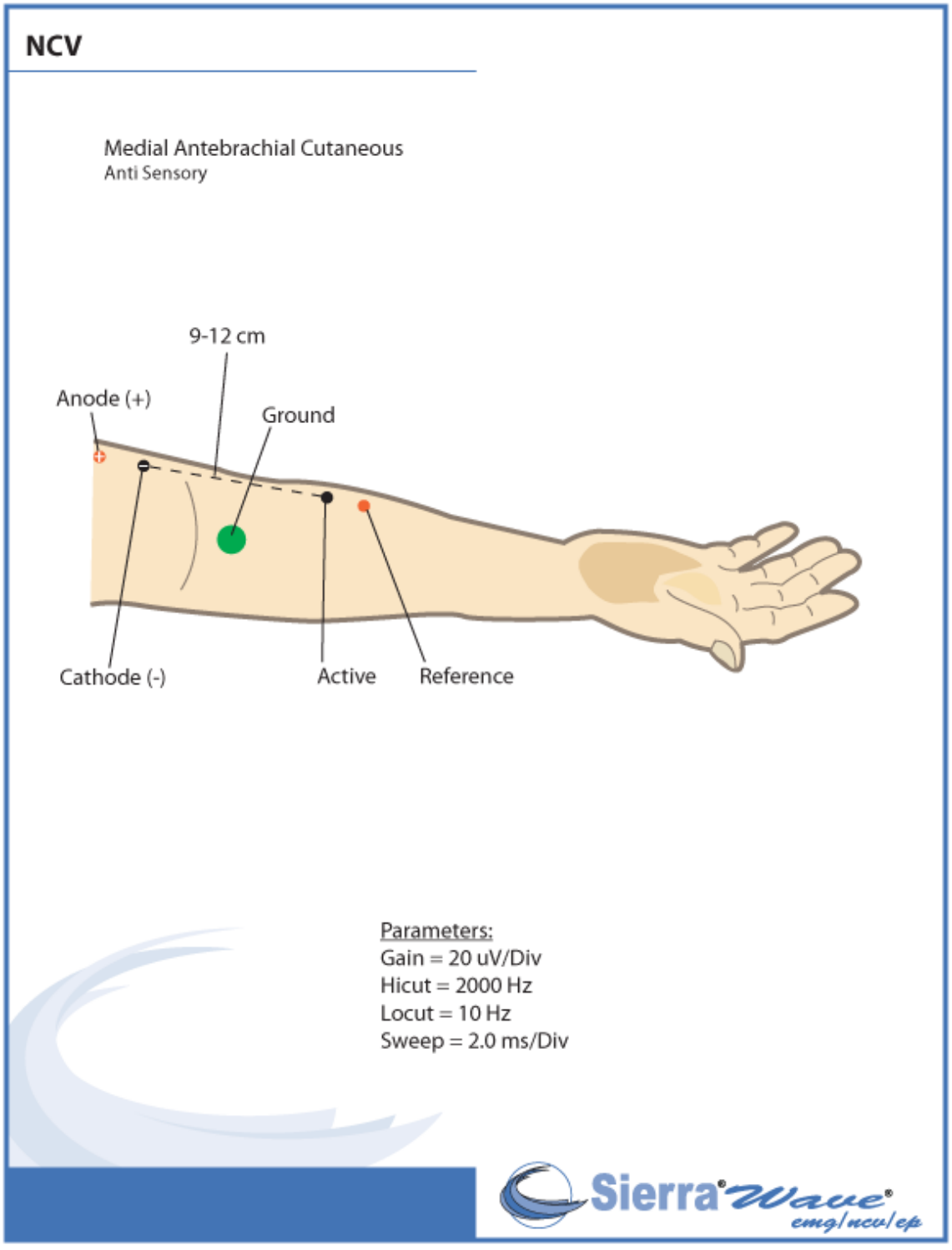
Dorsal Cutaneous



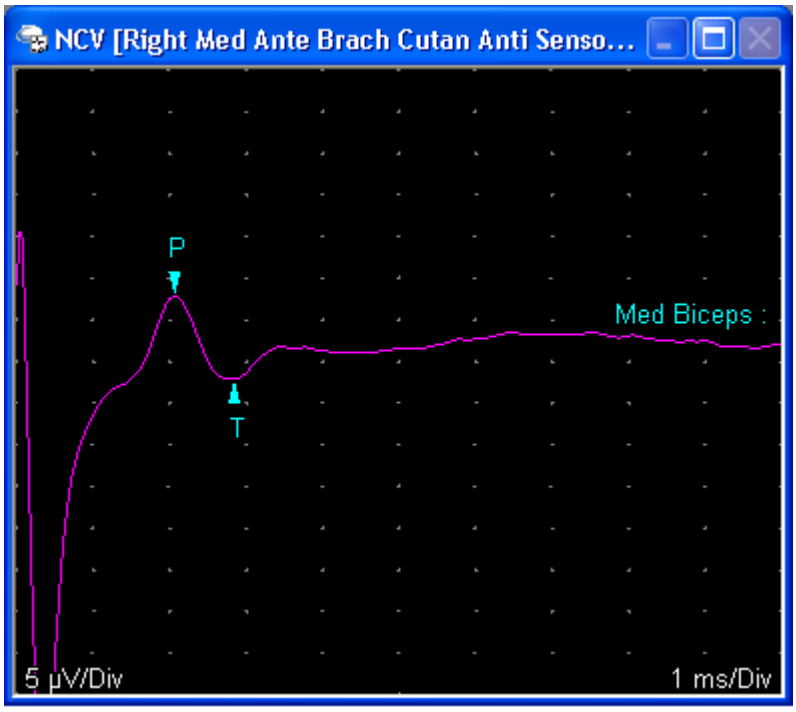
Example Trace:



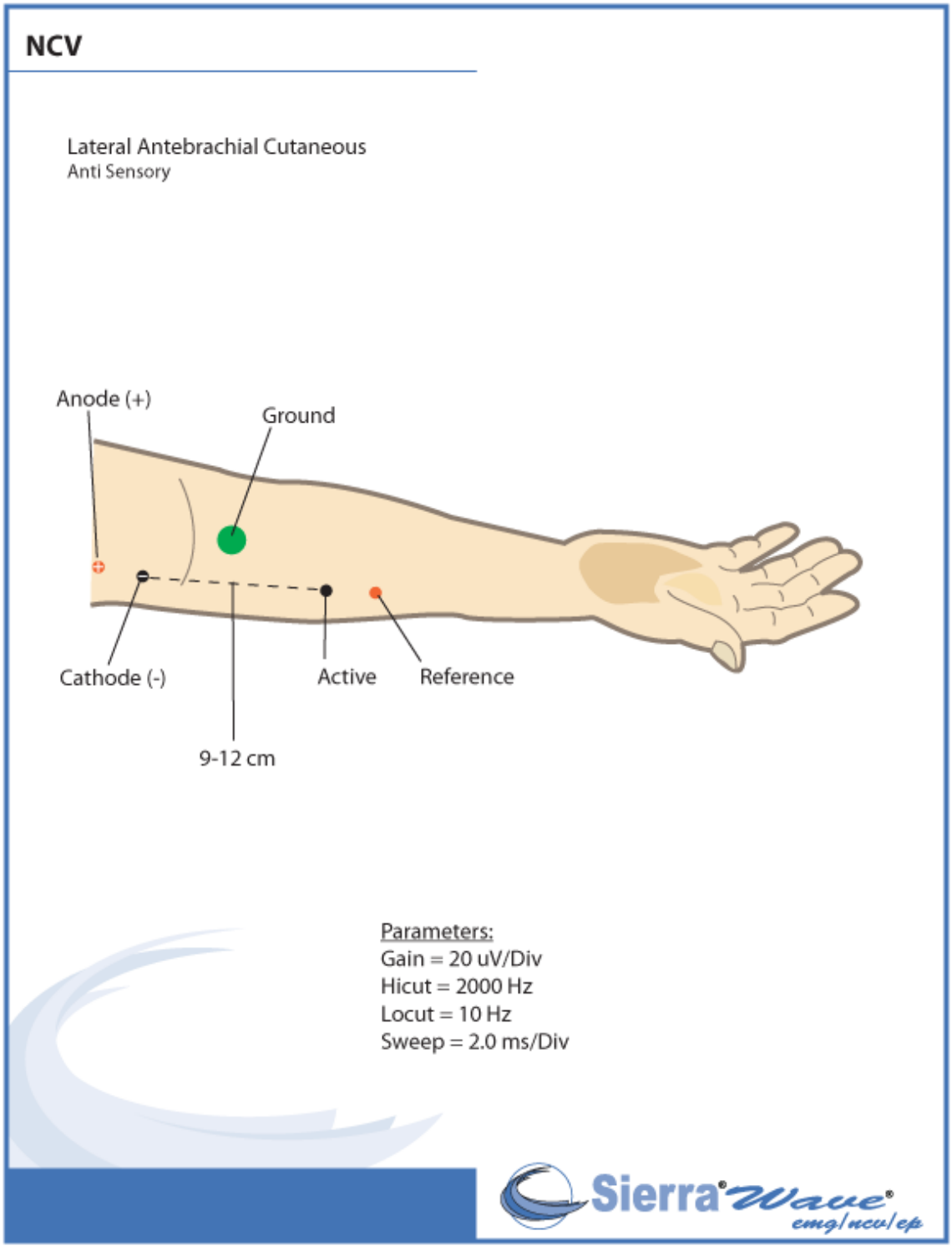
Medial Antebrachial Cutaneous



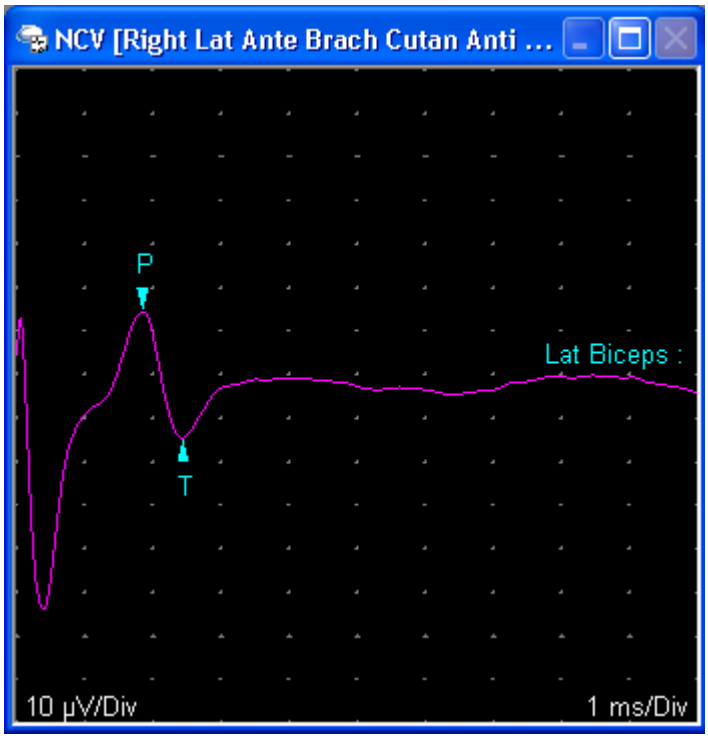
Example Trace:



Lateral Antebrachial Cutaneous

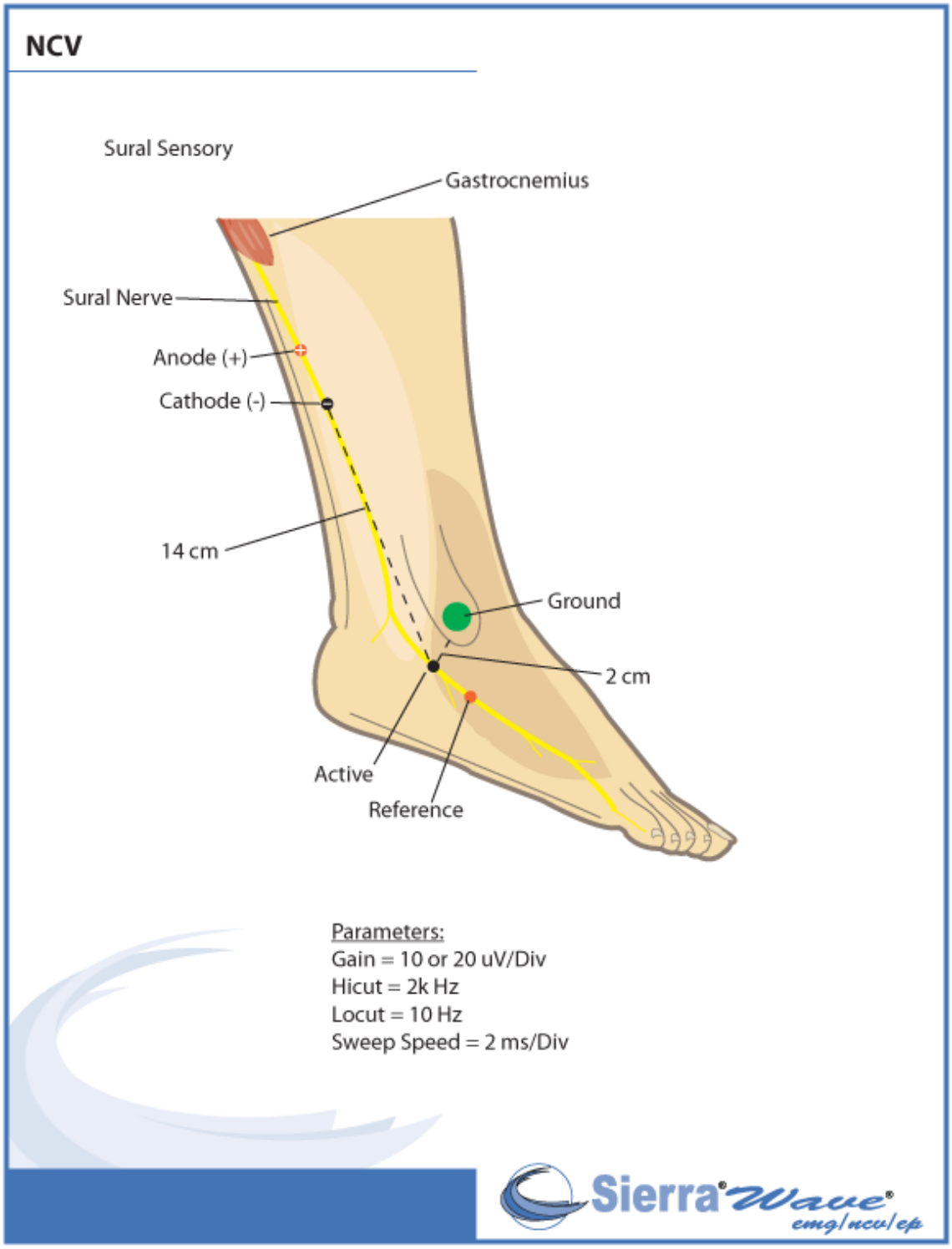


Example Trace:

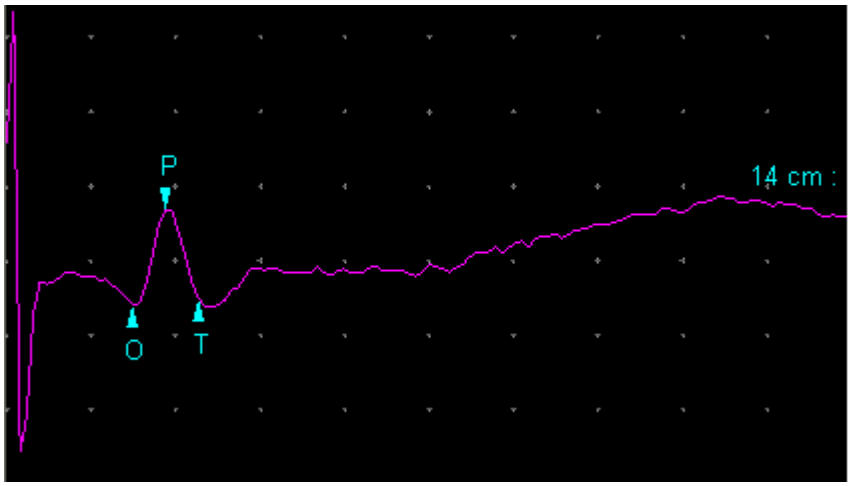


Lower Limb Sensory Nerves

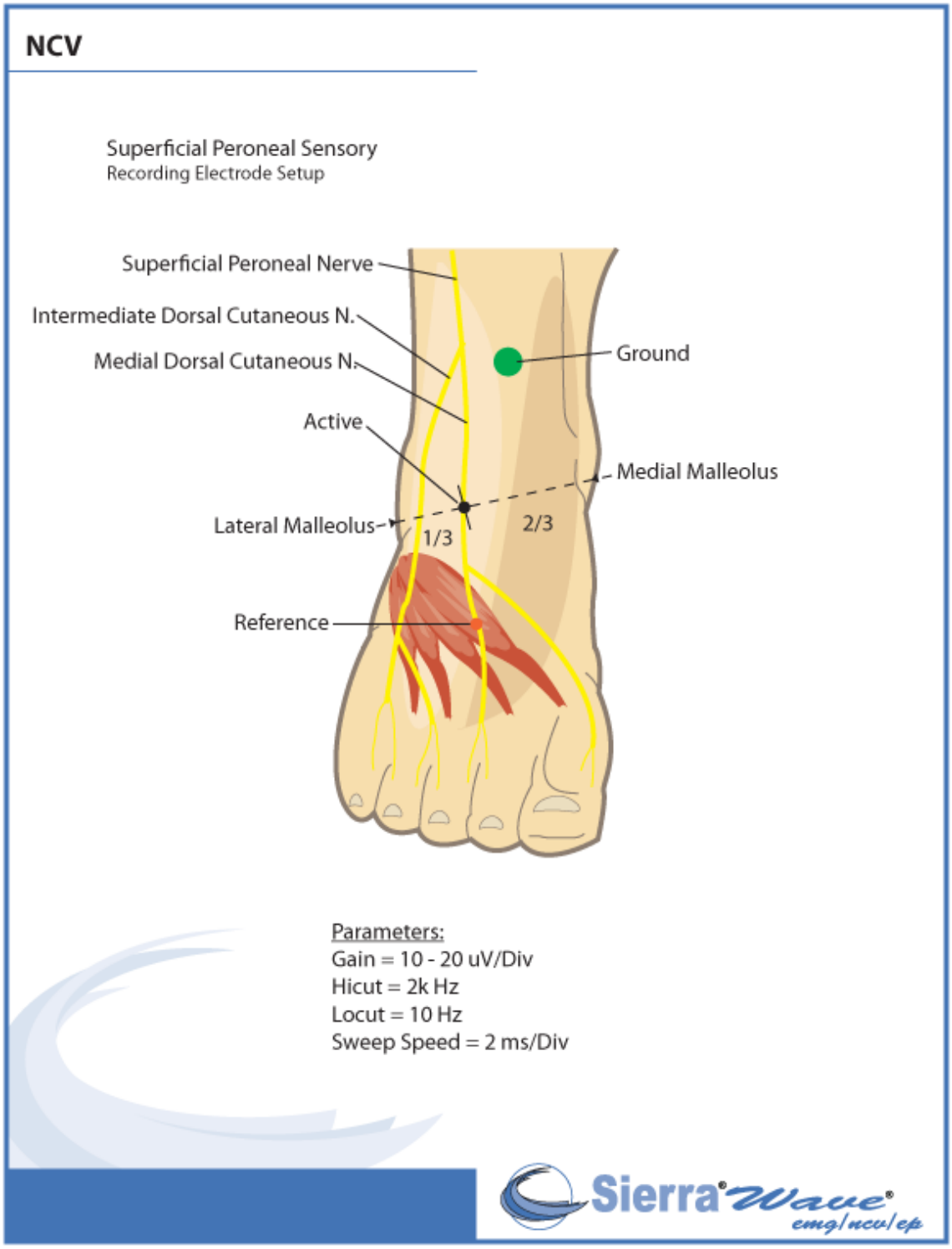
Sural Antidromic Sensory



Example Trace:



Superficial Peroneal Antidromic Sensory

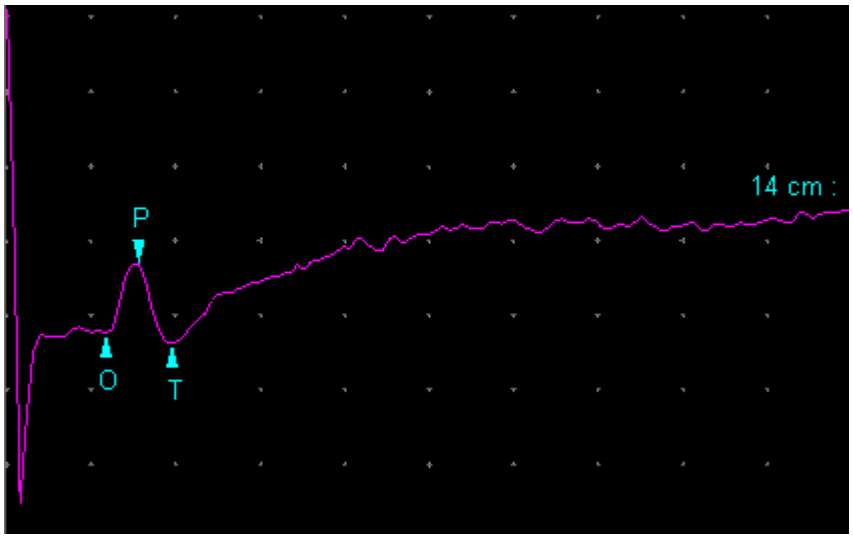


NCV

Superficial Peroneal Sensory
Stimulating Site

Sierra Wave emg/ncv/ep

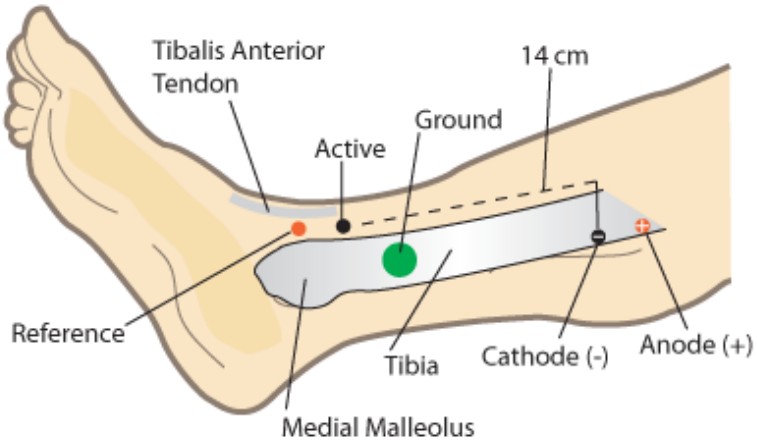
Example Trace:



Saphenous Antidromic Sensory

NCV

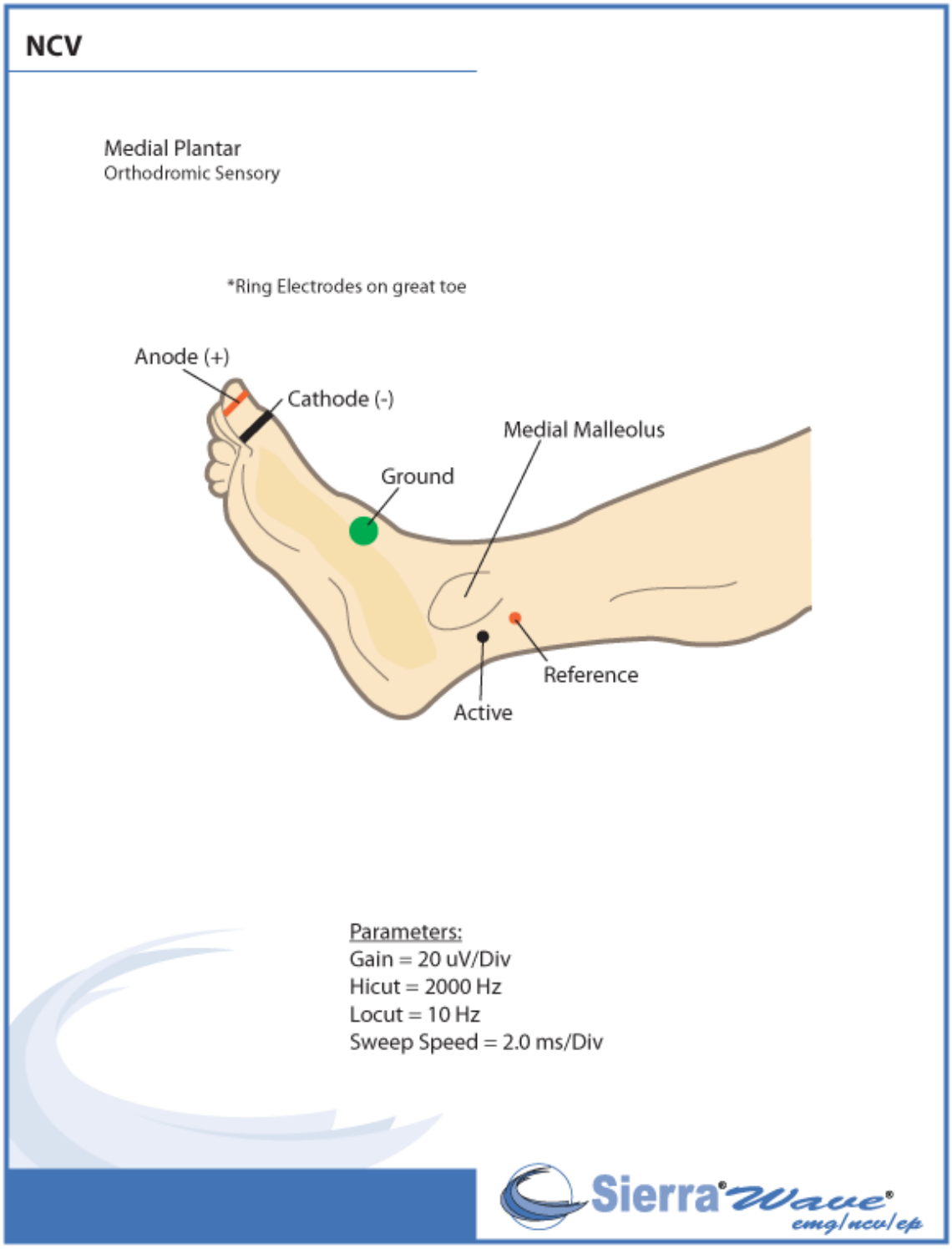
Saphenous
Anti Sensory



Parameters:
Gain = 20 uV/Div
Hicut = 2000 Hz
Locut = 10 Hz
Sweep Speed = 2.0 ms/Div

Sierra Wave emg/ncv/ep

Medial Plantar Sensory

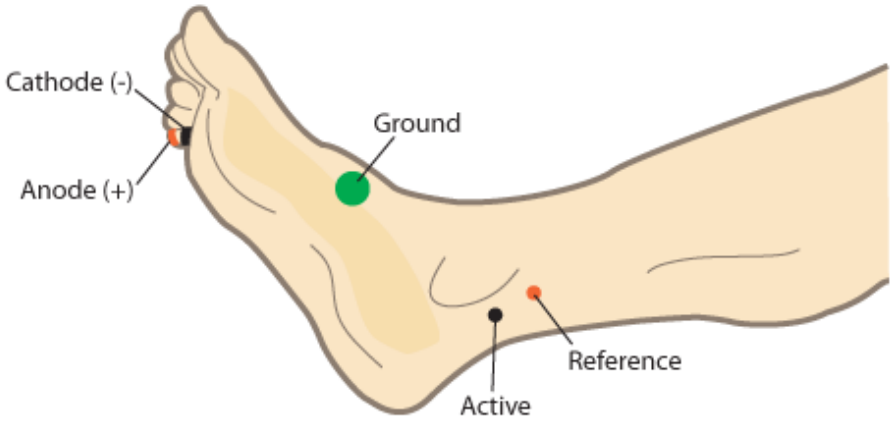


Lateral Plantar Sensory

NCV

Lateral Plantar
Orthodromic Sensory

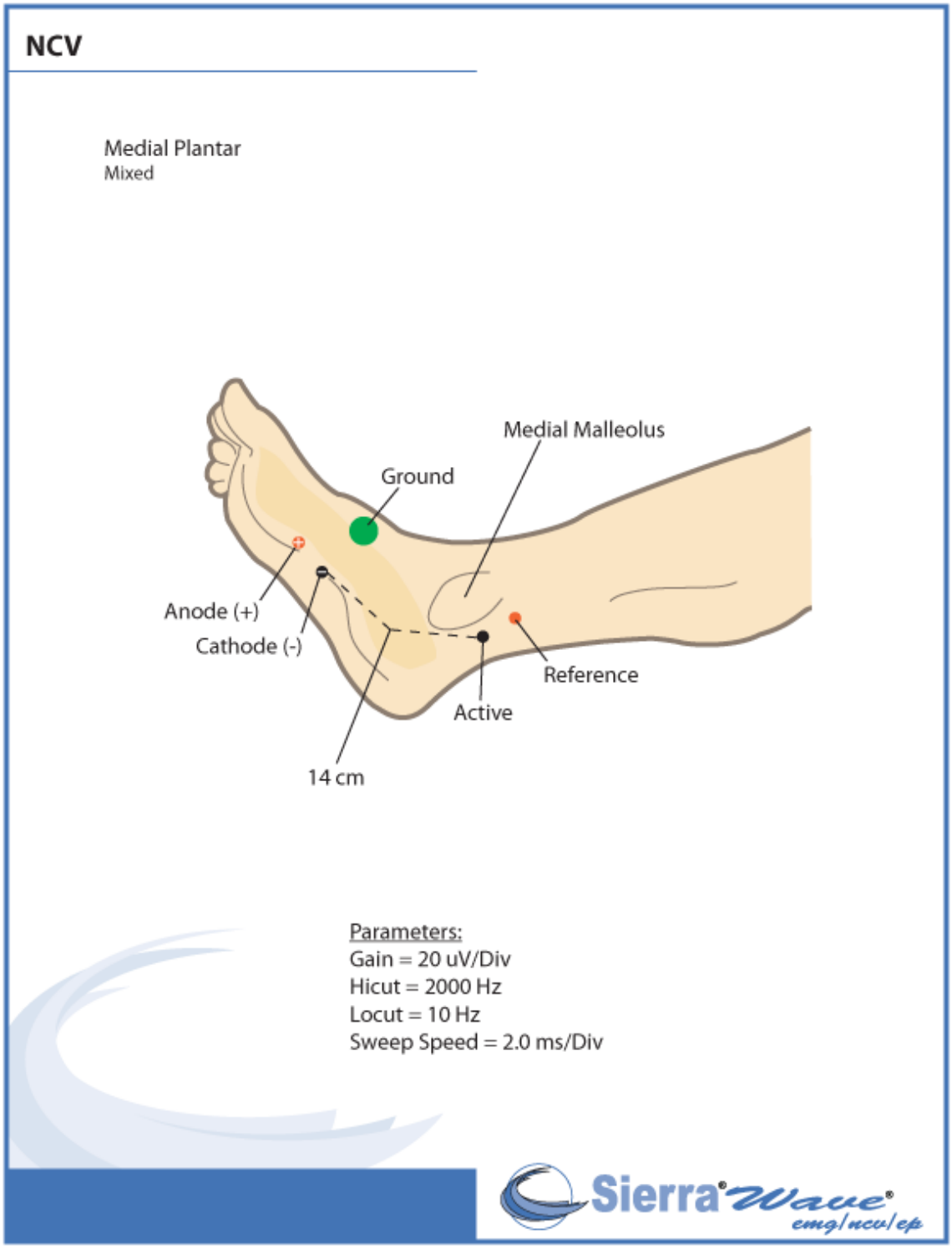
*Ring electrodes on fifth toe used for stimulation.



Parameters:
Gain = 20 uV/Div
Hicut = 2000 Hz
Locut = 10 Hz
Sweep Speed = 2.0 ms/Div

Sierra Wave emg/ncv/ep

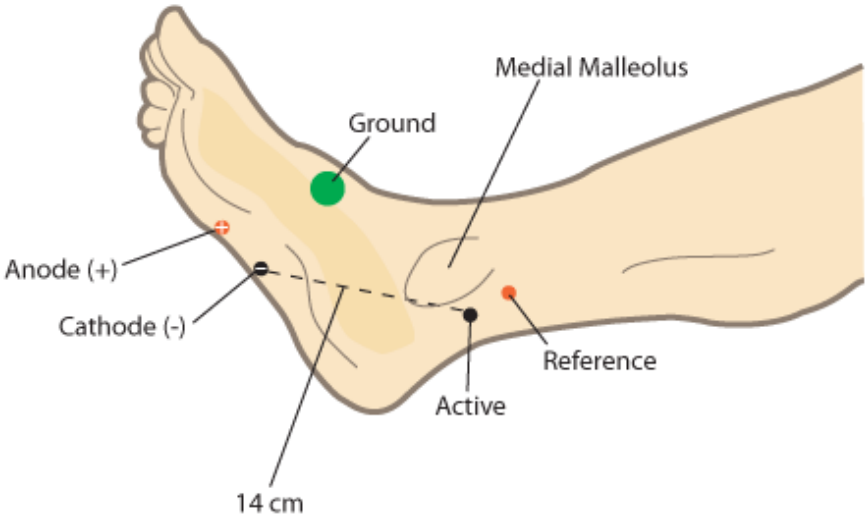
Medial Plantar Mixed



Lateral Plantar Mixed

NCV

Lateral Plantar
Mixed



Parameters:
Gain = 20 uV/Div
Hicut = 2000 Hz
Locut = 10 Hz
Sweep Speed = 2.0 ms/Div

Sierra Wave emg/ncv/ep

F Wave / H Reflex Setups

F Wave / H Reflex Index

Click on a nerve to display that topic.

Median F Wave

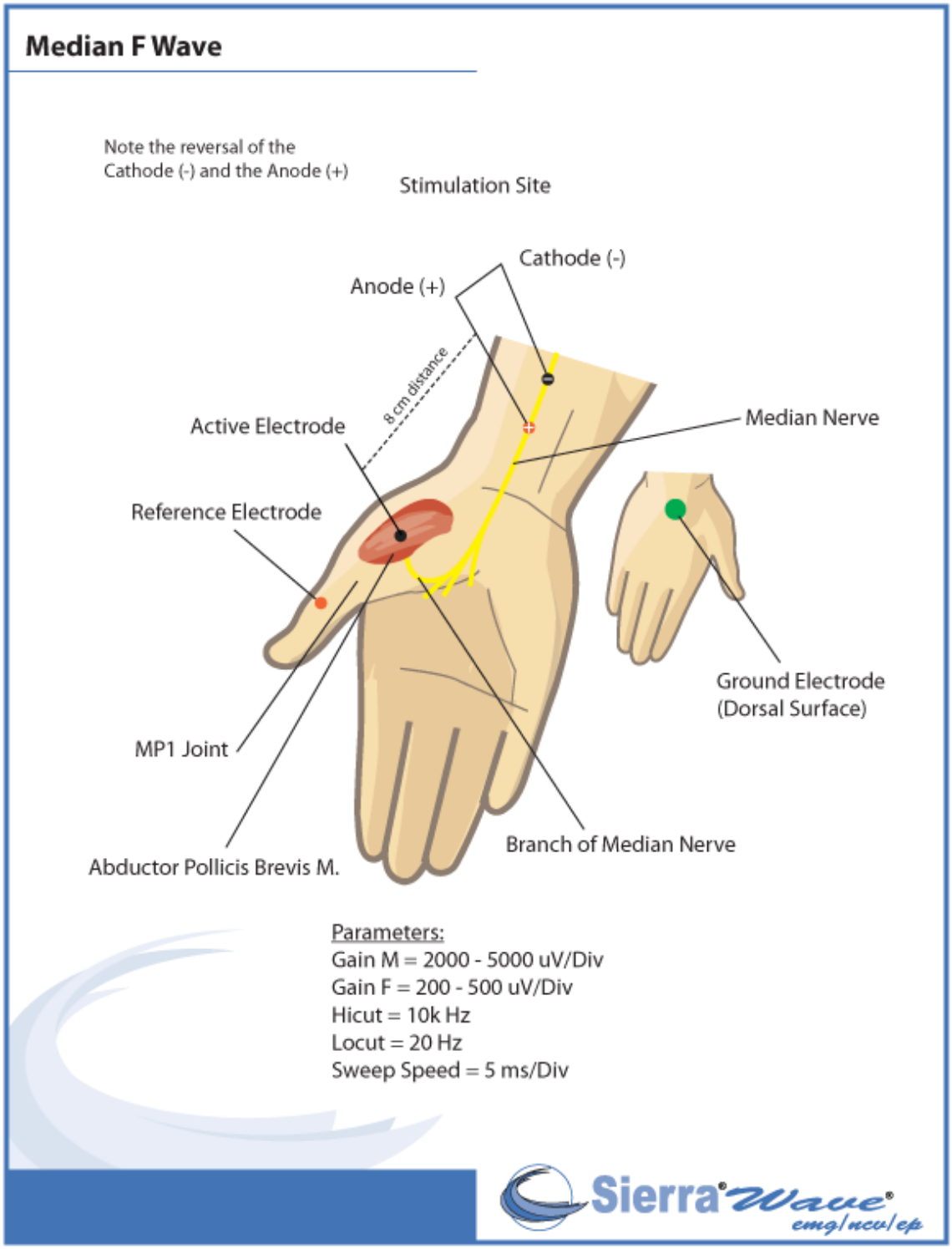
Ulnar F Wave

Peroneal F Wave

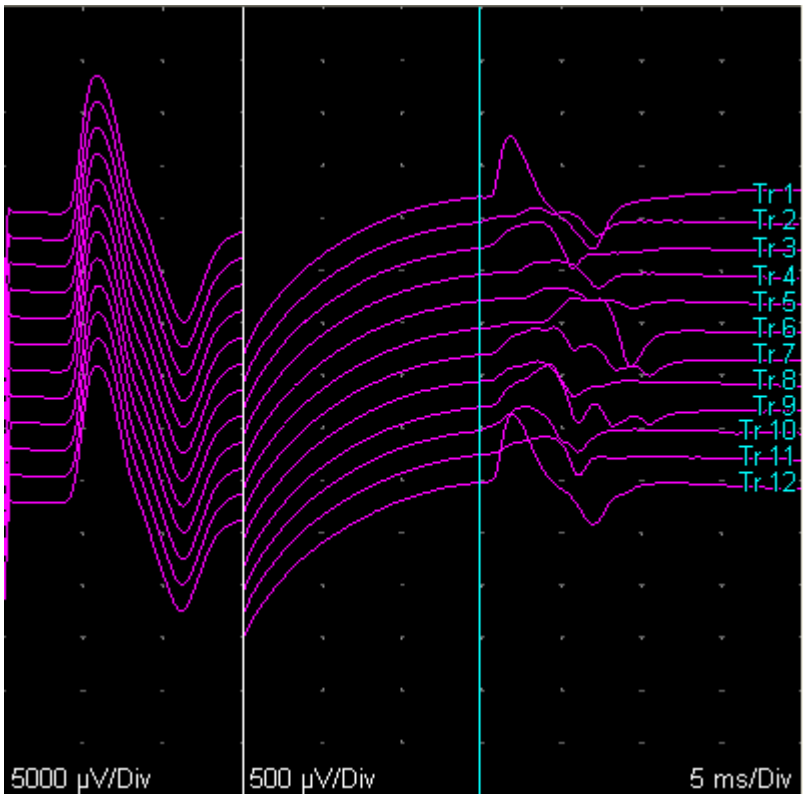
Tibial F Wave

H Reflex (Tibial)

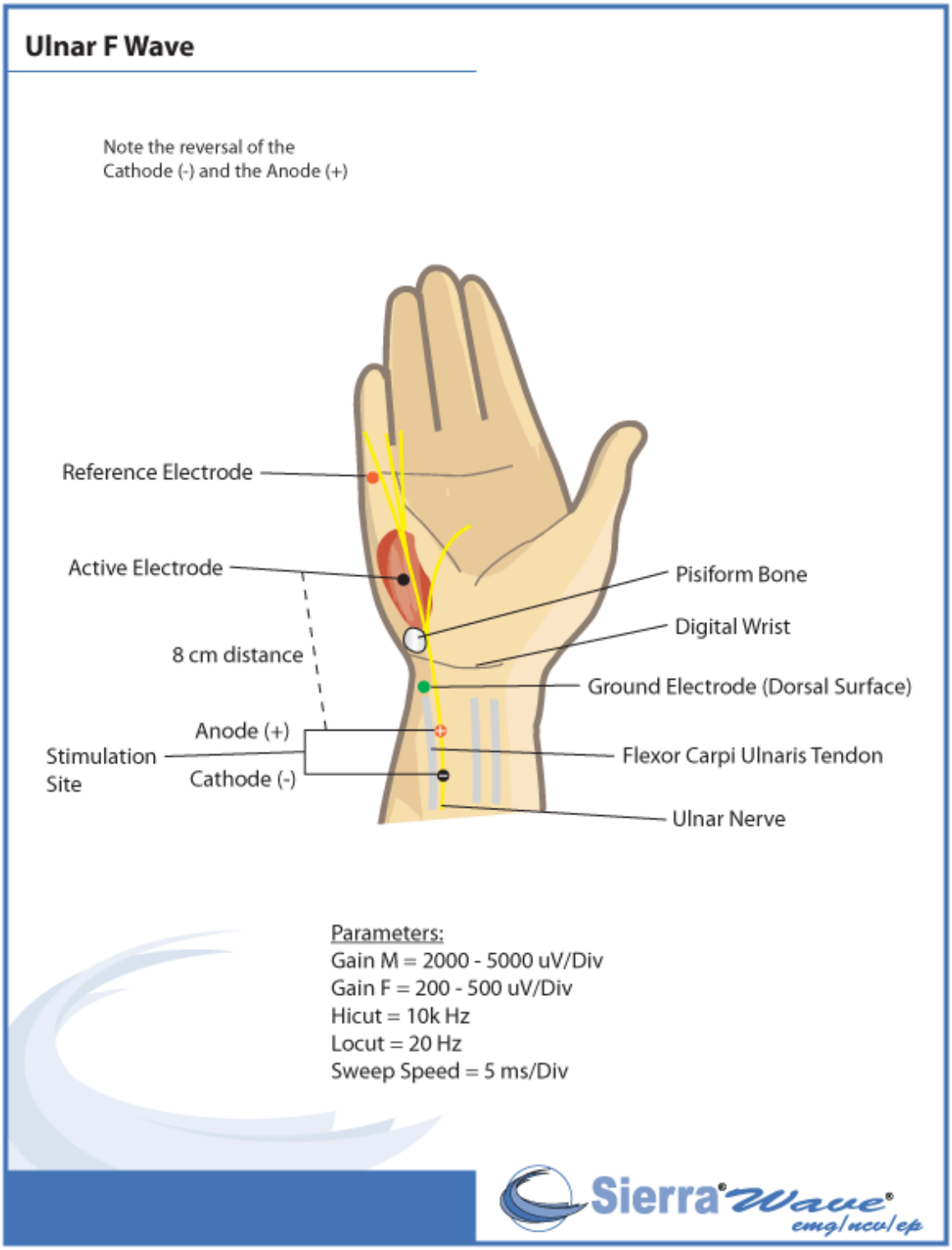
Median F Wave



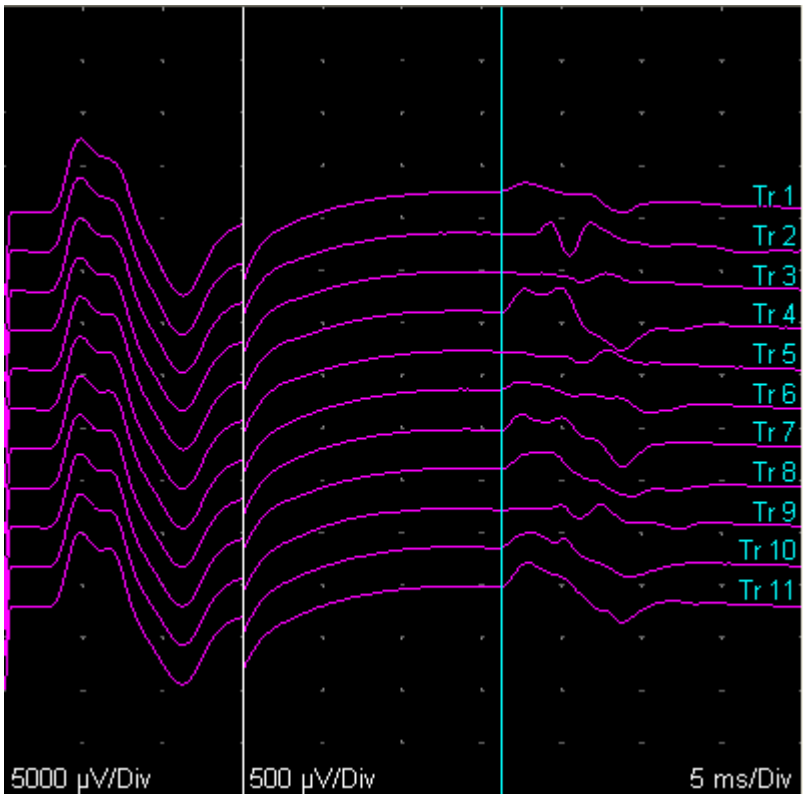
Example Traces:



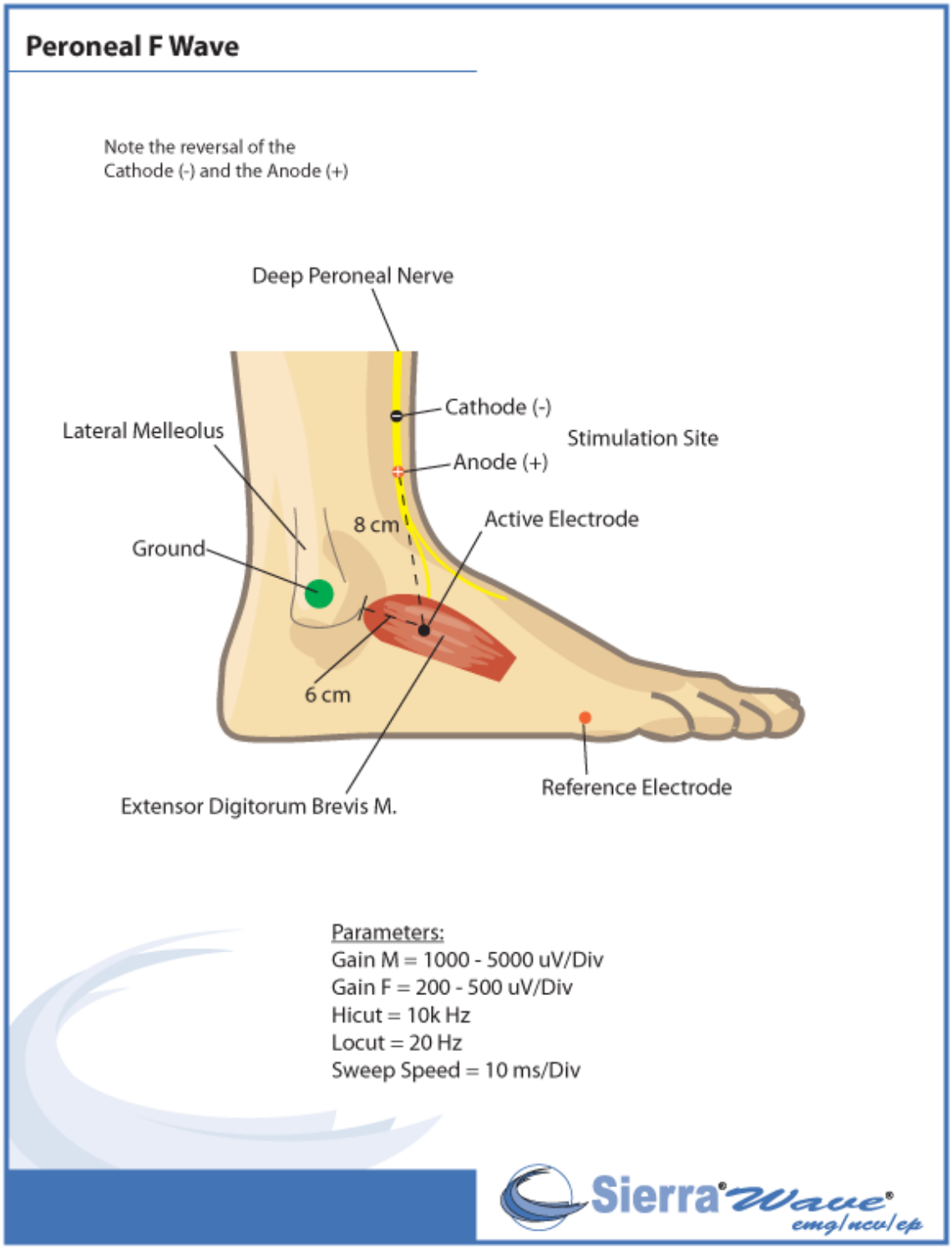
Ulnar F Wave


Ulnar F Wave
Note the reversal of the
Cathode (-) and the Anode (+)
Reference Electrode
Active Electrode
8 cm distance
Anode (+)
Stimulation
Site
Cathode (-)
Pisiform Bone
Digital Wrist
Ground Electrode (Dorsal Surface)
Flexor Carpi Ulnaris Tendon
Ulnar Nerve
Parameters:
Gain M = 2000 - 5000 uV/Div
Gain F = 200 - 500 uV/Div
Hicut = 10k Hz
Locut = 20 Hz
Sweep Speed = 5 ms/Div
Sierra Wave
emg/ncv/ep

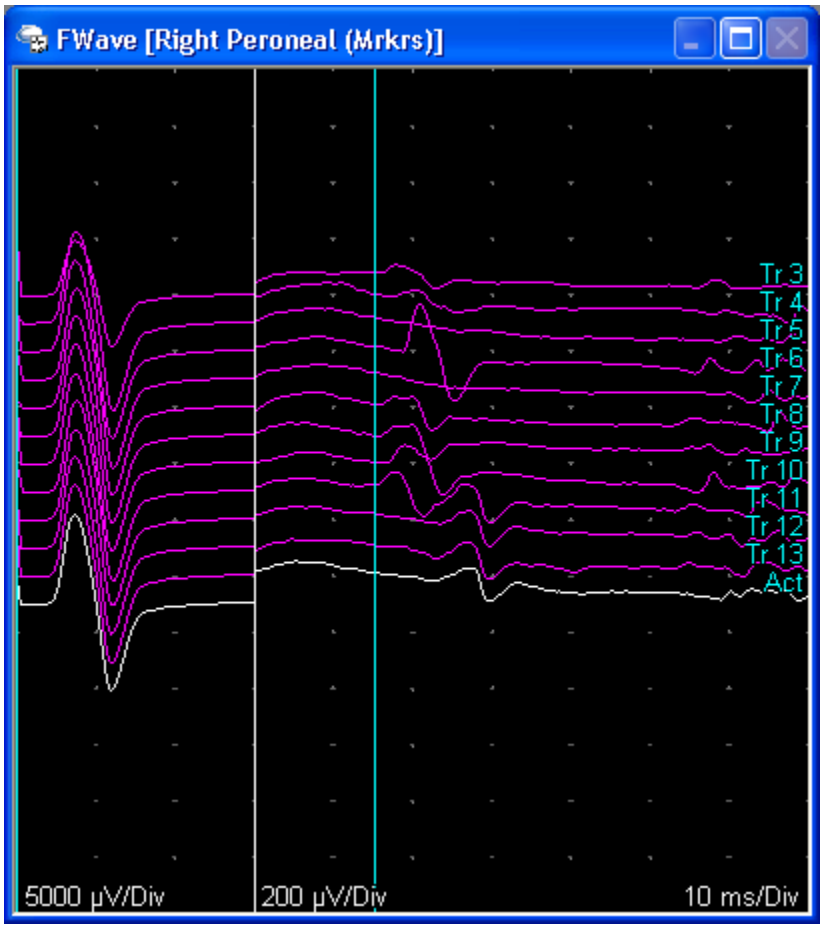
Example Traces:



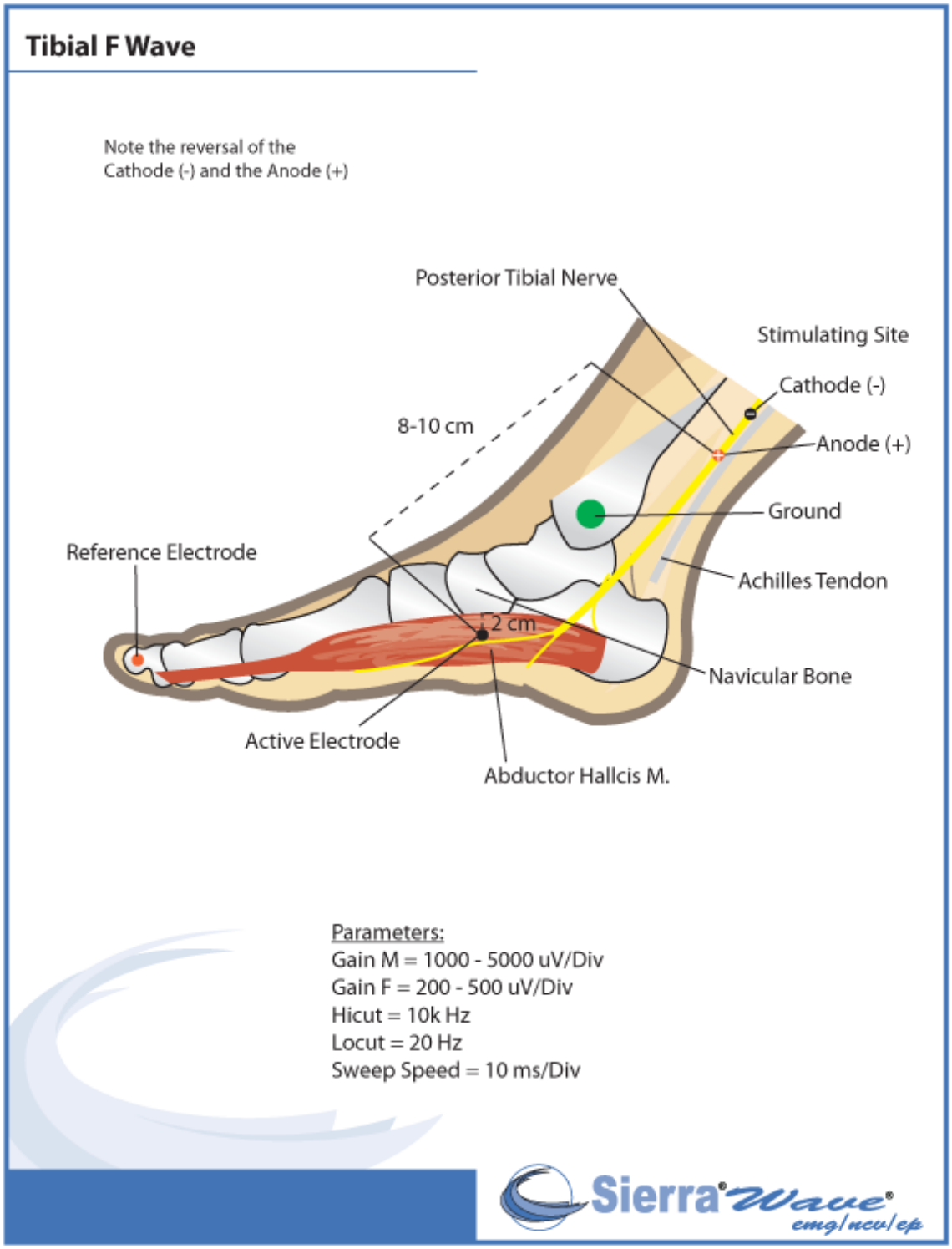
Peroneal F Wave



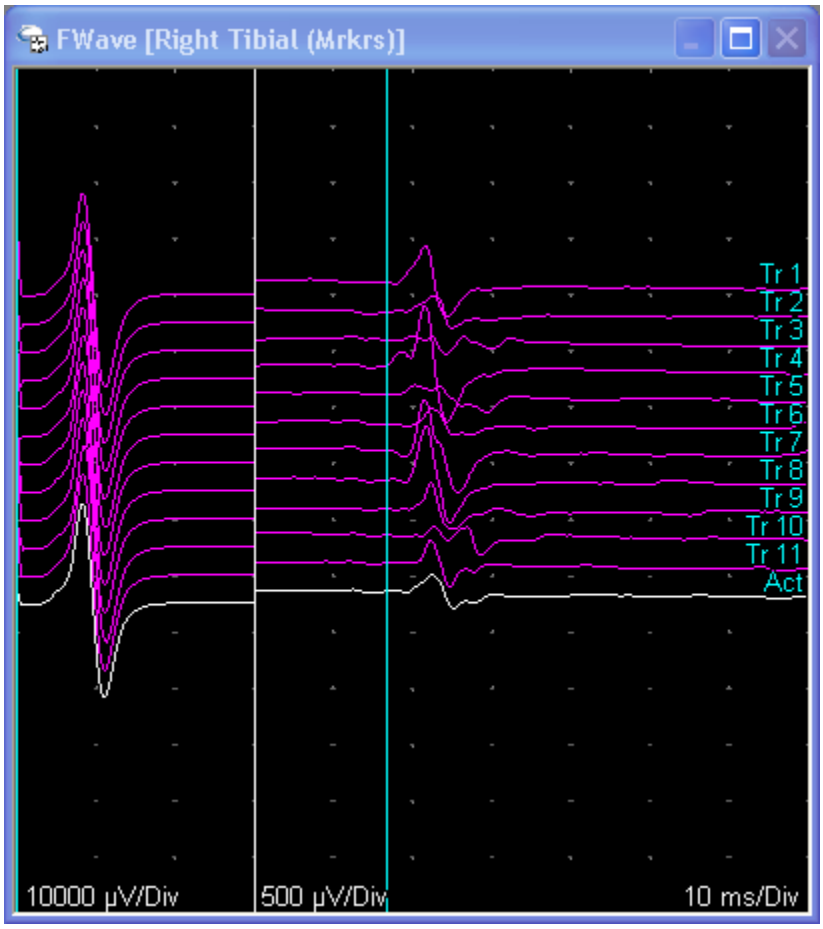
Example Traces:



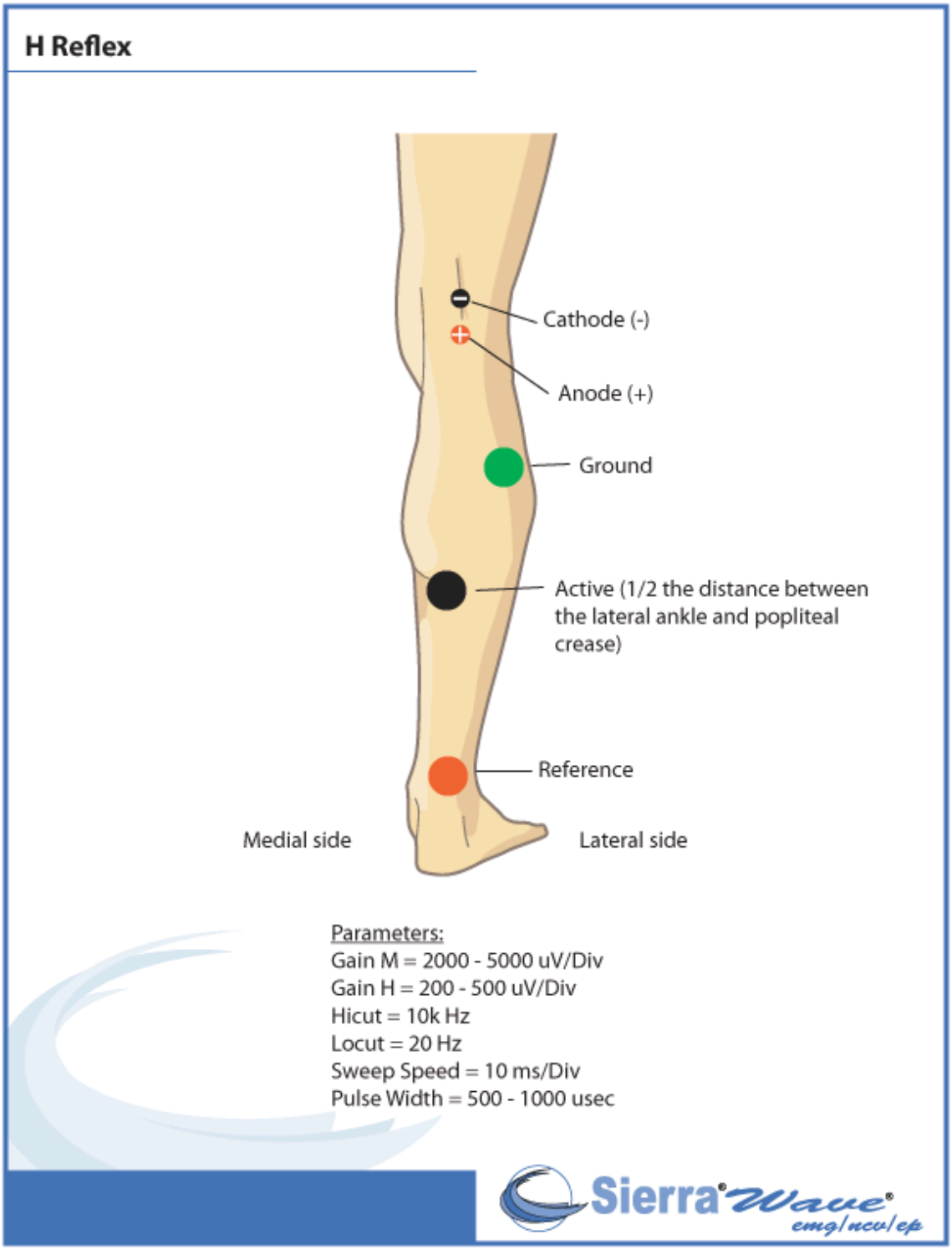
Tibial F Wave



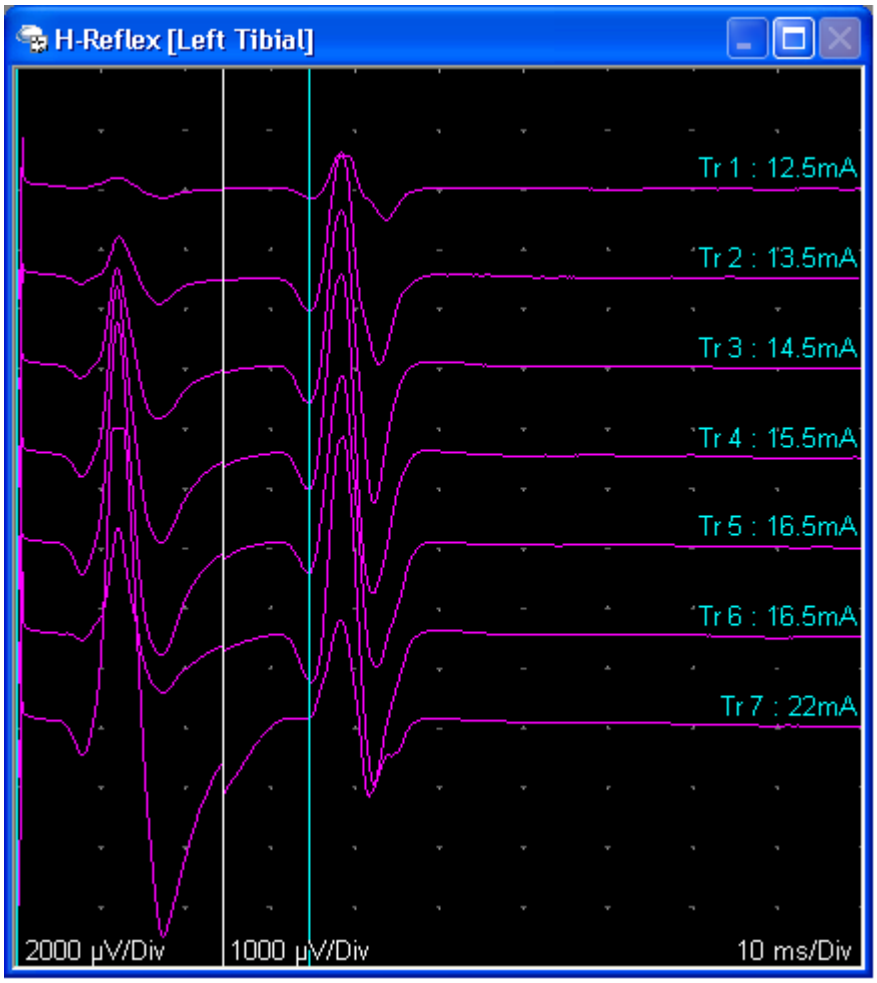
Example Traces:



H Reflex


H Reflex
Cathode (-)
Anode (+)
Ground
Active (1/2 the distance between the lateral ankle and popliteal crease)
Reference
Medial side
Lateral side
Parameters:
Gain M = 2000 - 5000 uV/Div
Gain H = 200 - 500 uV/Div
Hicut = 10k Hz
Locut = 20 Hz
Sweep Speed = 10 ms/Div
Pulse Width = 500 - 1000 usec
Sierra Wave
emg/ncv/ep

Example Traces:



EMG Muscles

Muscle Index

Hand Muscles

Abductor Pollicis Brevis

Adbductor Digiti Minimi

First Dorsal Interosseous

Forearm Muscles

Flexor Pollicis Longus

Flexor Digitorum Superficialis

Flexor Carpi Radialis

Extensor Indicis

Extensor Carpi Ulnaris

Extensor Carpi Radialis

Extensor Digitorum Communis

Extensor Pollicis Longus

Abductor Pollicis Longus

Pronator Teres

Brachioradialis

Anconeus

Supinator

Pronator Quadratus

Arm Muscles

Biceps Brachii

Triceps

Brachialis

Shoulder Muscles

Pectoralis Major

Supraspinatus

Infraspinatus

Latissimus Dorsi

Teres Major

Deltoid

Serratus Anterior

Rhomboid Major

Levator Scapula

Trapezius

Foot Muscles

Extensor Digitorum Brevis

Abductor Digiti Quinti

Abductor Hallucis

Leg Muscles

Posterior Tibialis

Peroneus Longus

Gastrocnemius - Lateral

Gastrocnemius - Medial

Anterior Tibialis

Soleus

Extensor Hallucis Longus

Extensor Digitorum Longus

Thigh Muscles

Biceps Femoris - Long Head

Biceps Femoris - Short Head

Adductor Longus

Vastus Medialis

Vastus Lateralis

Rectus Femoris

Adductor Magnus

Gracilis

Hip Muscles

Gluteus Maximus

Gluteus Medius

Iliopsoas

Non-Limb Muscles

Orbicularis Oris

Orbicularis Oculi

Sternocleidomastoid

Cervical Paraspinals

Lumbosacral Paraspinals

Innervation and Action

Common Arm Muscles

Muscle	Root	Plexus	Nerve	Action
Abductor Digiti Minimi	C8, T1	LT, AD, MC	Ulnar	Abduct digit 5
Abductor Pollicis Brevis	C8, T1	LT, AD, MC	Median	Abduct thumb
Abductor Pollicis Longus	C7-8	MT, LT, PD, PC	Radial (Post Int)	Abduct thumb
Anconeous	C7-8	UT, MT, LT, PD, PC	Radial	Extend elbow
Biceps	C5-6	UT, AD, LC	Musculocutaneous	Flex elbow
Brachialis	C5-6	UT, AD, LC	Musculocutaneous	Flex elbow
Brachioradialis	C5-6	UT, PD, PC	Radial	Flex elbow
Deltoid	C5-6	UT, PD, PC	Axillary	Abduct arm
Extensor Carpi Ulnaris	C7-8	LT, MT, PD, PC	Radial (Post Int)	Extend wrist
Extensor Digitorum Communis	C7-8	LT, MT, PD, PC	Radial (Post Int)	Extend digits 2 through 5
Extensor Indicis	C7-8	LT, MT, PD, PC	Radial (Post Int)	Extend index finger
Extensor Pollicis Longus	C7-8	MT, LT, PD, PC	Radial (Post Int)	Extend distal phalanx of thumb
First Dorsal Interosseus	C8, T1	LT, AD, MC	Ulnar	Abduct index finger
Flexor Carpi Radialis	C6-7	UT, MT, AD, LC	Median	Flex wrist
Flexor Carpi Ulnaris	C8, T1	LT, AD, MC	Ulnar	Flex wrist
Flexor Digitorum Profundus	C8, T1	MT, LT, AD, MC, LC	Median & Ulnar	Flex distal phalanges of digits 4 and 5
Flexor Digitorum Superficialis	C7-8, T1	MT, LT, AD, MC, LC	Median	Flex finger/wrist
Flexor Pollicis Longus	C7-8, T1	MT, LT, AD, MC, LC	Median (Ant Int)	Flex distal phalanx of thumb
Infraspinatus	C5-6	UT	Suprascapular	Arm external rotation
Latissimus Dorsi	C6-7-8	UT, MT, LT, PD, PC	Thoracodorsal	Adduct the arm
Levator Scapula	C3-4-5	C5 root, C3-4 crv pl.	Dorsal Scapular	Elevate scapula
Pectoralis Major (clavicular hd)	C5-6-7	UT, MT, AD, LC	Lateral Pectoral	Adduct the arm
Pectoralis Major (sternocostal hd)	C8, T1	LT, AD, MC	Medial Pectoral	Adduct the arm
Pronator Quadratus	C7-8, T1	MT, LT, AD, MC	Median (Ant Int)	Pronation of forearm
Pronator Teres	C6-7	UT, MT, AD, LC	Median	Pronation of forearm
Rhomboid (major)	C5	C5 root	Dorsal Scapular	Adduct scapula
Serratus Anterior	C5-6-7	C5-6 roots	Long Thoracic	Stabilize scapula
Supinator	C5-6	UT, PD, PC	Radial	Supination of forearm
Supraspinatus	C5-6	UT	Suprascapular	Abduct arm
Teres Major	C5-6	UT, PD, PC	Subscapular (lower)	Adduct and Rotate arm
Trapezius	CN XI, C3-4	---	Spinal Accessory	Adduct scapula
Triceps	C6-7-8	UT, MT, LT, PD, PC	Radial	Extend elbow

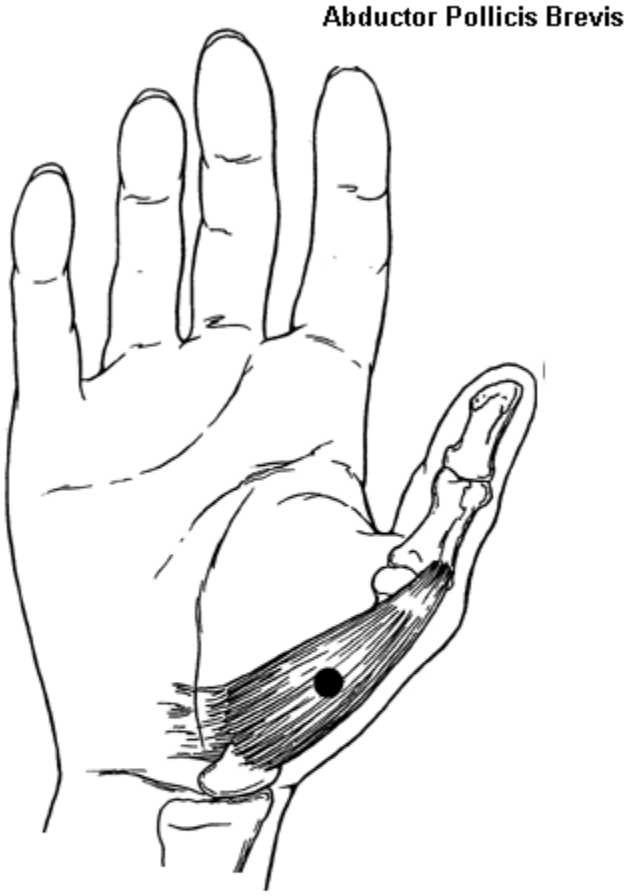
Plexus Abbreviations
Trunks: UT = upper (superior) trunk; MT = middle trunk; LT = lower (inferior) trunk
Divisions: AD = anterior divisions; PD = posterior divisions
Cords: MC = medial cord; LC = lateral cord; PC = posterior cord

Common Leg Muscles

Muscle	Root	Plexus/Division	Nerve	Action
Abductor Digiti Minimi	S1-2	Sacral/Anterior	Tibial→Lateral Plantar	Abduct the 5th toe
Abductor Hallucis	L5-S1	Sacral/Anterior	Tibial→Medial Plantar	Abduct and flex big toe
Adductor Longus	L2-4	Lumbar/Anterior	Obturator	Adduct the thigh
Adductor Longus	L2-4	Lumbar/Anterior	Obturator	Adduct the thigh
Adductor Magnus	L3-4	Lumbar/Anterior	Obturator	Adduct the thigh
Biceps Femoris (long head)	L5, S1-2	Sacral/Anterior	Tibial	Extend the thigh
Biceps Femoris (short head)	L5-S1	Sacral/Posterior	Common Peroneal	Flex the knee
Extensor Digitorum Brevis	L5-S1	Sacral/Posterior	Common Peroneal→Deep Peroneal	Extend 2nd-4th toes
Extensor Digitorum Longus	L5-S1	Sacral/Posterior	Common Peroneal→Deep Peroneal	Extend toes and dorsiflex the ankle
Extensor Hallucis Longus	L5-S1	Sacral/Posterior	Common Peroneal→Deep Peroneal	Extend the big toe
Flexor Digitorum Brevis	S1-2	Sacral/Anterior	Tibial→Medial Plantar	Flex middle phalanges
Flexor Digitorum Longus	L5-S1	Sacral/Anterior	Tibial	Flex lateral four toes
Flexor Hallucis Brevis	L5-S1	Sacral/Anterior	Tibial→Medial Plantar	Flex the big toe
Flexor Hallucis Longus	S2-3	Sacral/Anterior	Tibial	Flex the big toe
Gluteus Maximus	L5, S1-2	Sacral/Posterior	Inferior Gluteal	Abduct and medially rotate thigh
Gluteus Medius	L4-5, S1	Sacral/Posterior	Superior Gluteal	Abduct and medially rotate thigh
Gracilis	L2-3	Lumbar/Anterior	Obturator	Adduct the thigh
Iliopsoas	L2-3	Lumbar/Posterior	Femoral	Adduct thigh
Lateral Gastrocnemius	S1-2	Sacral/Anterior	Tibial	Plantar flexion of the ankle
Medial Gastrocnemius	S1-2	Sacral/Anterior	Tibial	Plantar flexion of the ankle
Peroneus Longus	L5-S1	Sacral/Posterior	Common Peroneal→Superficial Peroneal	Plantar flexion of the ankle and eversion of the foot
Rectus Femoris	L2-4	Lumbar/Posterior	Femoral	Extend the knee
Semitendinous	L5-S1	Sacral/Anterior	Tibial	Flex the knee
Soleus	S1-2	Sacral/Anterior	Tibial	Plantar flexion of the ankle
Tensor Fascia Lata	L4-5, S1	Sacral/Posterior	Superior Gluteal	Abduct hip
Tibialis Anterior	L4-5	Sacral/Posterior	Common Peroneal→Deep Peroneal	Dorsiflex ankle
Tibialis Posterior	L5-S1	Sacral/Anterior	Tibial	Plantar flexion of the ankle
Vastus Lateralis	L2-4	Lumbar/Posterior	Femoral	Extend the knee
Vastus Medialis	L2-4	Lumbar/Posterior	Femoral	Extend the knee

Hand

Abductor Pollicis Brevis



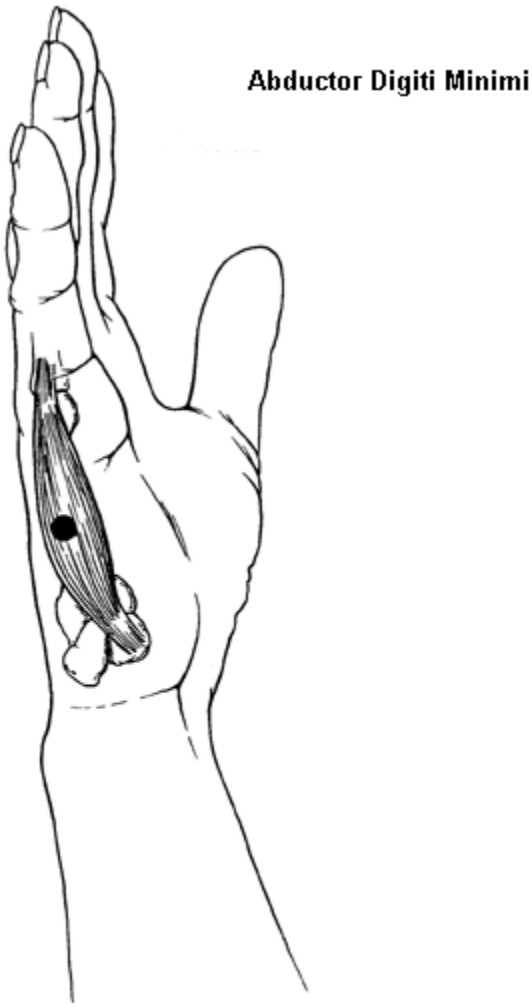
Innervation: Median

Root Levels: C8, T1

Positioning: Arm at side, hand in supination.

Activation: Abduction of thumb (i.e., movement of thumb out of the plane of the palm).

Abductor Digiti Minimi



Innervation: Ulnar

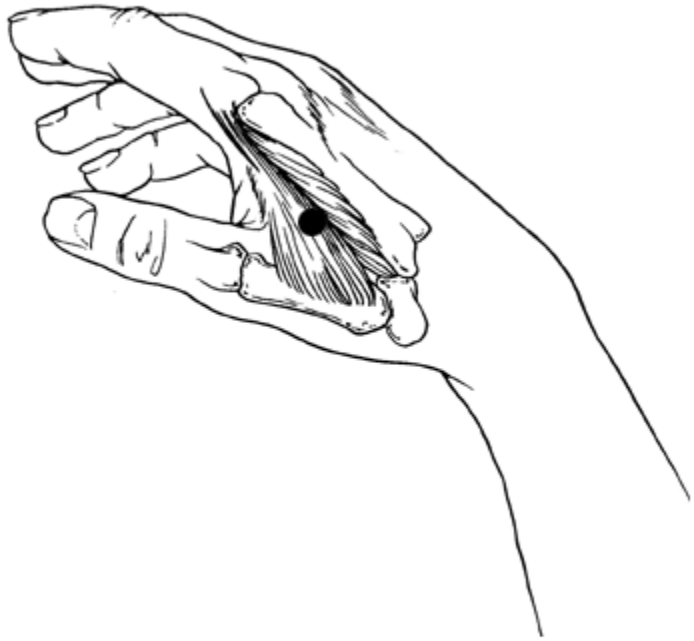
Root Levels: C8, T1

Positioning: Arm at side, hand pronated.

Activation: Abduction of digit 5.

First Dorsal Interosseous

First Dorsal Interosseous



Innervation: Ulnar

Root Levels: C8, T1

Positioning: Arm at side, forearm in neutral.

Activation: Abduction of digit 2 within the plane of the palm.

Forearm

Flexor Pollicis Longus

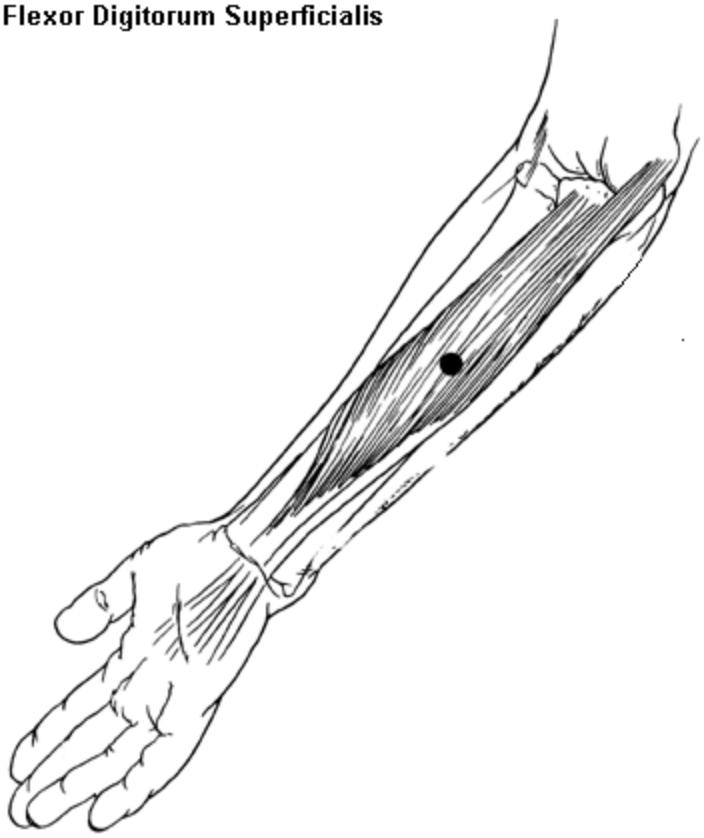
Innervation: Anterior interosseous branch of median nerve

Root Levels: C7, C8

Positioning: Forearm in full supination.

Activation: Flexion of distal phalanx of thumb.

Flexor Digitorum Superficialis



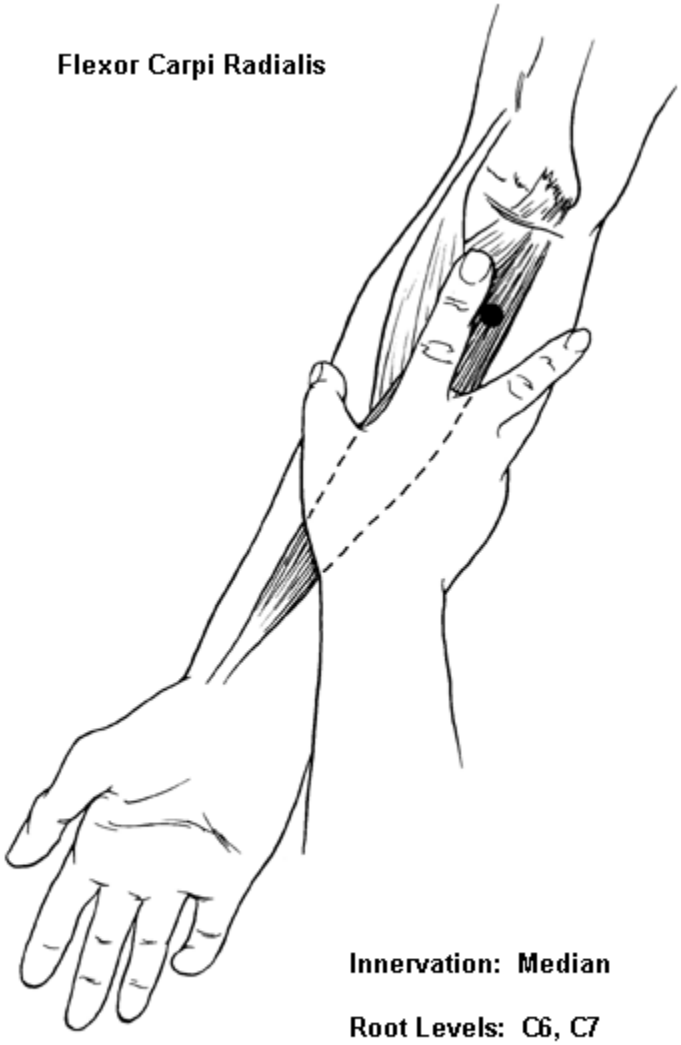
Innervation: Median

Root Levels: C7, C8, T1

Positioning: Arm at side, forearm fully supinated.

Activation: Finger or wrist flexion.

Flexor Carpi Radialis



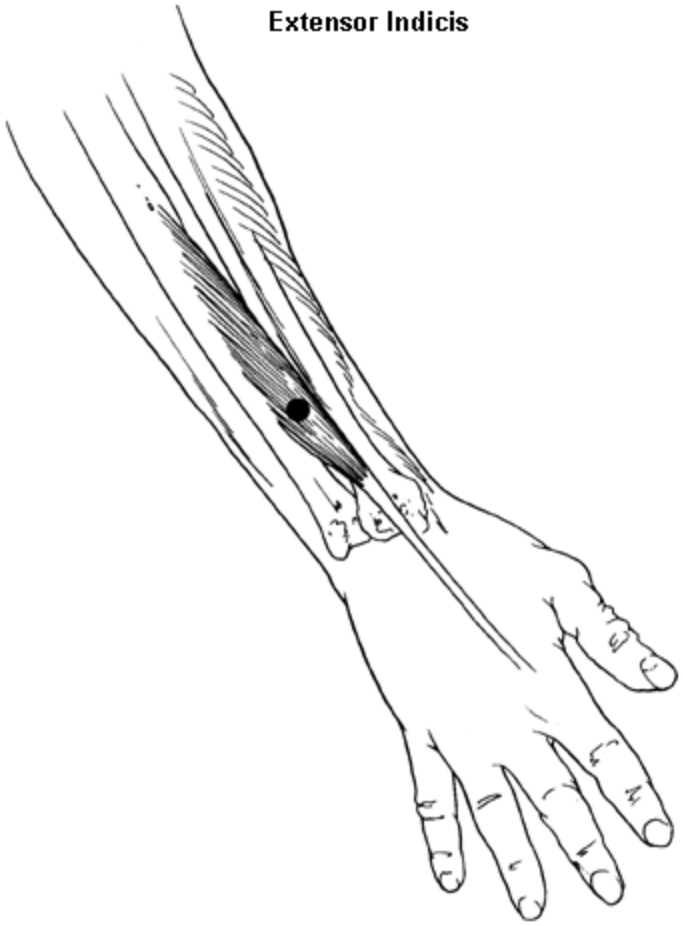
Innervation: Median

Root Levels: C6, C7

Positioning: Forearm fully supinated.

Activation: Wrist flexion.

Extensor Indicis



Innervation: Posterior interosseous branch of radial nerve

Root Levels: C7, C8

Positioning: Forearm fully pronated.

Activation: Extension of the index finger.

Extensor Carpi Ulnaris

Extensor Carpi Ulnaris

Innervation: Posterior interosseous branch of radial nerve

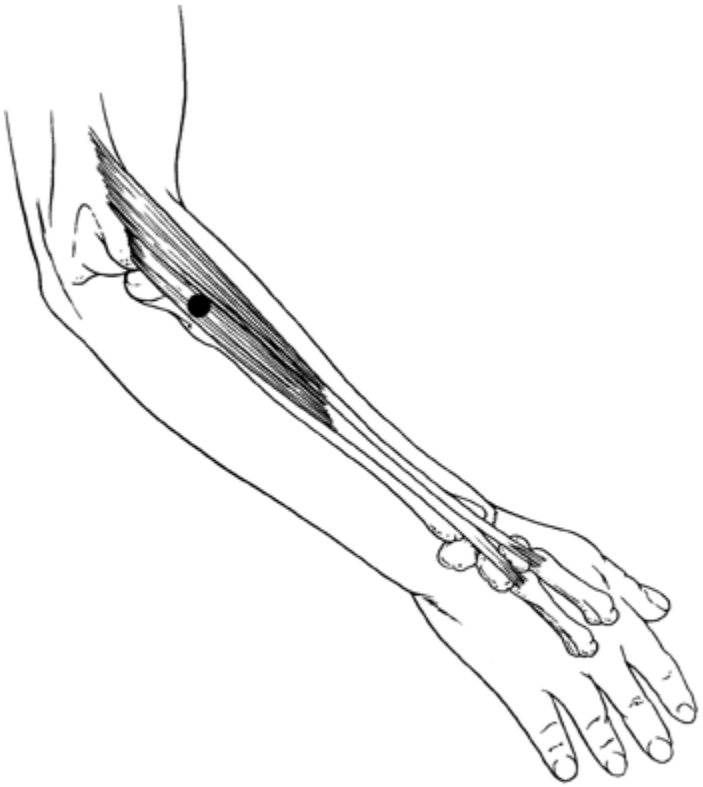
Root Levels: C7, C8

Positioning: Forearm fully pronated.

Activation: Wrist extension combined with ulnar deviation.

Extensor Carpi Radialis

Extensor Carpi Radialis



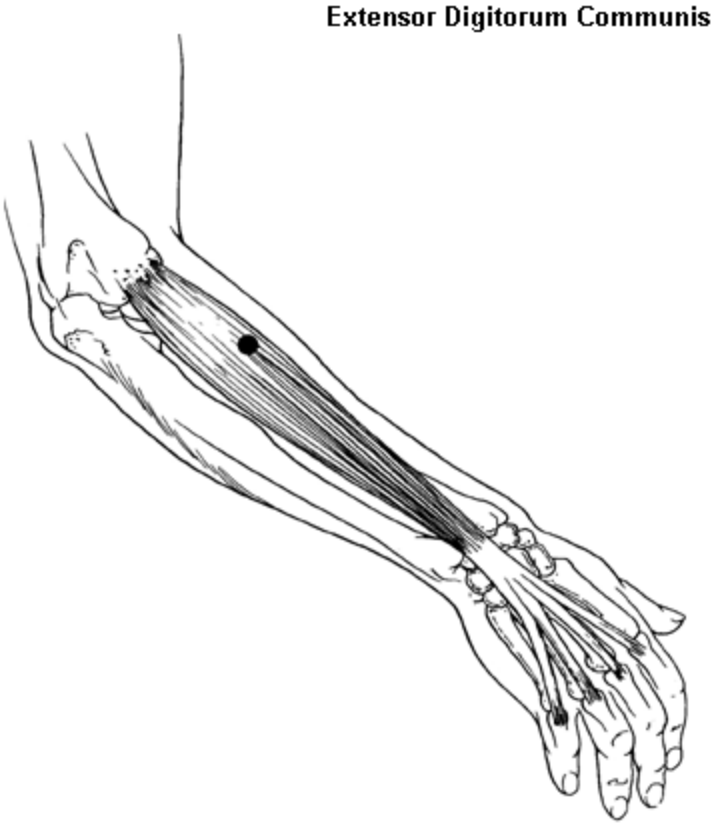
Innervation: Radial

Root Levels: C6, C7

Positioning: Forearm fully pronated, elbow flexed 30 degrees.

Activation: Wrist extension.

Extensor Digitorum Communis



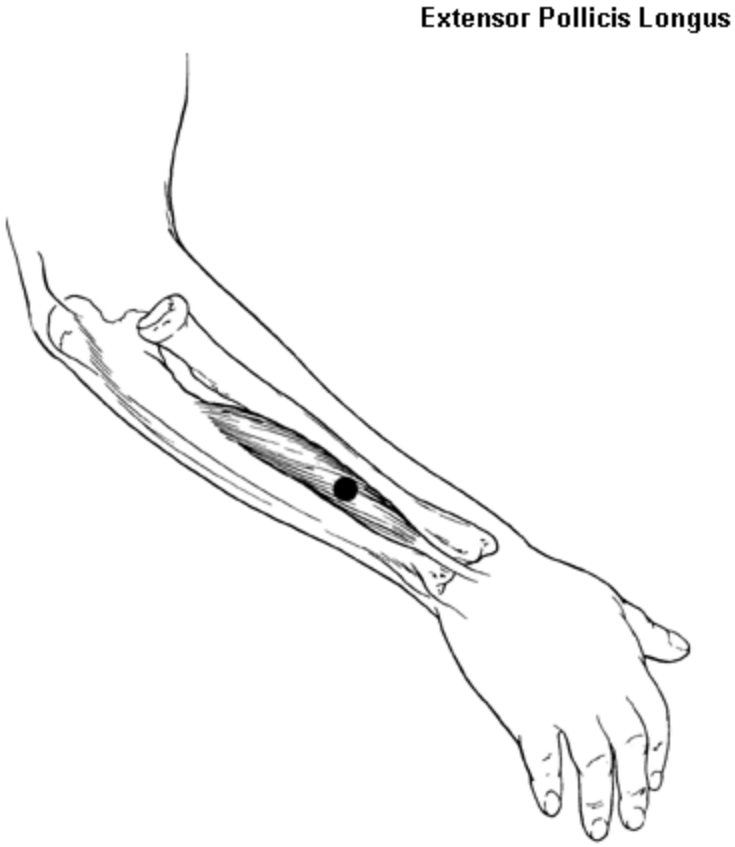
Innervation: Posterior interosseous branch of radial nerve

Root Levels: C7, C8

Positioning: Forearm fully pronated.

Activation: Extension of digits 2 through 5.

Extensor Pollicis Longus



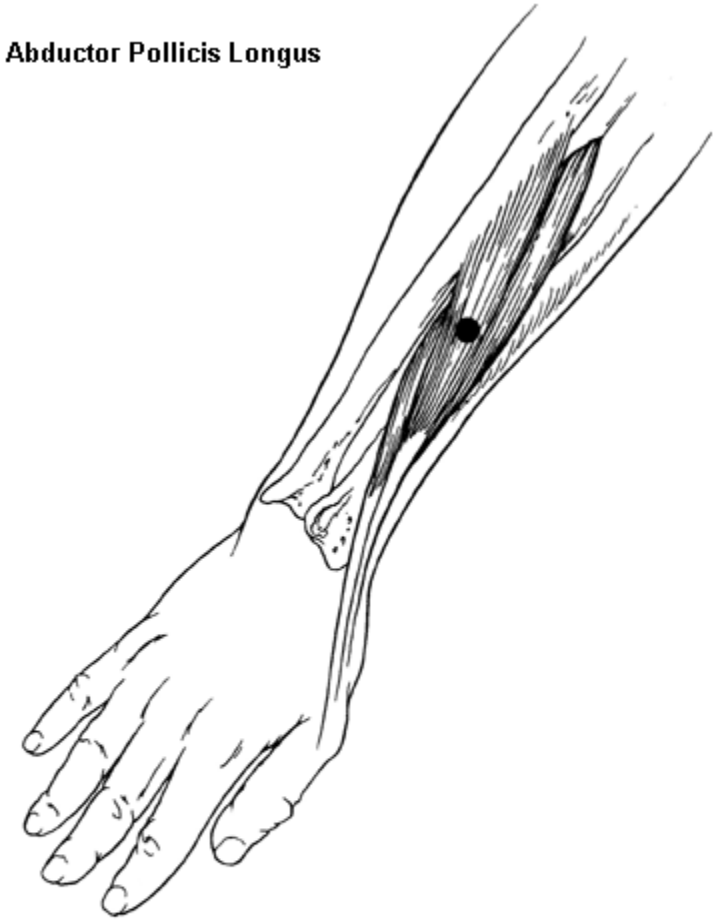
Innervation: Posterior interosseous branch of radial nerve

Root Levels: C7, C8

Positioning: Forearm fully pronated.

Activation: Extension of distal phalanx of thumb.

Abductor Pollicis Longus



Innervation: Posterior interosseous branch of radial nerve

Root Level: C7, C8

Positioning: Forearm fully pronated at the side.

Activation: Abduction and extension of the proximal phalanx of the thumb.

Pronator Teres

Innervation: Median

Root Levels: C6, C7

Positioning: Forearm fully supinated.

Activation: Elbow flexion or, if necessry, forearm pronation.

Brachioradialis

Brachioradialis

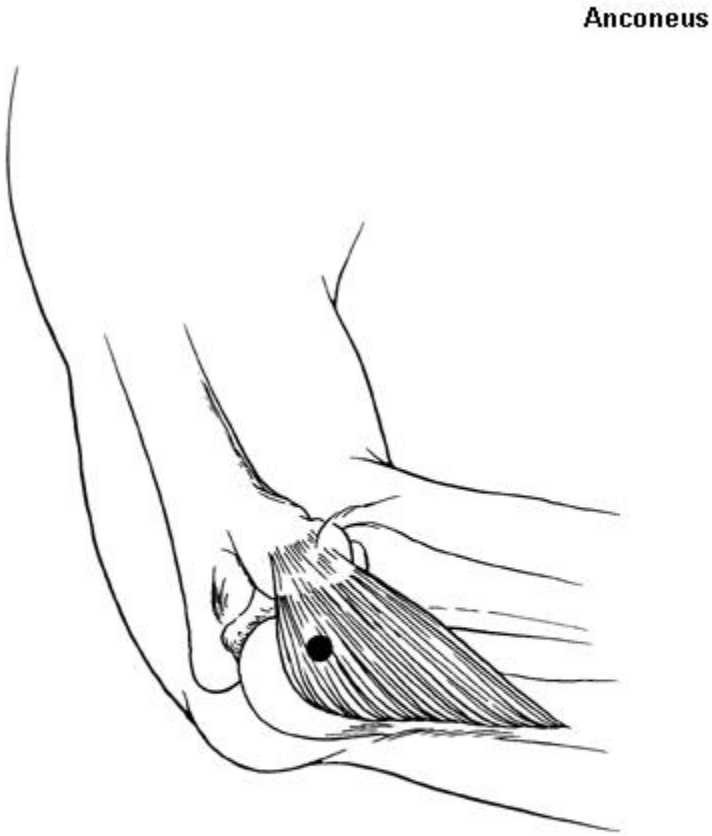
Innervation: Radial

Root Levels: C5, C6

Positioning: Forearm fully supinated.

Activation: Elbow flexion, with the forearm in mid pronation-supination.

Anconeus



Innervation: Radial

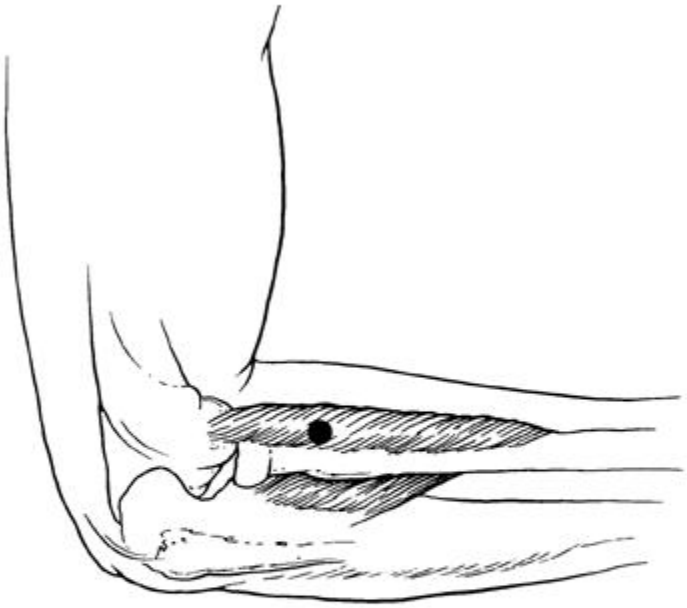
Root Levels: C7, C8

Positioning: Forearm in pronation, across abdomen.

Activation: Elbow extension.

Supinator

Supinator



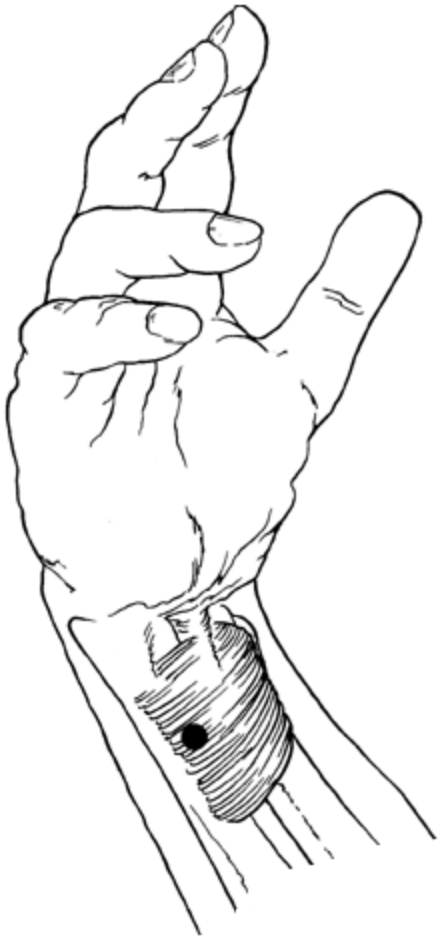
Innervation: Radial

Root Levels: C5, C6

Positioning: Forearm in pronation.

Activation: Forearm supination.

Pronator Quadratus



Pronator Quadratus

Innervation: Anterior interosseous branch of median nerve

Root Levels: C7, C8, T1

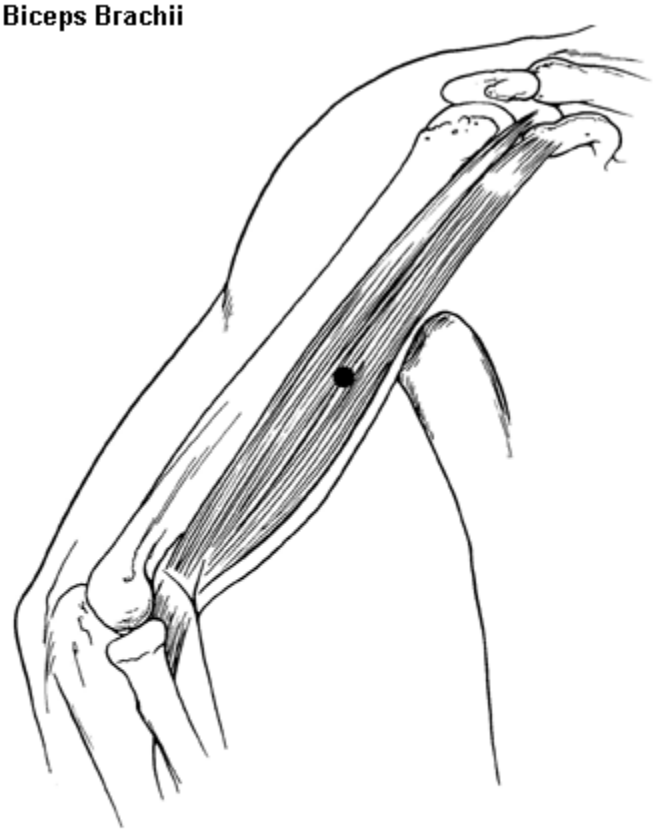
Positioning: Arm at side, forearm fully supinated, wrist flexed.

Activation: Forearm pronation.

Arm

Biceps Brachii

Biceps Brachii



Innervation: Musculocutaneous

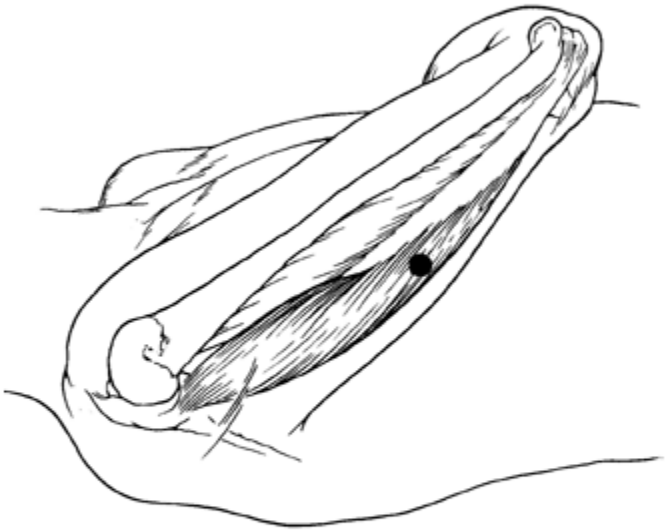
Root Levels: C5, C6

Positioning: Arm at side, elbow flexed 30 degrees.

Activation: Elbow flexion, with the forearm in supination.

Triceps

Triceps



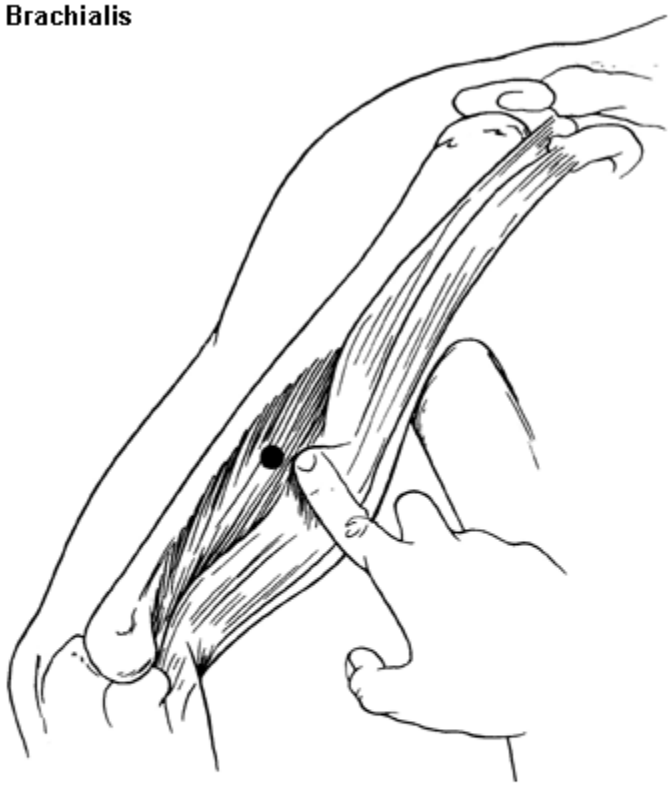
Innervation: Radial

Root Levels: C7, C8

Positioning: Supine, arm adducted across chest.

Activation: Elbow extension.

Brachialis



Innervation: Musculocutaneous

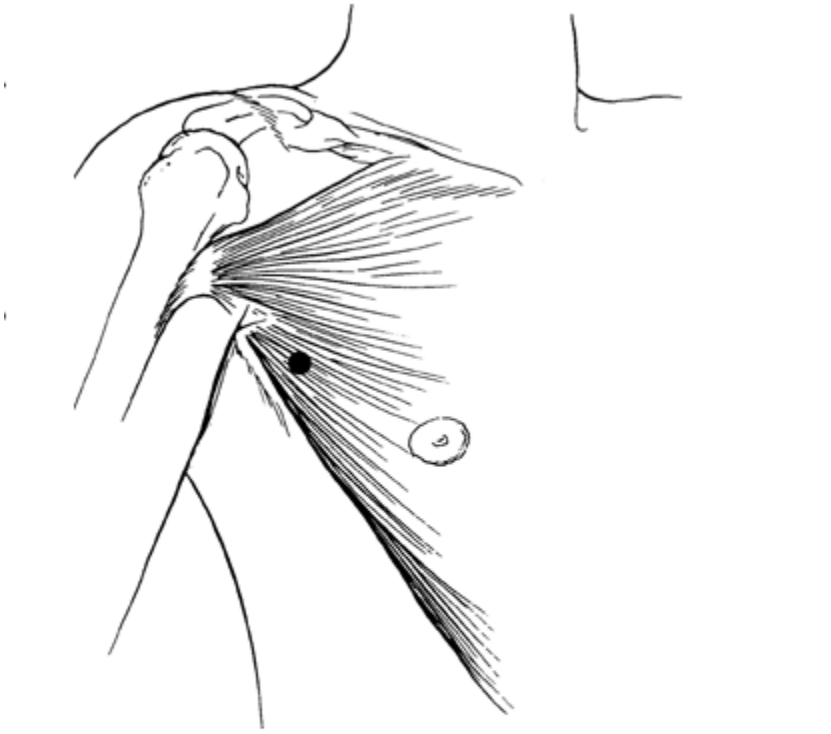
Root Levels: C5, C6

Positioning: Arm at side, elbow flexed 30 degrees

Activation: Elbow flexion; the degree of forearm pronation-supination is irrelevant.

Shoulder

Pectoralis Major



Innervation: Medial and lateral pectoral nerves

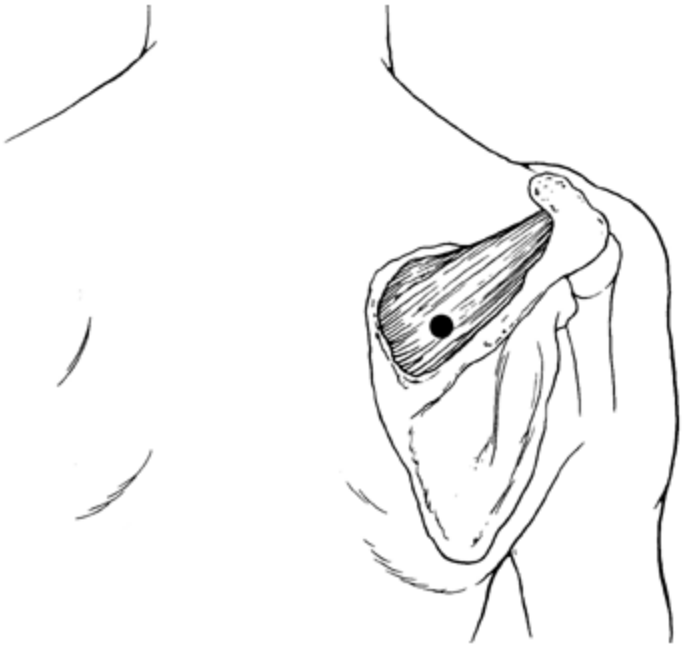
Root Levels: C7, C8, T1

Positioning: Supine.

Activation: Adduction of the arm.

Supraspinatus

Supraspinatus



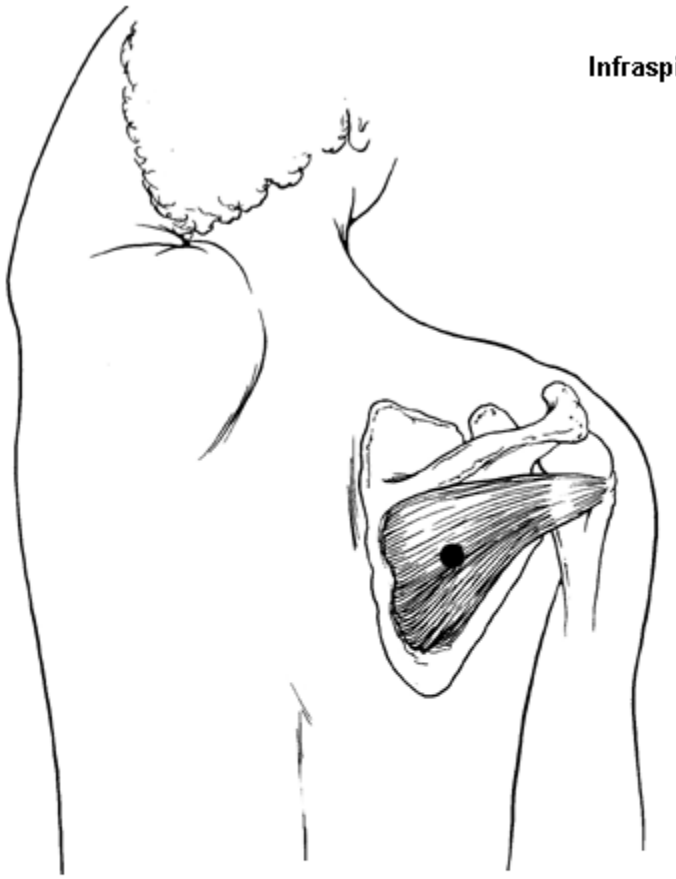
Innervation: Suprascapular

Root Levels: C5, C6

Positioning: Prone or lying on contralateral side, arm relaxed at side.

Activation: Arm abduction.

Infraspinatus



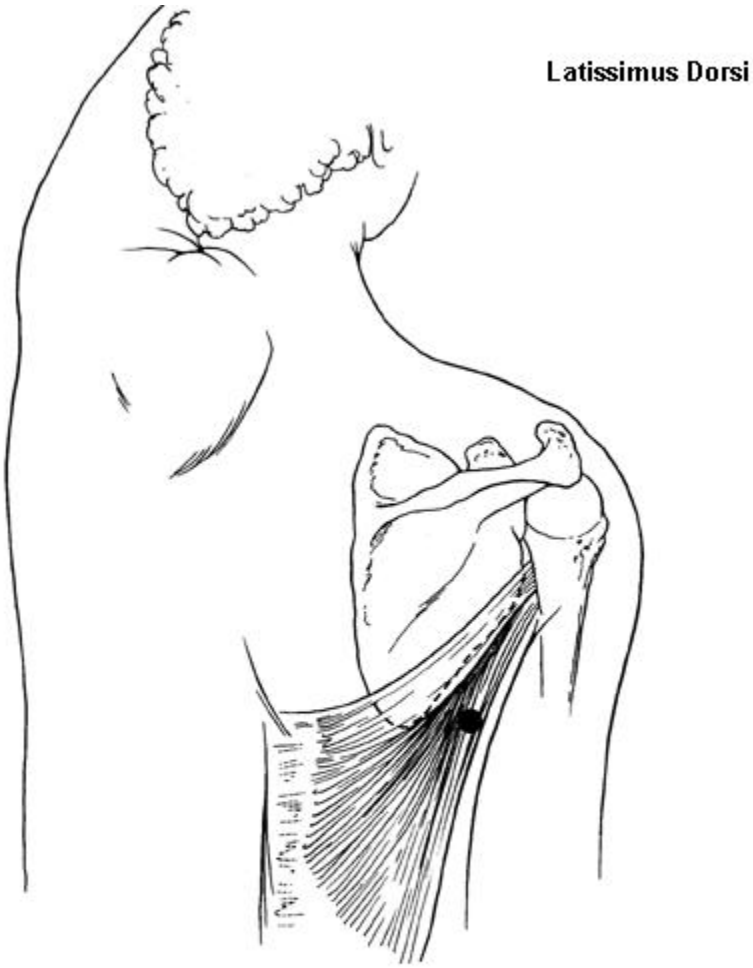
Innervation: Suprascapular

Root Levels: C5, C6

Positioning: Lying on contralateral side, arm across front of body or lying prone.

Activation: External rotation of the arm. Activation is usually possible simply by the patient lifting the arm off the table.

Latissimus Dorsi



Innervation: Thoracodorsal

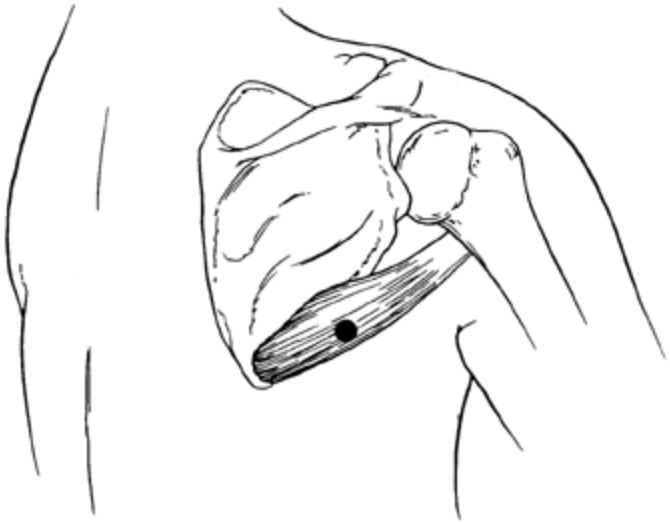
Root Levels: C6, C7, C8

Positioning: Lying on side, arm across chest

Activation: Extension and adduction of the humerus.

Teres Major

Teres Major



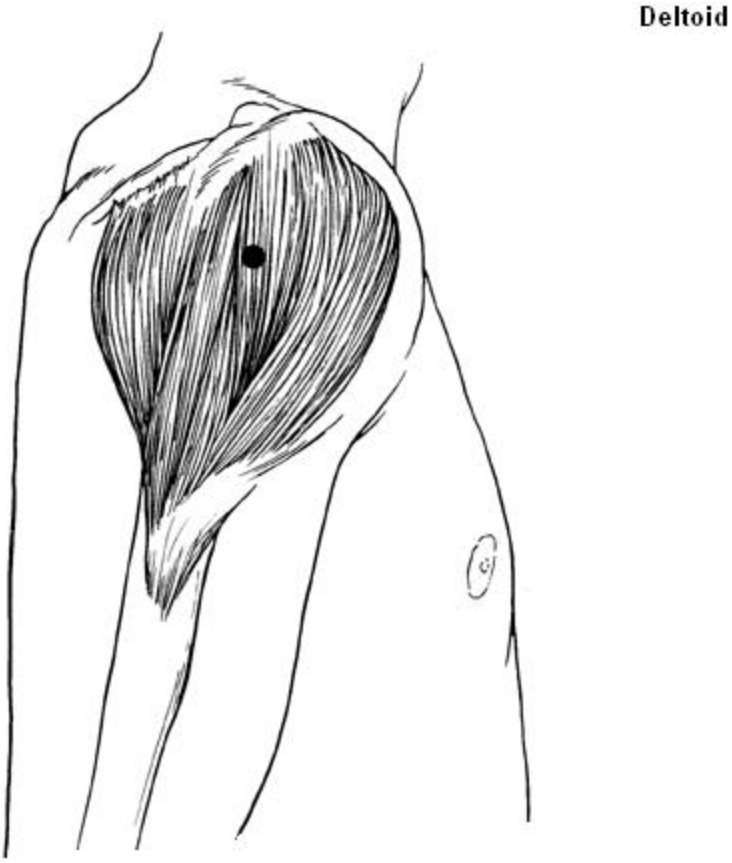
Innervation: Lower subscapular

Root Levels: C5, C6

Positioning: Lying on contralateral side or prone.

Activation: Internal rotation of the arm.

Deltoid



Innervation: Axillary

Root Levels: C5, C6

Positioning: Supine, arm at side

Activation: Arm abduction.

Serratus Anterior

Serratus Anterior

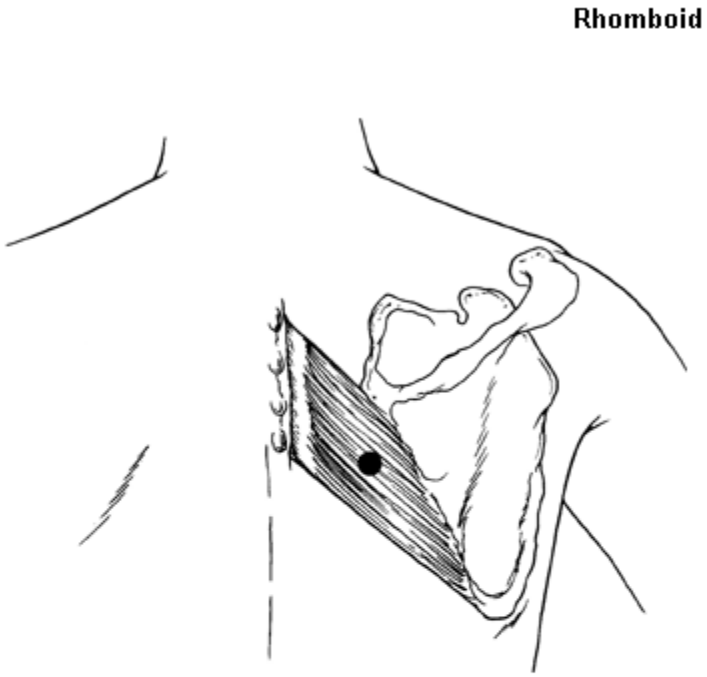
Innervation: Long thoracic

Root Levels: C5, C6, C7

Positioning: Lying on contralateral side, arm across chest.

Activation: Elevation and reaching forward with the arm (i.e., scapular protraction).

Rhomboid Major



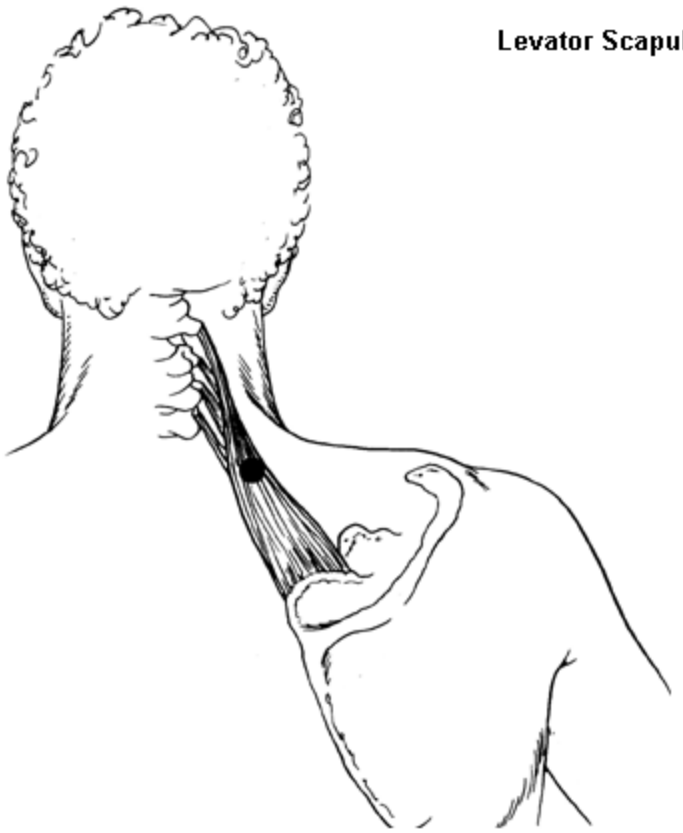
Innervation: Dorsal scapular

Root Levels: C5

Positioning: Prone, bend elbow and internally rotate shoulder.

Activation: Scapular adduction. Have the patient lift the elbow off the table against resistance.

Levator Scapula



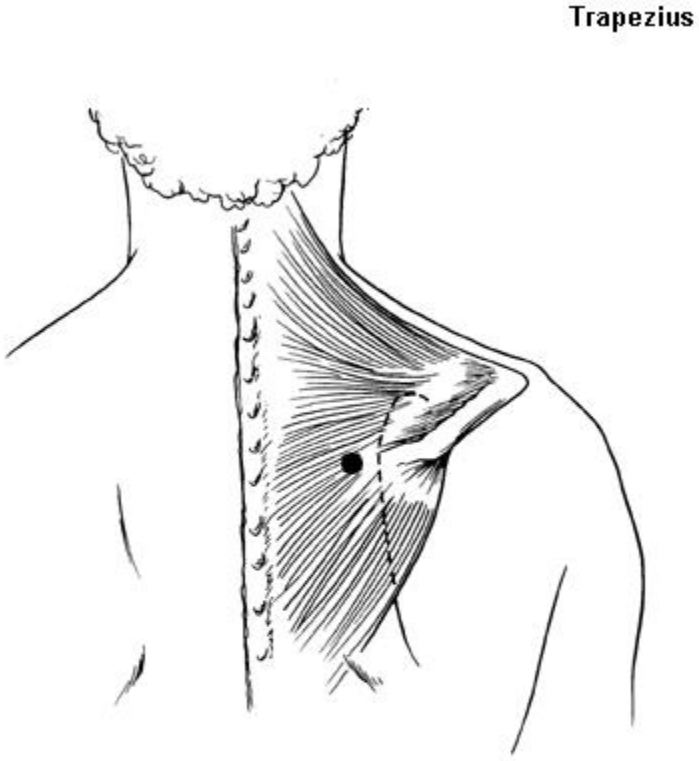
Innervation: Cervical plexus

Root Levels: C3, C4, C5

Positioning: Prone or lying on contralateral side.

Activation: Scapular elevation. Have the patient shrug the shoulder.

Trapezius



Innervation: Spinal accessory, cervical (subtrapezial) plexus

Root Levels: Cranial nerve X1, C3, C4

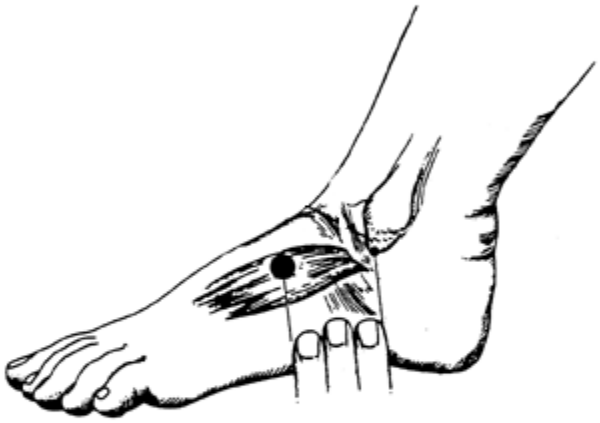
Positioning: Prone.

Activation: Scapular adduction.

Foot

Extensor Digitorum Brevis

Extensor Digitorum Brevis



Innervation: Deep peroneal nerve

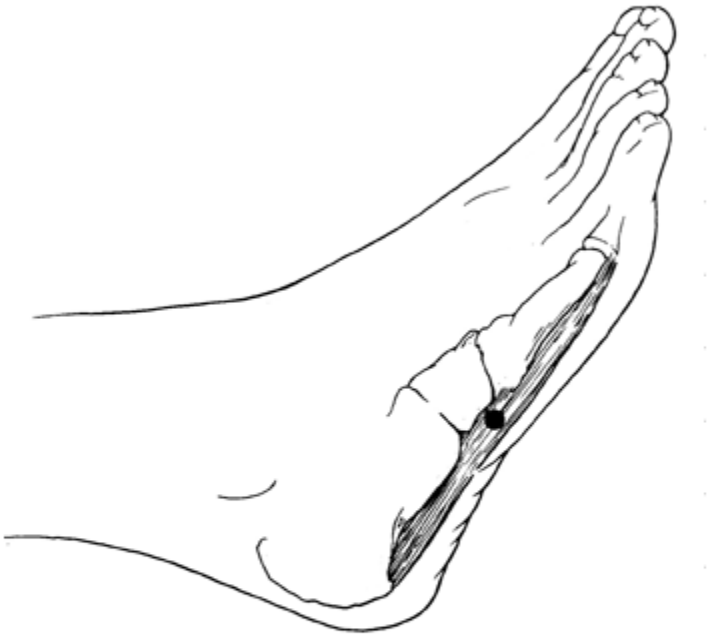
Root Levels: L5, S1

Positioning: Supine.

Activation: Extend the phalanges of the second, third, and fourth toes.

Abductor Digiti Quinti

Abductor Digiti Quinti



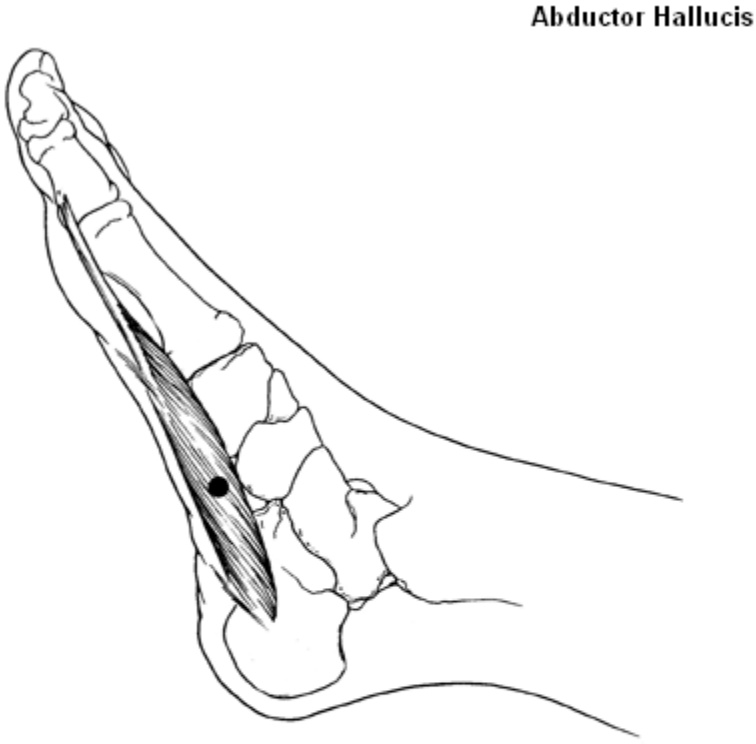
Innervation: Lateral plantar branch of tibial nerve

Root Levels: S1, S2

Positioning: Supine, leg internally rotated.

Activation: Small toe abduction. Ask the patient to fan the toes.

Abductor Hallucis



Innervation: Medial plantar branch of tibial nerve

Root Levels: S1, S2

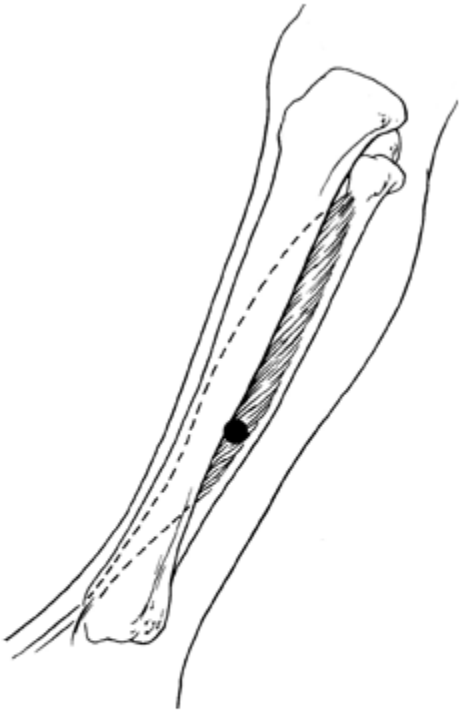
Positioning: Supine, leg externally rotated.

Activation: Can be difficult. Ask patient to fan or curl the toes.

Leg

Posterior Tibialis

Posterior Tibialis



Innervation: Tibial

Root Levels: L5, S1

Positioning: Supine.

Activation: Plantar flexion and inversion of the ankle.

Peroneus Longus

Peroneus Longus

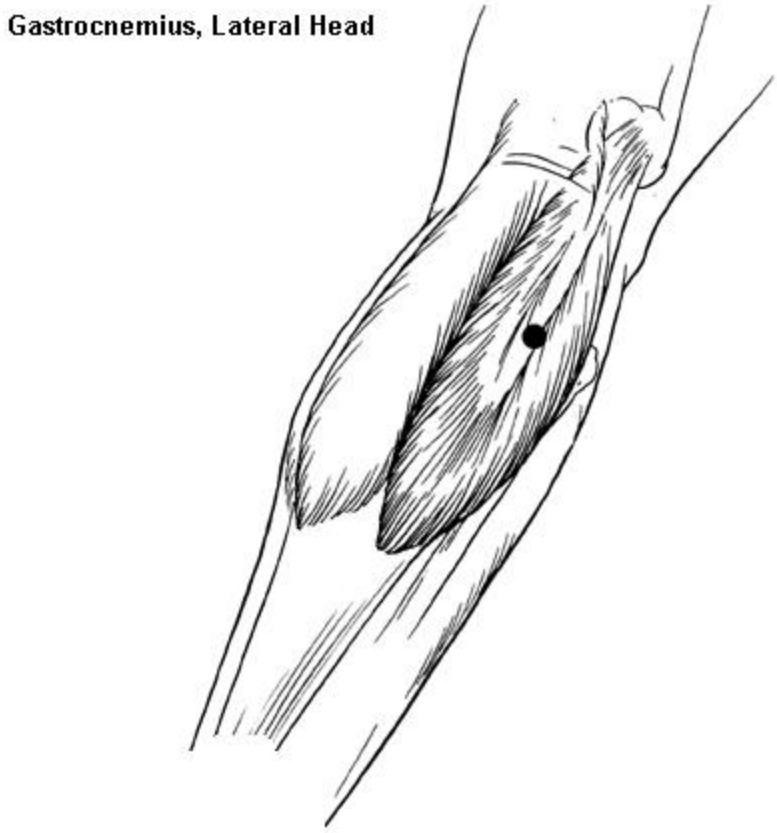
Innervation: Superficial branch of peroneal nerve

Root Levels: L5, S1

Positioning: Supine or lying on side.

Activation: Eversion and plantar flexion of the ankle. Patients find plantar flexion easier to perform.

Gastrocnemius - Lateral Head



Innervation: Tibial

Root Levels: S1, S2

Positioning: Lying on contralateral side or prone.

Activation: Ankle plantar flexion.

Gastrocnemius - Medial Head

Gastrocnemius, Medial Head

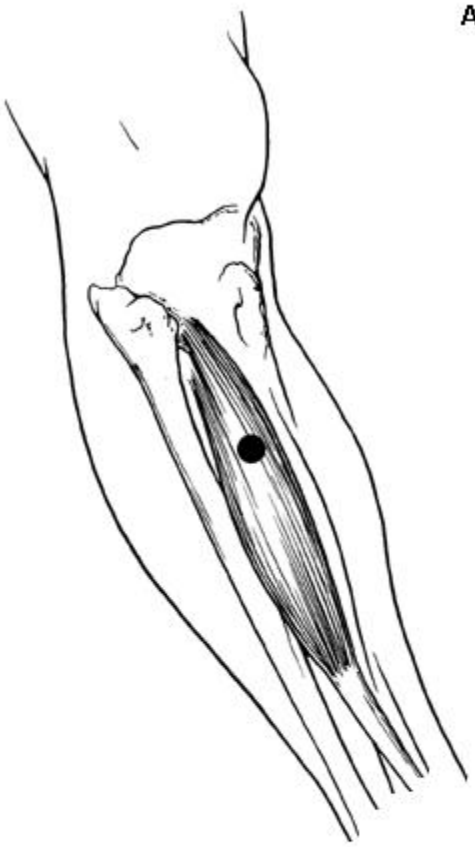
Innervation: Tibial

Root Levels: L5, S1, S2

Positioning: Supine.

Activation: Ankle plantar flexion.

Anterior Tibialis



Innervation: Deep branch of peroneal nerve

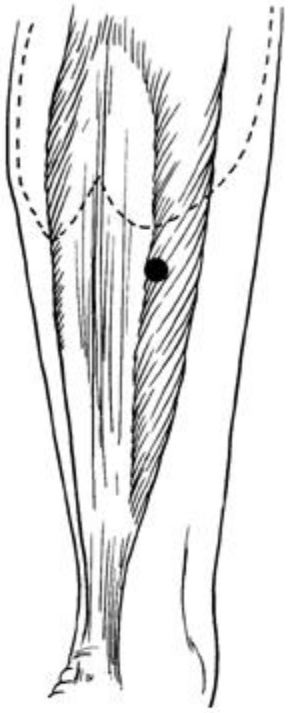
Root Levels: L4, L5

Positioning: Supine.

Activation: Ankle dorsiflexion. If necessary, hold the toes in plantar flexion while the patient dorsiflexes the ankle.

Soleus

Soleus



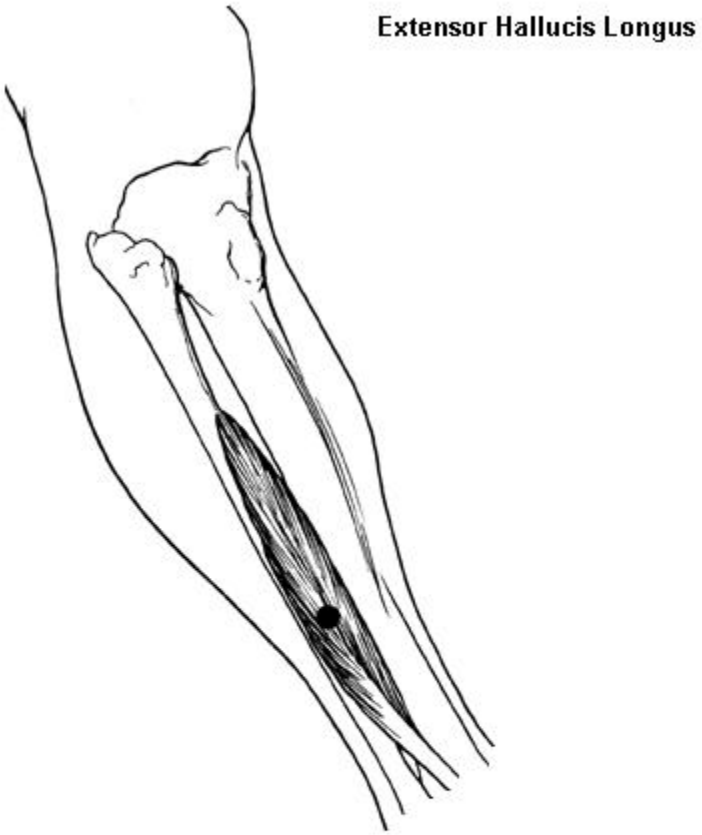
Innervation: Tibial

Root Levels: S1, S2

Positioning: Prone.

Activation: Ankle plantar flexion.

Extensor Hallucis Longus



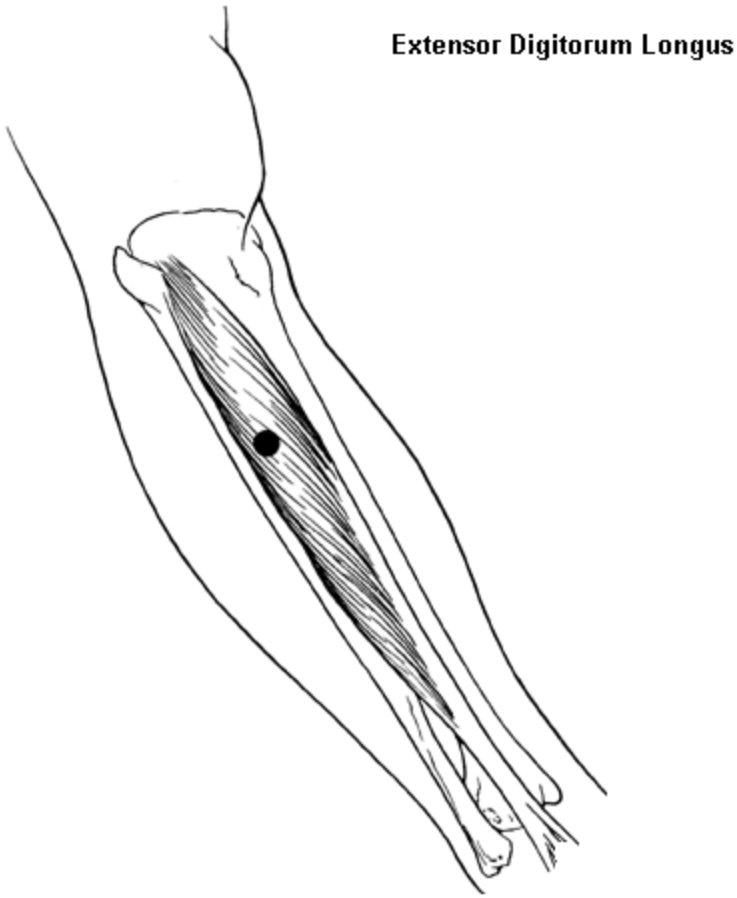
Innervation: Deep branch of the peroneal nerve

Root Levels: L5, S1

Positioning: Supine.

Activation: Great toe extension.

Extensor Digitorum Longus



Innervation: Deep branch of the peroneal nerve

Root Levels: L5, S1

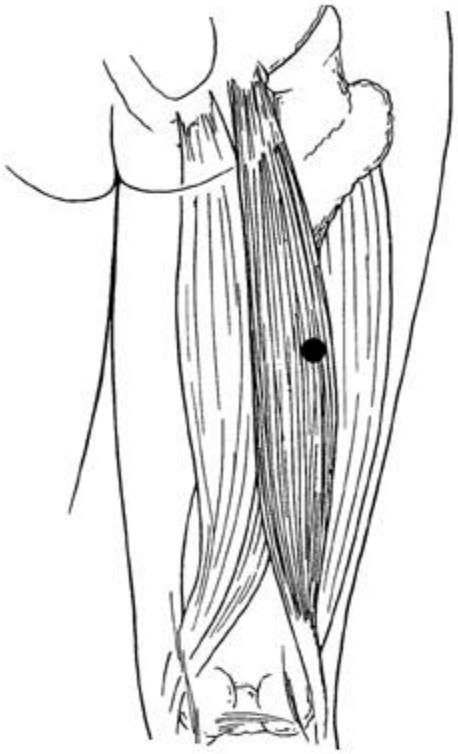
Positioning: Supine.

Activation: Extension of digits 2 through 5.

Thigh

Biceps Femoris - Long Head

Biceps Femoris, Long Head



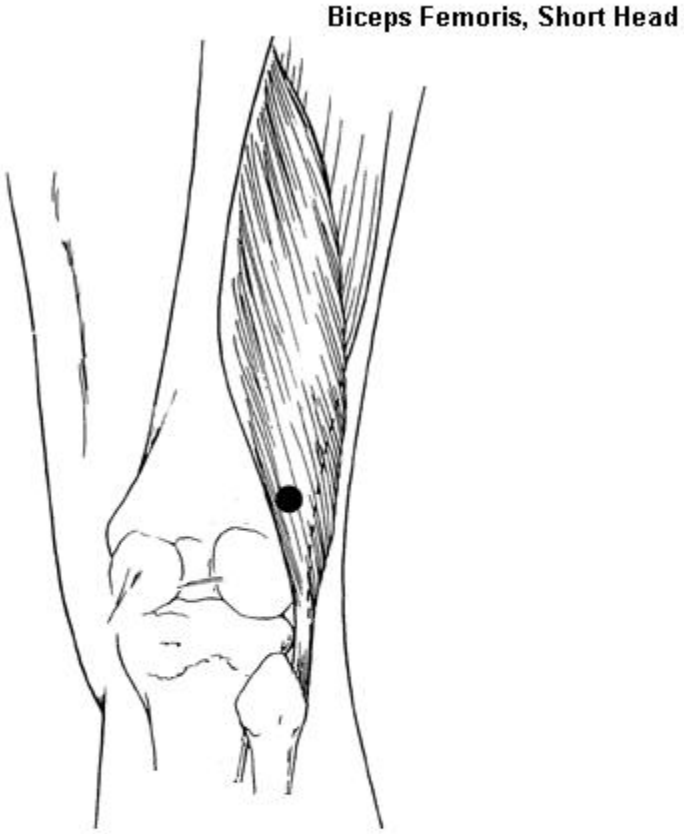
Innervation: Tibial portion of sciatic nerve

Root Levels: L5, S1, S2

Positioning: Prone.

Activation: Knee flexion.

Biceps Femoris - Short Head



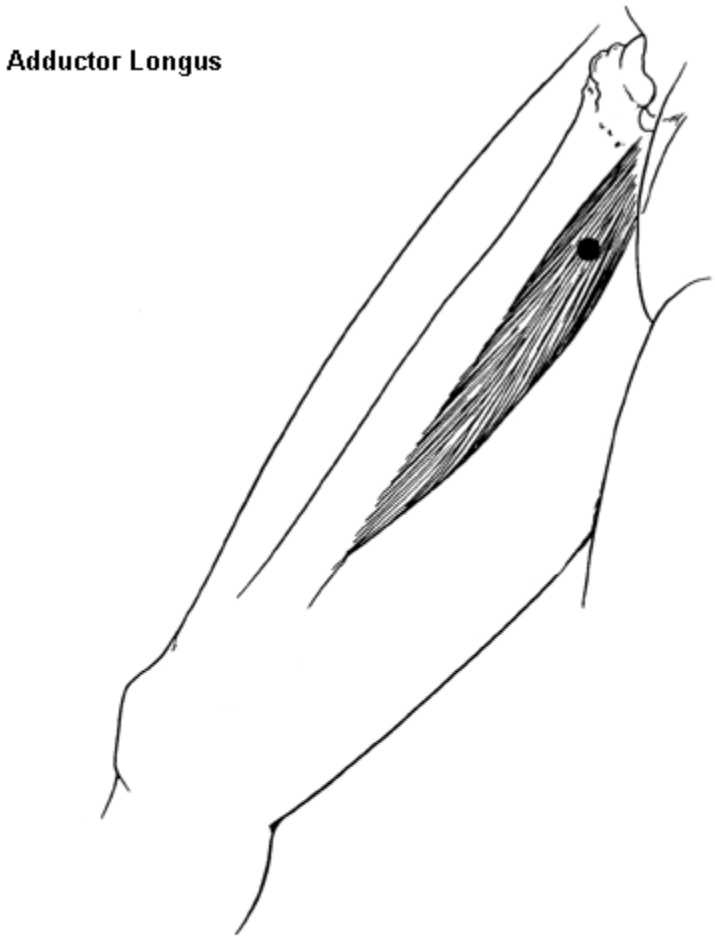
Innervation: Peroneal portion of sciatic nerve

Root Levels: L5, S1

Positioning: Prone.

Activation: Knee flexion.

Adductor Longus



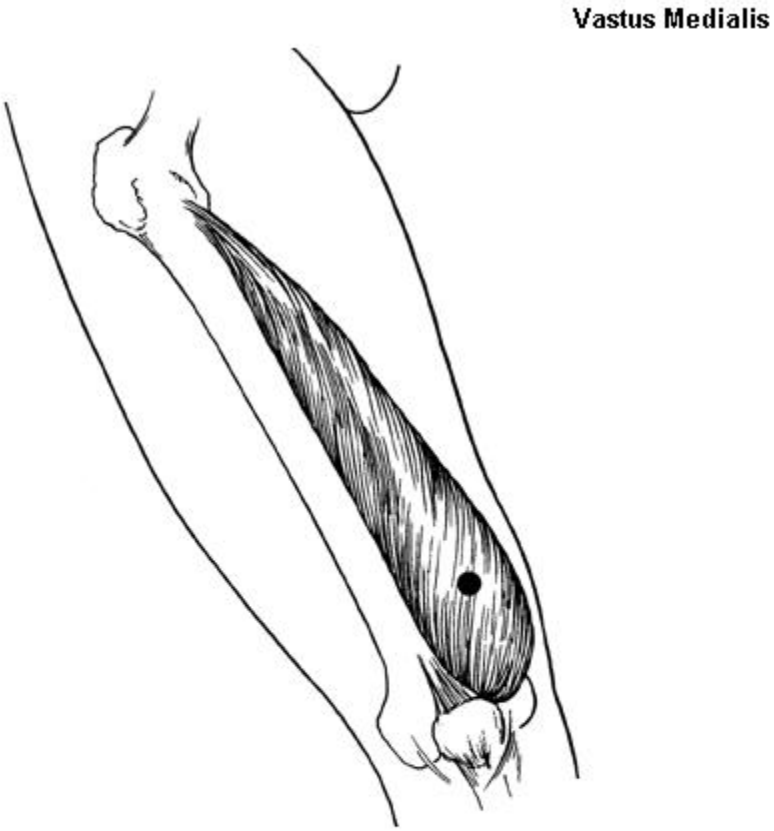
Innervation: Obturator

Root Levels: L2, L3, L4

Positioning: Supine, thigh slightly abducted and externally rotated.

Activation: Thigh adduction.

Vastus Medialis



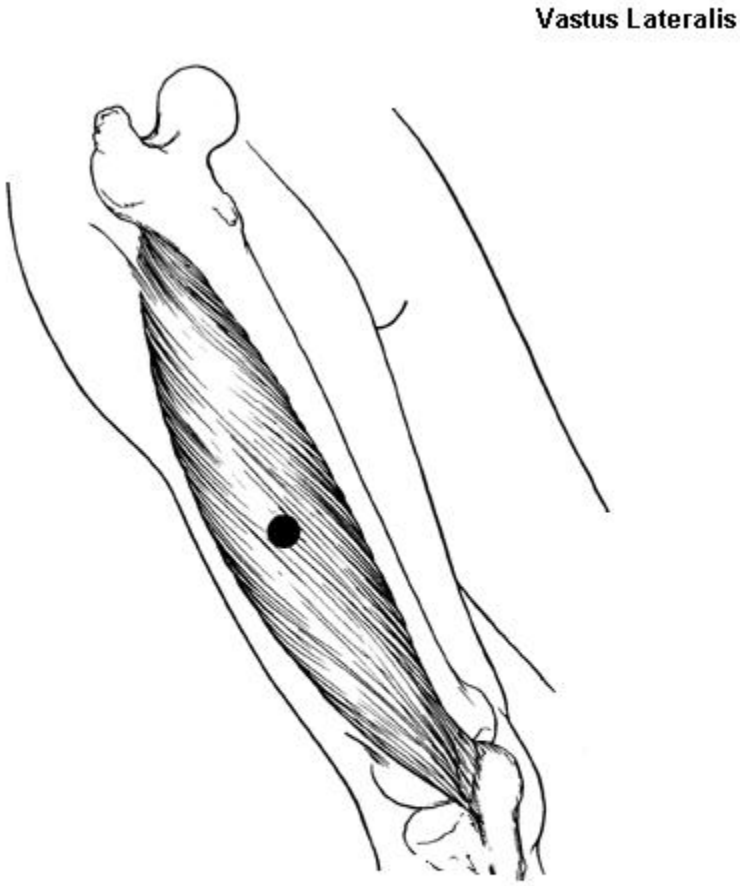
Innervation: Femoral

Root Levels: L2, L3, L4

Positioning: Supine.

Activation: Knee extension.

Vastus Lateralis



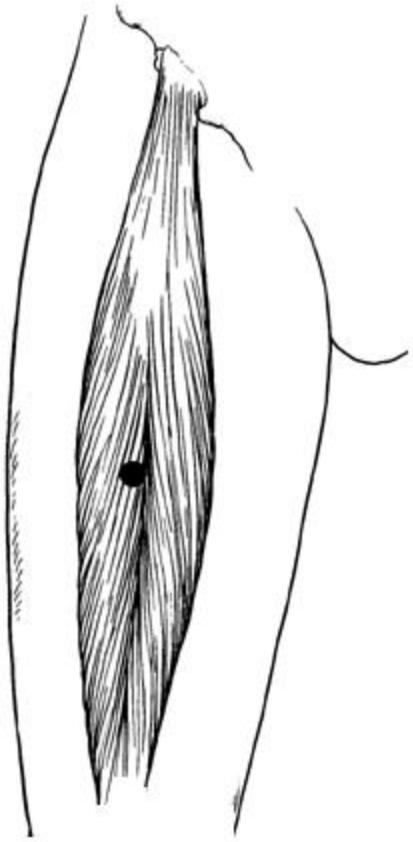
Innervation: Femoral

Root Levels: L2, L3, L4

Positioning: Supine.

Activation: Knee extension.

Rectus Femoris



Innervation: Femoral

Root Levels: L2, L3, L4

Positioning: Supine.

Activation: Knee extension.

Adductor Magnus

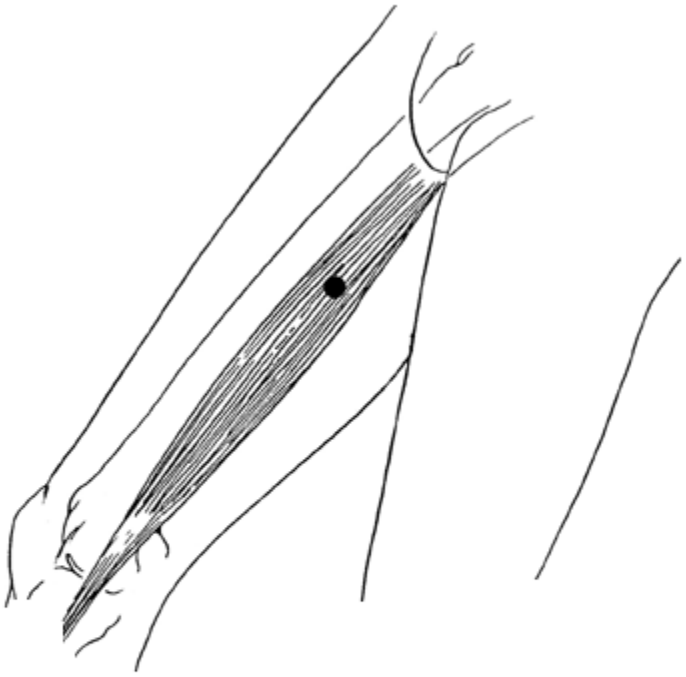
Innervation: Obturator and sciatic

Root Levels: L2, L3, L4

Positioning: Supine, thigh externally rotated and abducted.

Activation: Thigh adduction.

Gracilis



Innervation: Obturator

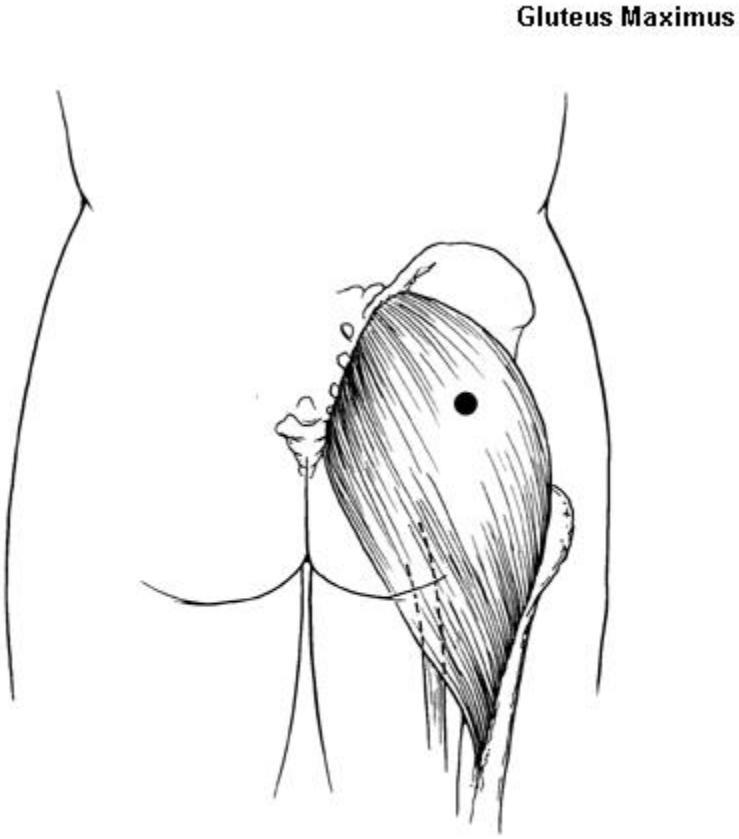
Root Levels: L2, L3, L4

Positioning: Supine, with thigh externally rotated and abducted.

Activation: Thigh adduction.

Hip

Gluteus Maximus



Innervation: Inferior gluteal

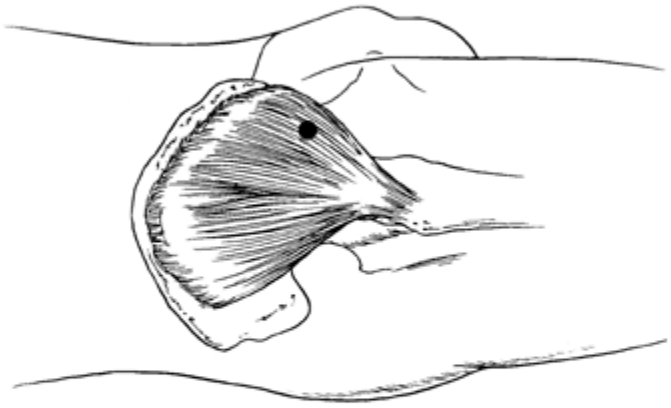
Root Levels: L5, S1, S2

Positioning: Prone.

Activation: Hip extension or hip abduction.

Gluteus Medius

Gluteus Medius



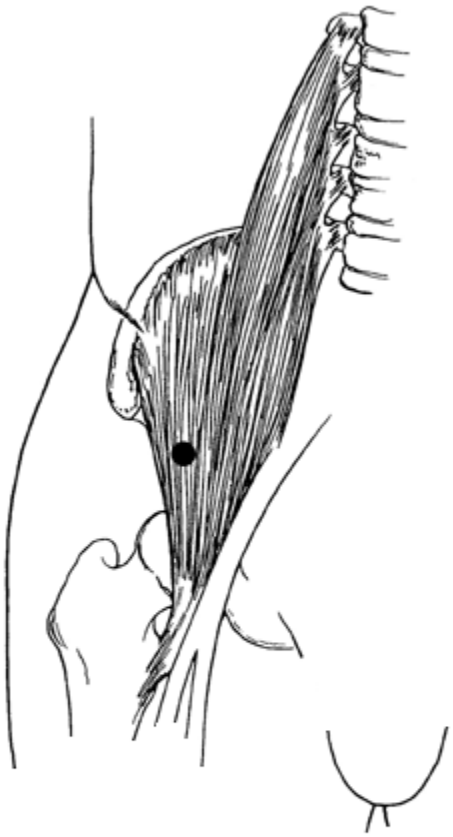
Innervation: Superior gluteal

Root Levels: L4, L5, S1

Positioning: Supine.

Activation: Internal rotation of the thigh.

Iliopsoas



Innervation: Femoral

Root Levels: L2, L3

Positioning: Supine.

Activation: Hip flexion.

Non-Limb

Orbicularis Oris

Innervation: Buccal branches of facial nerve

Root Levels: Cranial nerve VII

Positioning: Supine.

Activation: Whistling motion of the lips.

Orbicularis Oculi

Innervation: Temporal and zygomatic branches of facial nerve

Root Levels: Cranial nerve VII

Positioning: Supine.

Activation: Closing or squeezing of the eyelids.

Sternocleidomastoid

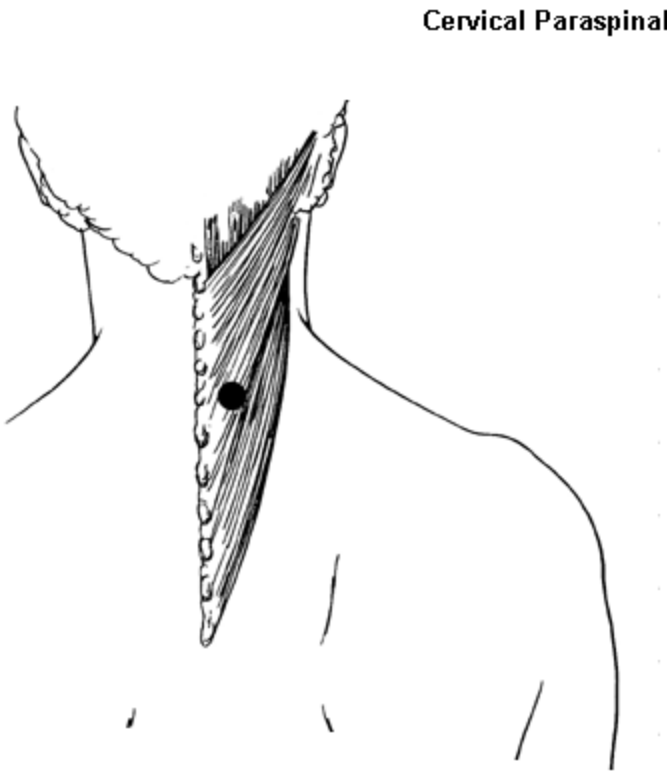
Innervation: Spinal accessory, cervical plexus

Root Levels: Cranial nerve XI, C2, C3

Positioning: Supine, with head turned to the contralateral side.

Activation: Have the patient turn the head to the opposite side, against your hand.

Cervical Paraspinals



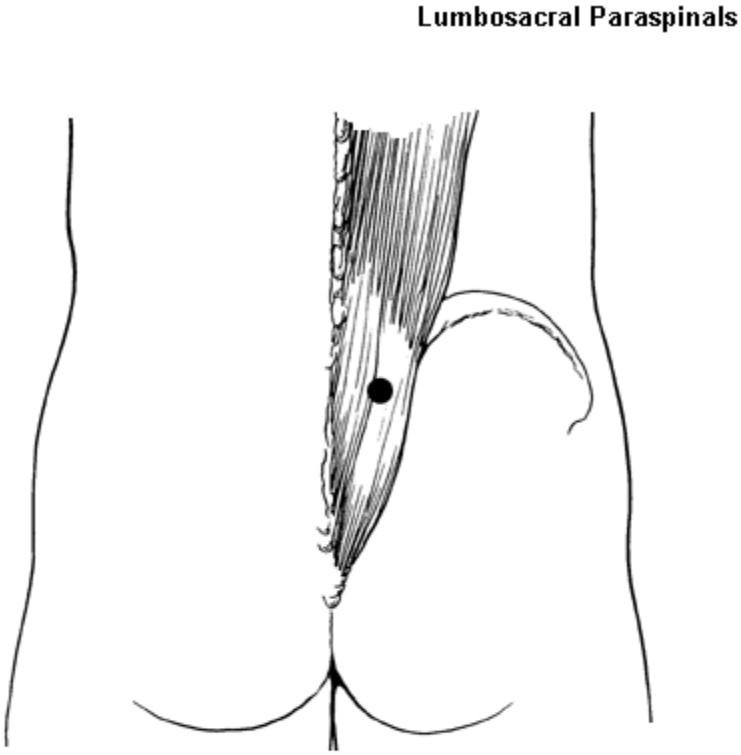
Innervation: Posterior primary rami

Root Levels: C1 - T1

Positioning: Prone, with neck flexed over a pillow under upper chest, arms by side.

Activation: Gentle isometric neck extensions, with the electrode in subcutaneous tissue first.

Lumbosacral Paraspinals



Innervation: Posterior primary rami

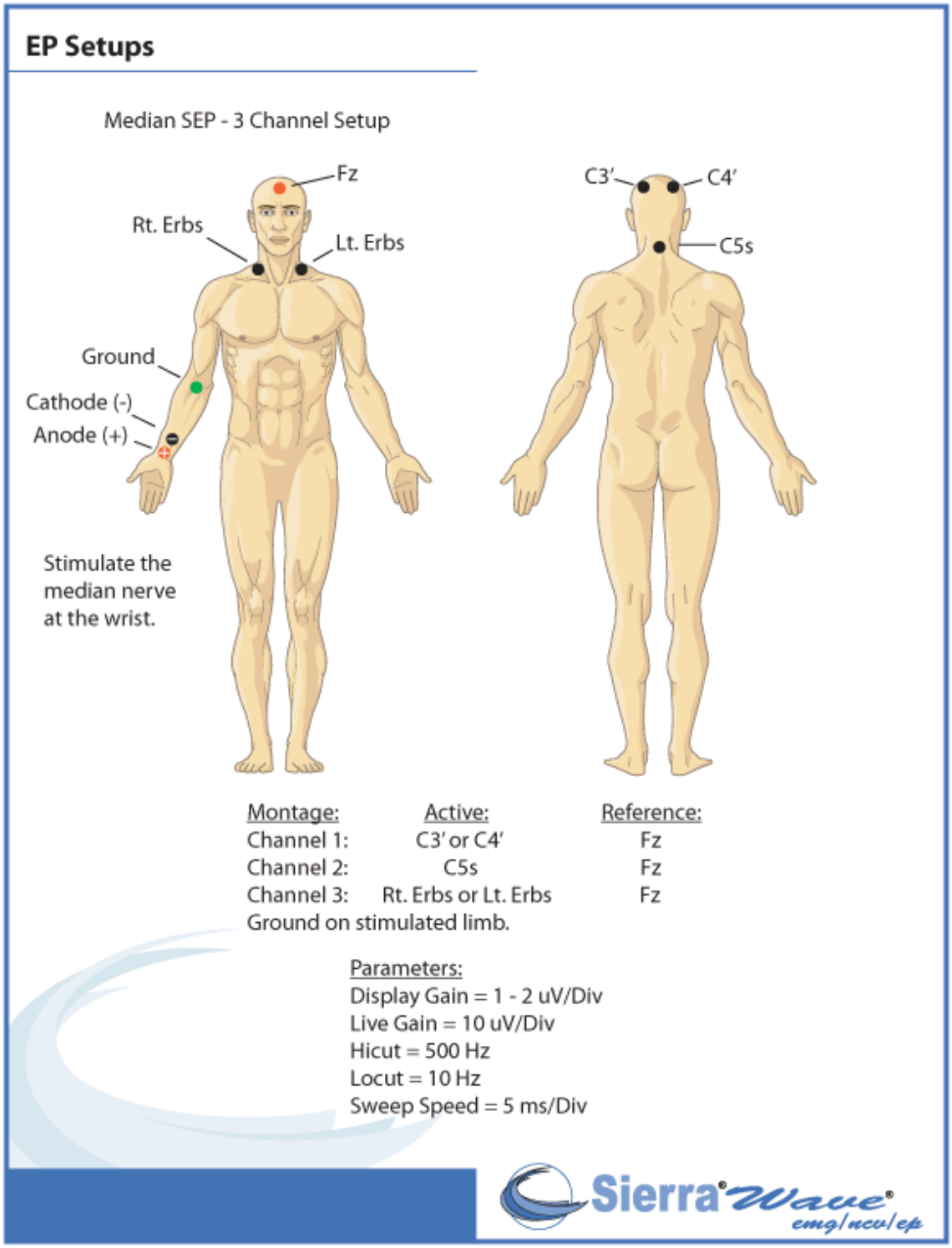
Root Levels: L1 - S1, (S2)

Positioning: Prone.

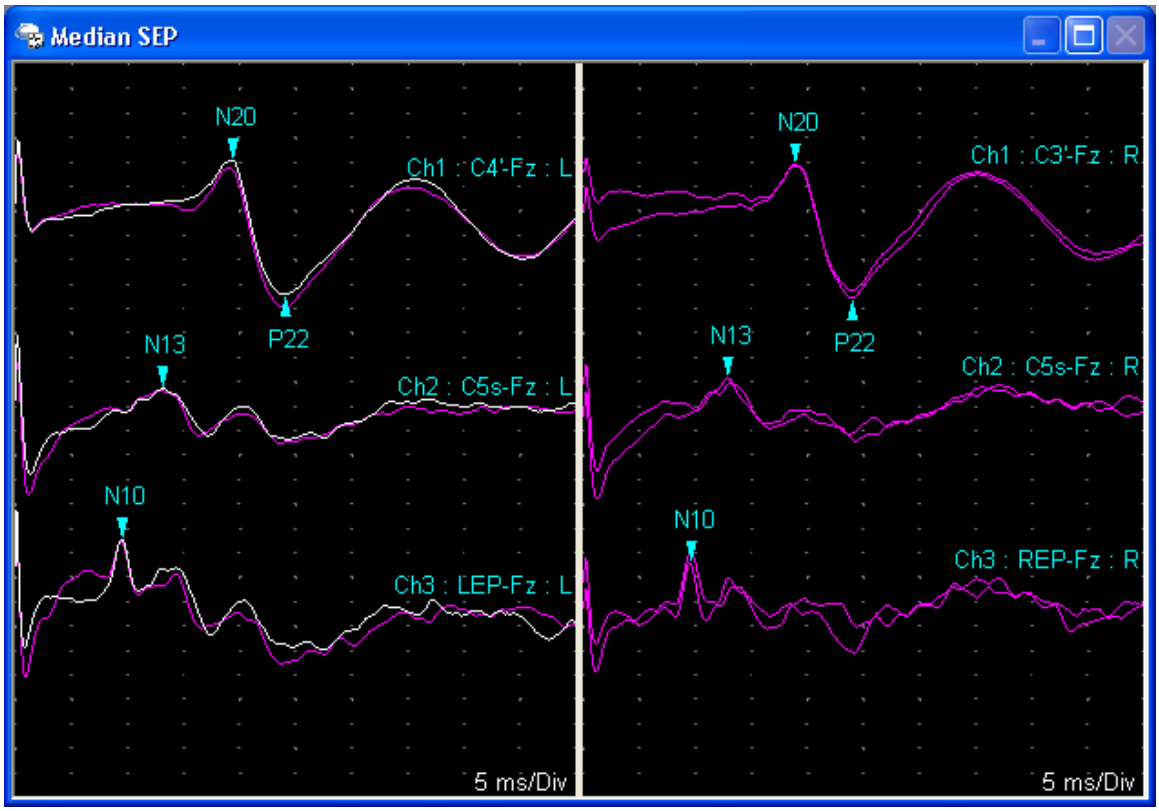
Activation: Hip extension. This will secondarily cause the paraspinal muscles to contract.

EP Setups

Median SEP Setup



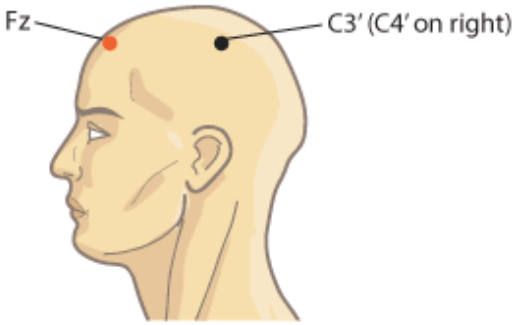
Example Traces:



Upper SEP Dermatomes

EP Setups

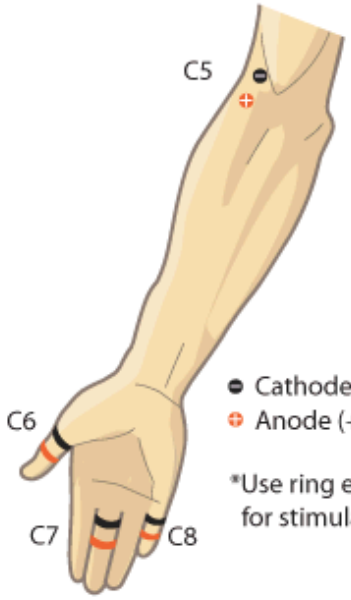
Upper Extremity Dermatomal SEPs
(C5, C6, C7 and C8)



Dermatome Setup - 1 channel

	Active:	Reference:
Right Side Stimulation:	C3'	Fz
Left Side Stimulation:	C4'	Fz

Stimulation (C5, C6, C7 and C8 nerve roots. Ground the arm proximal to the stimulation site)



⊖ Cathode (-)
⊕ Anode (+)

*Use ring electrodes for stimulation

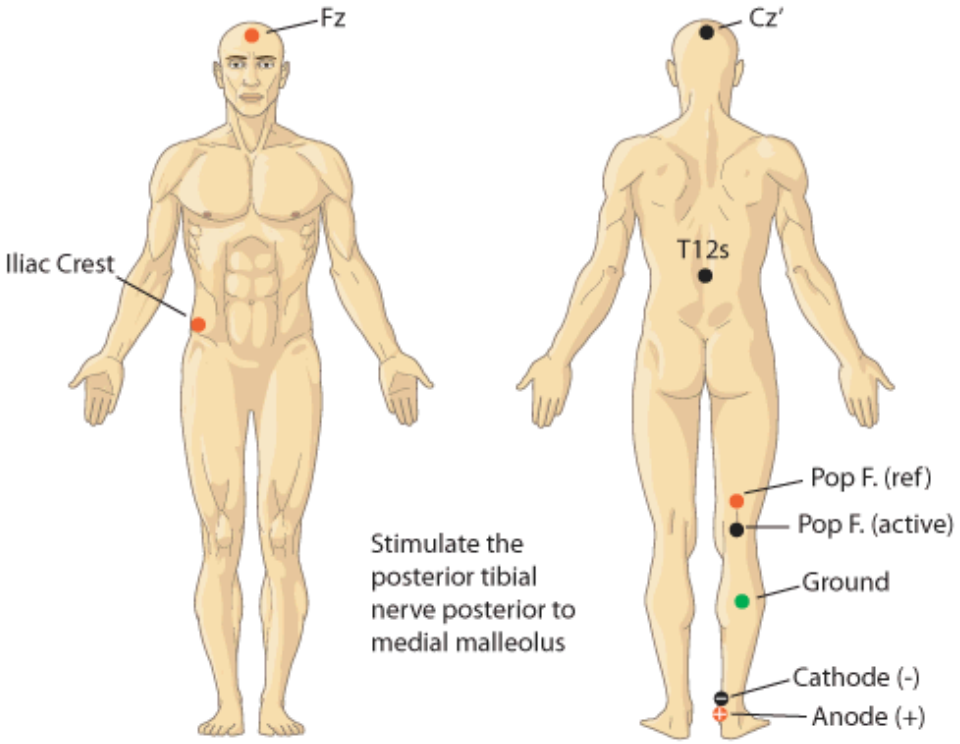
Parameters:
Display Gain = 1 - 2 uV/Div
Live Gain = 10 uV/Div
Hicut = 500 Hz
Locut = 10 Hz
Sweep Speed = 5 ms/Div

Sierra Wave emg/ncv/ep

Tibial SEP Setup

EP Setups

Tibial SEP - 3 Channel Setup



Stimulate the posterior tibial nerve posterior to medial malleolus

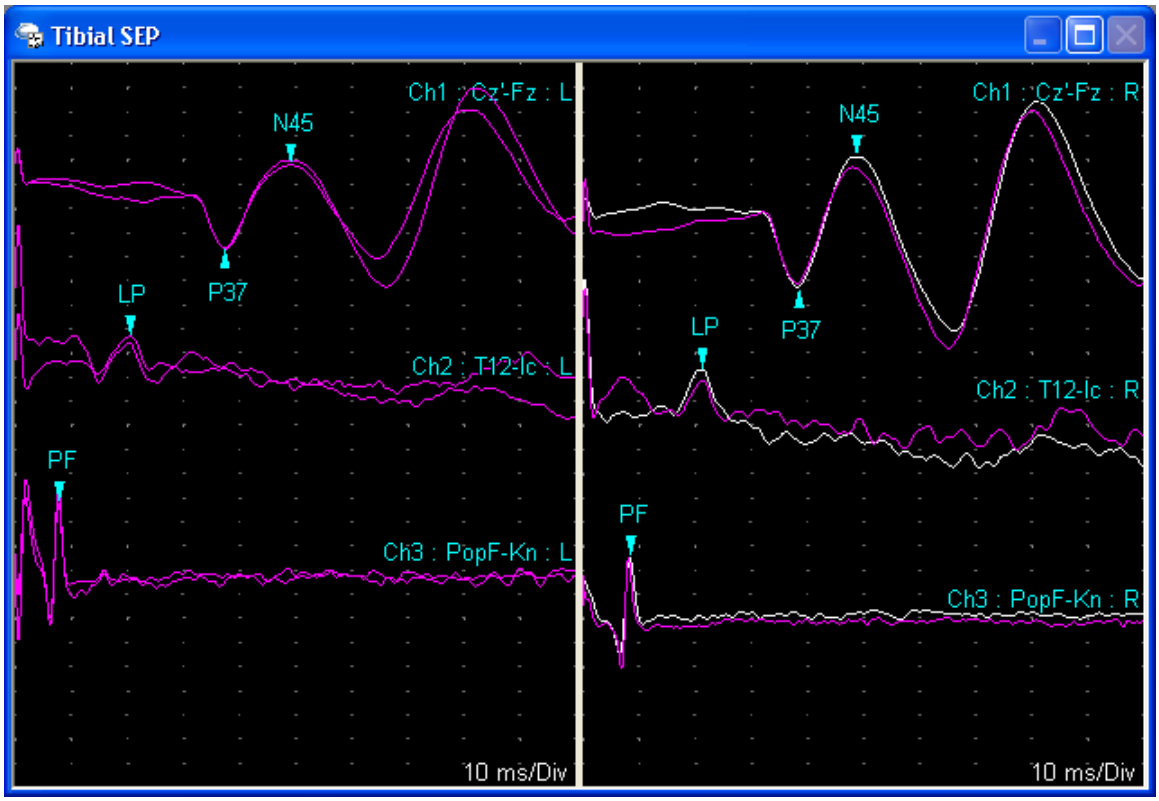
Montage:	Active:	Reference:
Channel 1:	Cz'	Fz
Channel 2:	T12s	Iliac Crest
Channel 3:	Rt. Pop or Lt. Pop	Proximal Pop F or Knee

Ground on stimulated limb.

Parameters:
Display Gain = 1 - 2 uV/Div
Live Gain = 10 uV/Div
Hicut = 500 Hz
Locut = 10 Hz
Sweep Speed = 10 ms/Div

Sierra Wave emg/ncv/ep

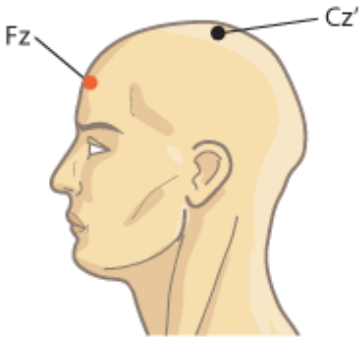
Example Traces:



Lower SEP Dermatomes

EP Setups

Lower Extremity Dermatomal SEPs
(L3, L4, L5 and S1)

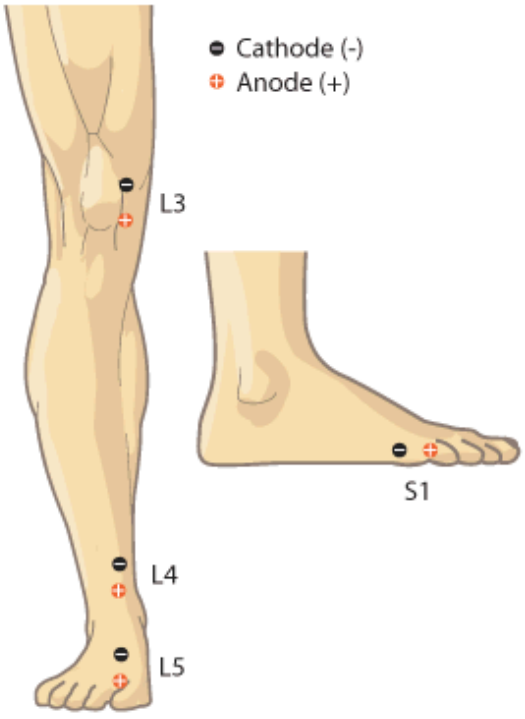


Dermatome Setup - 1 channel

	Active:	Reference:
Both Right and Left Stimulation:	Cz'	Fz

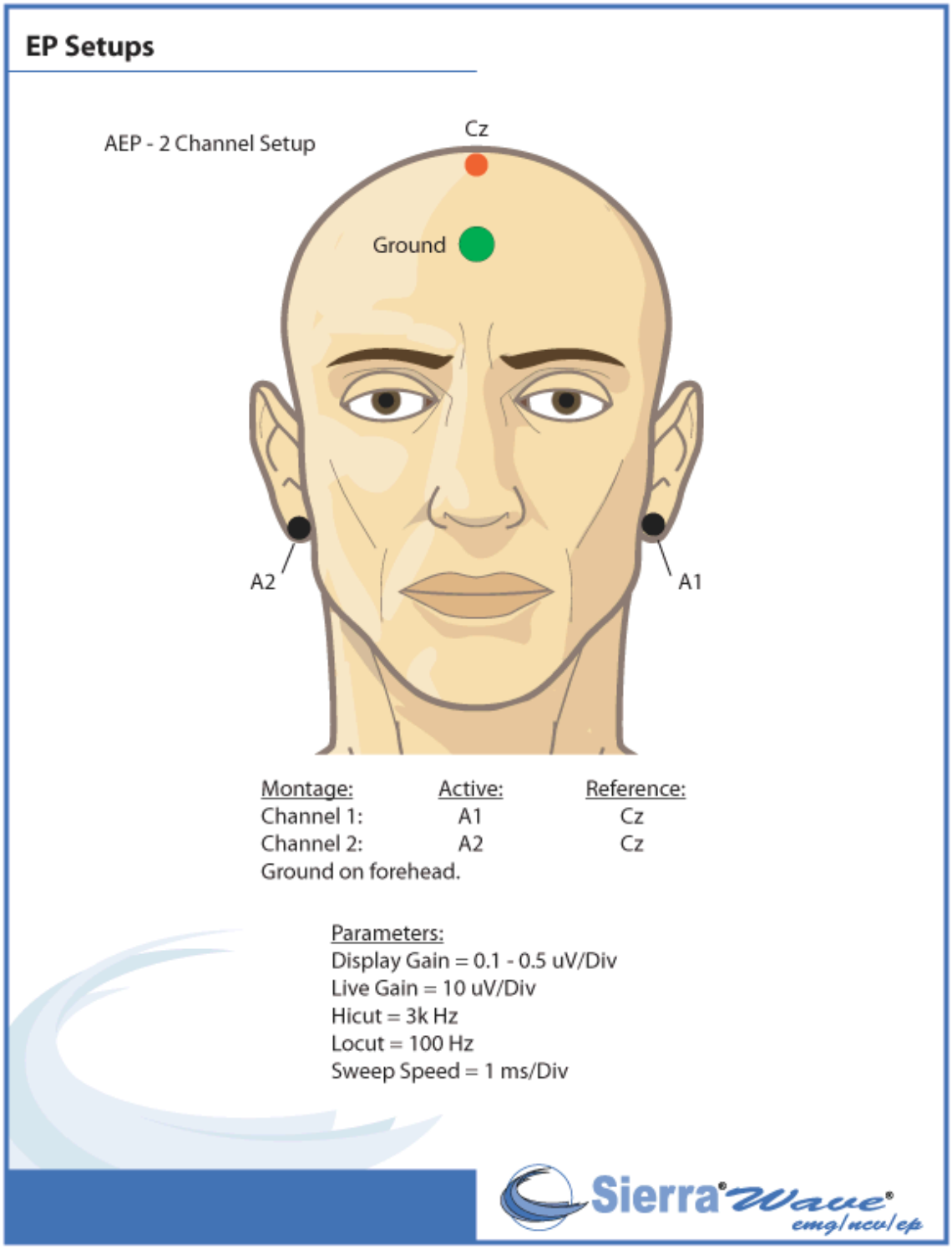
Parameters:
Display Gain = 1 - 2 uV/Div
Live Gain = 10 uV/Div
Hicut = 500 Hz
Locut = 10 Hz
Sweep Speed = 10 ms/Div

Stimulation (L3, L4, L5 and S1 nerve roots. Ground the leg ipsilateral to the stimulation site)

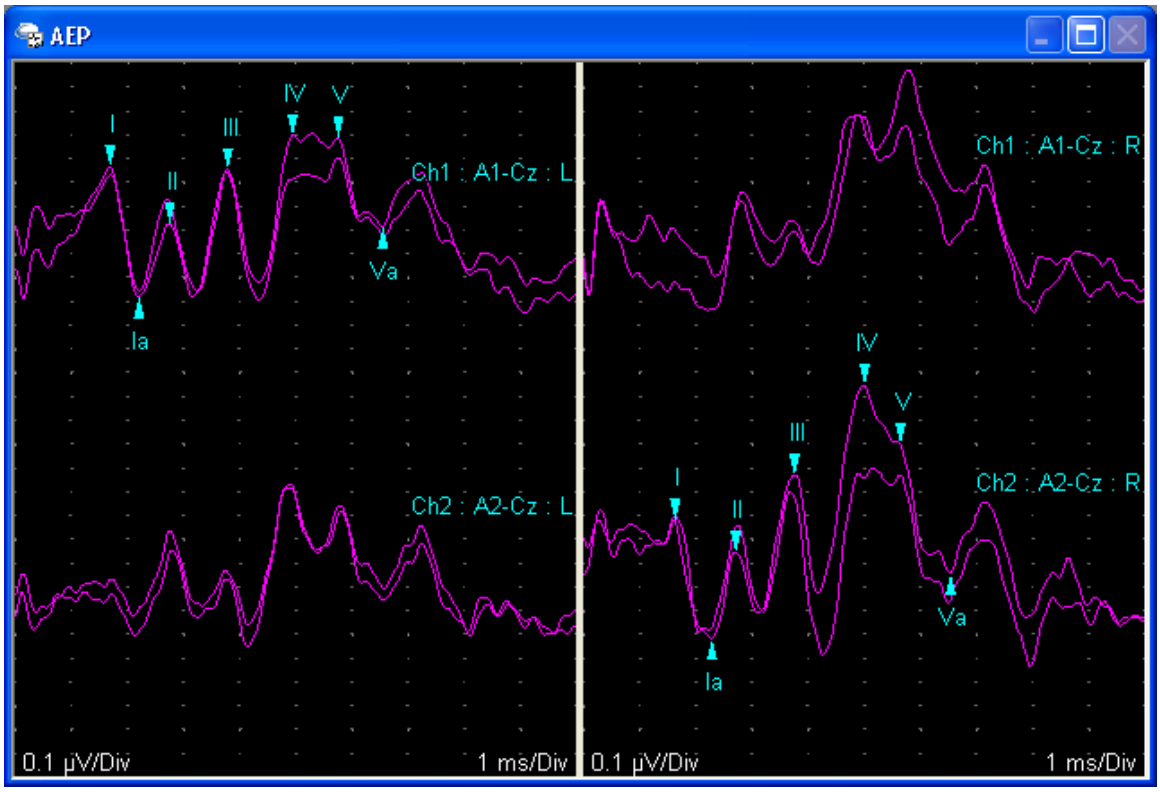


Sierra Wave emg/ncv/ep

AEP Setup


EP Setups
AEP - 2 Channel Setup
Cz
Ground
A2
A1
Montage: Active: Reference:
Channel 1: A1 Cz
Channel 2: A2 Cz
Ground on forehead.
Parameters:
Display Gain = 0.1 - 0.5 uV/Div
Live Gain = 10 uV/Div
Hicut = 3k Hz
Locut = 100 Hz
Sweep Speed = 1 ms/Div
Sierra Wave
emg/ncv/ep

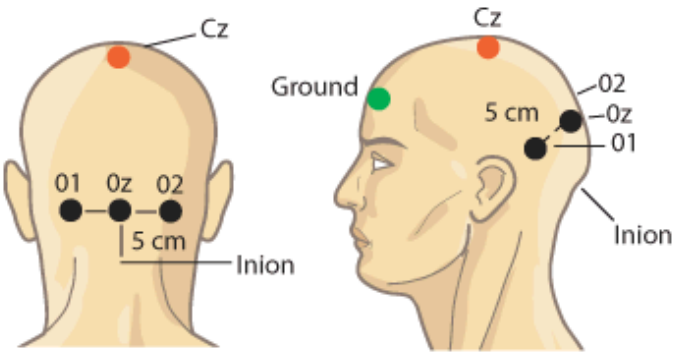
Example Traces:



VEP Setup

EP Setups

VEP Setup



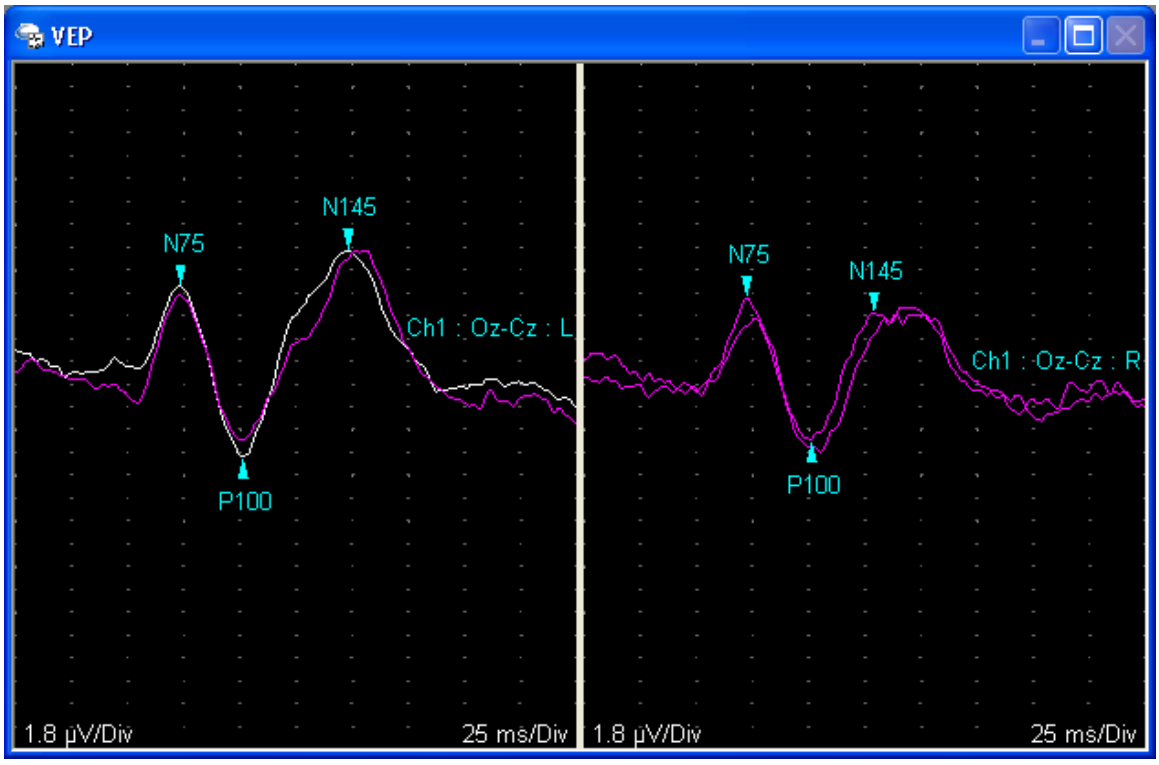
1 Ch Montage:	Active:	Reference:
Channel 1:	Oz	Cz

3 Ch Montage:	Active:	Reference:
Channel 1:	O1	Cz
Channel 2:	Oz	Cz
Channel 3:	O2	Cz

Ground on forehead.

Parameters:
Display Gain = 2 - 5 uV/Div
Live Gain = 10 uV/Div
Hicut = 200 Hz
Locut = 1 Hz
Sweep Speed = 25 ms/Div

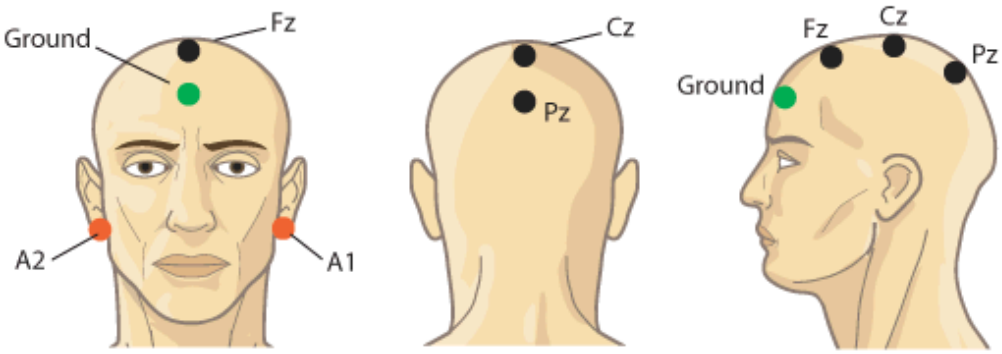
Example Traces:



P300 Setup

EP Setups

P300 - 3 Channel Setup

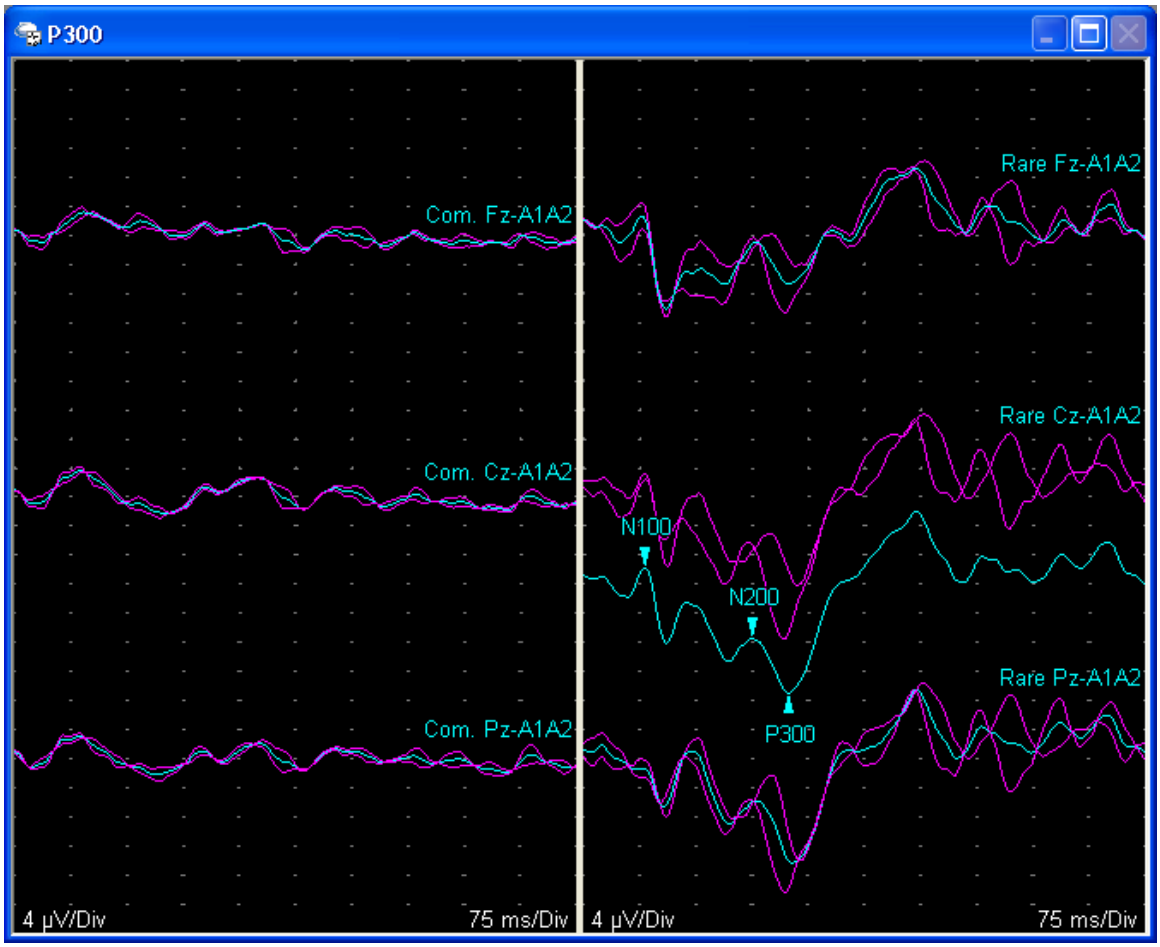


Montage:	Active:	Reference:
Channel 1:	Fz	A1A2*
Channel 2:	Cz	A1A2*
Channel 3:	Pz	A1A2*
Ground on forehead		*Linked ear reference

Parameters:
Display Gain = 2 uV/Div
Live Gain = 20 uV/Div
Hicut Filter = 30-100 Hz
Locut Filter = 1 Hz
Sweep Speed = 75-100 msDiv
Reject = Off
Rep Rate = less than 1/sec
Average Count = 200 (20% Rare)

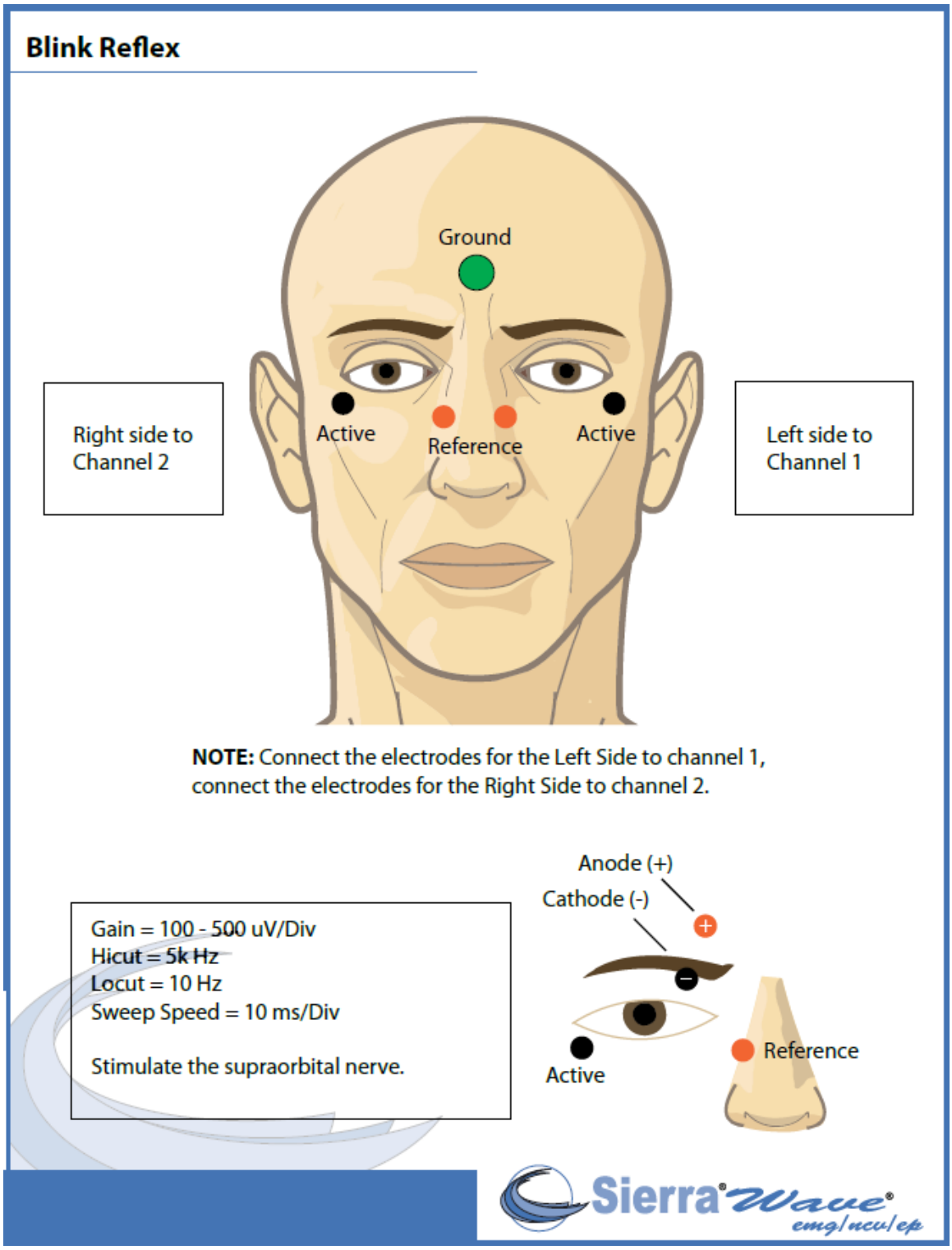
Sierra Wave emg/ncv/ep

Example Traces:

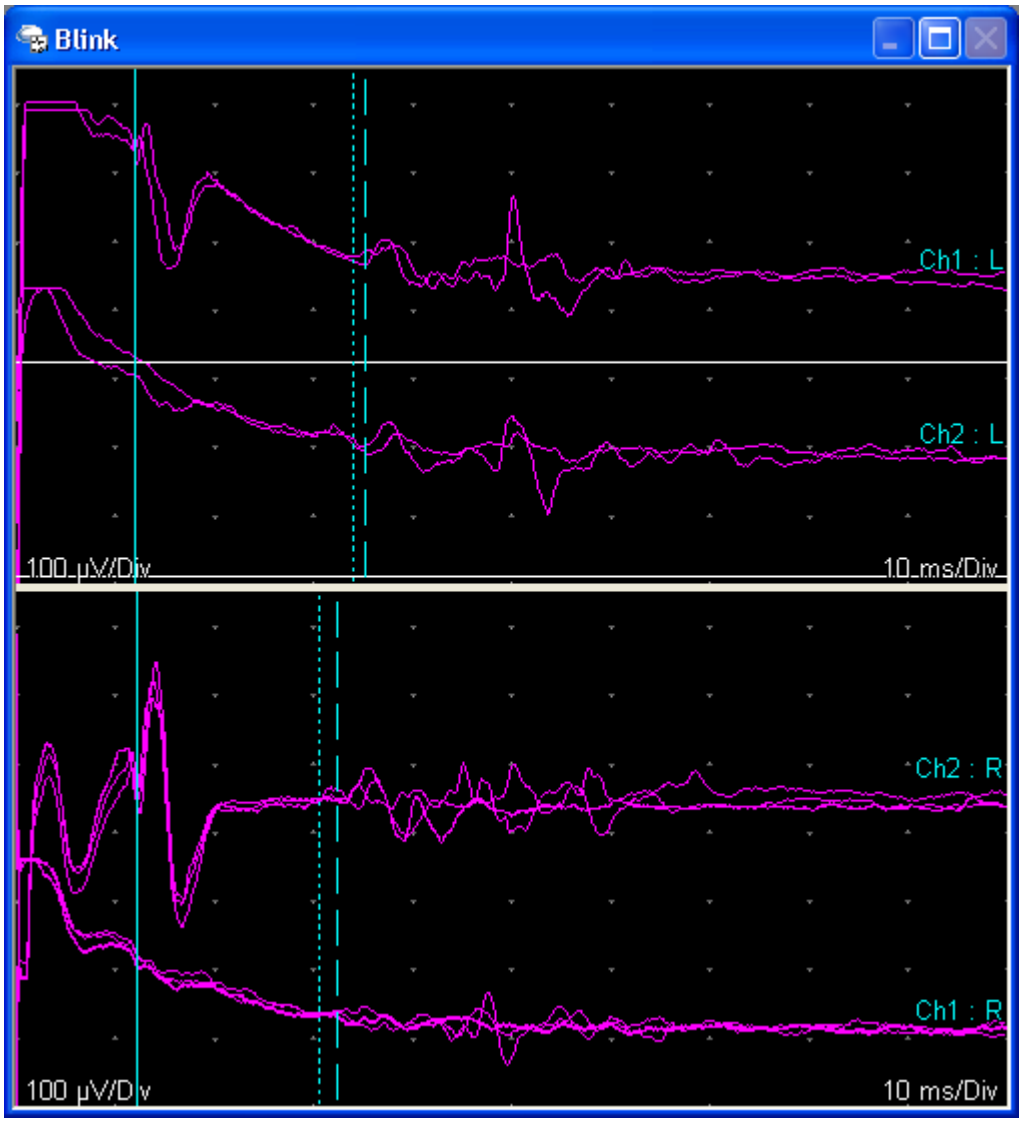


Blink Setup

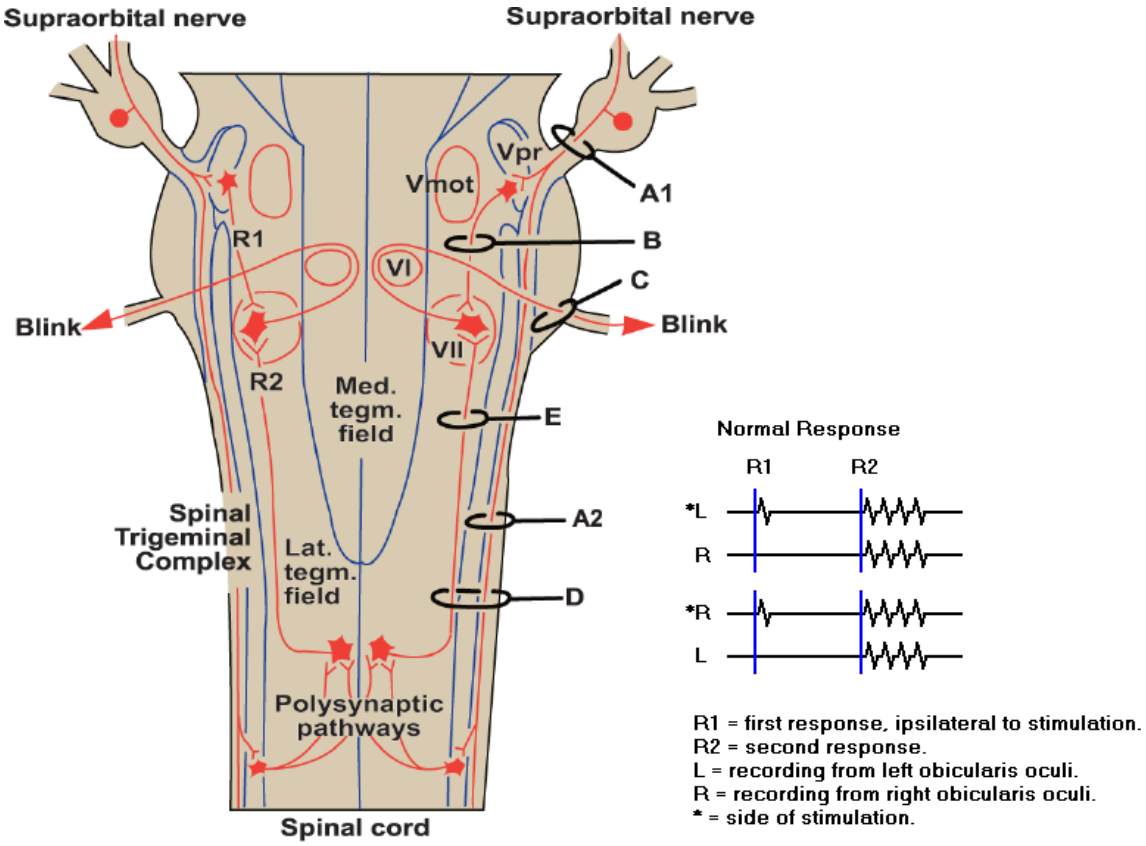
Blink Reflex Setup

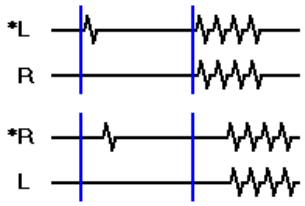
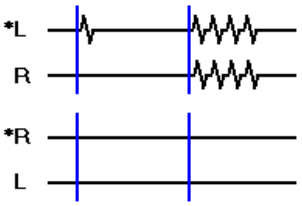
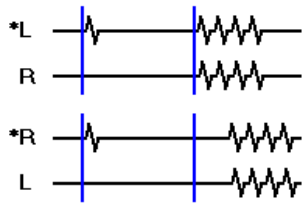
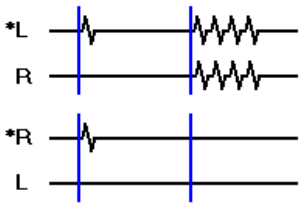
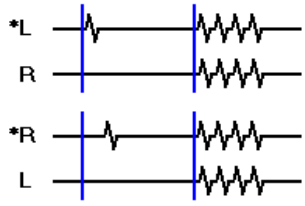
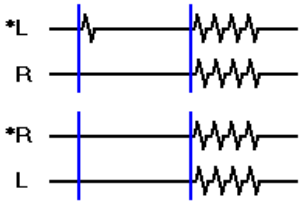
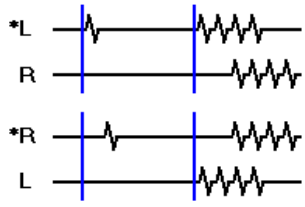
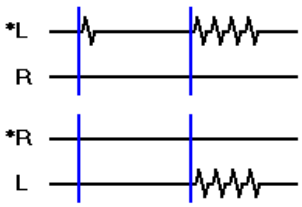
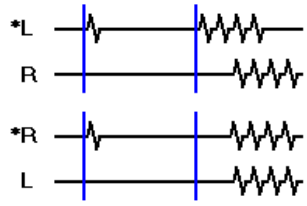
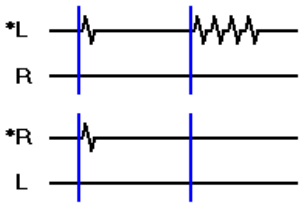
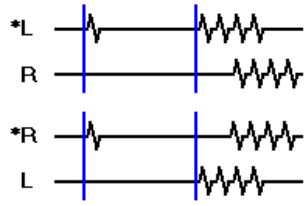
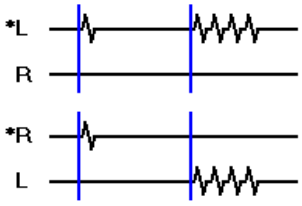


Example Traces:



Brainstem Lesions and Blink Reflex Responses



Lesion Site	Delayed Response	Absent Response
A1 Rt. V nerve pontine entrance. (Afferent Type)		
A2 Rt. V nerve spinal complex.		
B Rt. Mid Pons.		
C Rt. VII nerve, pontine exit. VII nerve nucleus. (Efferent Type)		
D Rt. V nerve spinal complex + crossed interneuron fibers. (Mixed Type)		
E Rt. Tegmental field, uncrossed + crossed interneuron fibers.		

Service & Maintenance

Grounding the Cart

If you use a cart with your Sierra Wave and do not use the isolation transformer, you will need to ground the cart to the Sierra Wave..

1. Remove the screw connecting black ground wire (grounds base unit to laptop) from the rear panel of Sierra base unit.
2. Insert screw through eye of black ground wire and the eye of the green/yellow ground wire.
3. Reinsert screw with both ground wires attached into the Sierra base unit. Tighten screw to secure the connection.
4. Attach crocodile clip on black ground wire to back of laptop with screw provided.
5. Attach green/yellow ground wire to the cart with screw provided.

Replacing the System Fuse

A blown fuse usually results from an overload condition, excessive vibration, or a failure in the main module. If a fuse is blown, the Sierra Wave will not power up.

To replace the fuse

1. Turn off and disconnect all equipment.
2. Locate the fuse holders on the bottom right rear of the base unit.
3. Insert a flathead screwdriver into the fuse holder cap and unscrew cap.
4. Remove old fuse and replace with a new 2A fuse. Replacement fuses must have appropriate safety approvals (e.g., UL, CSA, VDE, BSI, etc..).
5. Reinsert fuse holder cap into base unit and tighten.

Removing the Laptop from the Sierra Wave

To remove the laptop

1. Turn off Sierra Wave base unit.
2. Shut down laptop following standard windows procedures.

3. Close the laptop.
4. Disconnect all cables from the back of the laptop.
5. Gently lift the laptop off the instrument base (laptop is secured with velcro).

Preventive Maintenance & Calibration

To ensure that your instrument provides optimum performance, Cadwell recommends that you schedule annual preventive maintenance and system calibration.

For general cleaning and sterilization recommendations, see the topic Recommendations.

Servicing the Sierra Wave

If the Cadwell Service department determines that the problem lies at the component level or is in the custom keyboard or computer, you may be asked to ship the base unit of your Sierra Wave or the laptop computer to Cadwell Laboratories for service or repair.

See Shipping Instructions for further details.

Shipping Instructions

To send equipment for repair

1. Place the item to be shipped in the original shipping box or other appropriate shipping container (you can purchase a shipping box and foam from the Cadwell Service Dept).
2. Obtain a Service Return Order (SRO) number from Cadwell and put it on the left corner of the box.
3. Send item to:

   Cadwell Laboratories, Inc.

   Attn: Service Department

   909 North Kellogg Street

   Kennewick, WA 99336

If sending an item in for exchange follow "Exchanging Parts instructions.

Exchanging Parts

To send an item in on exchange.

1. Call Cadwell Laboratories to order a replacement item.
2. After receiving the replacement item, use the packing material (box and packing material) along with the enclosed airbill to return the defective item to Cadwell Laboratories.

Warranty Information

Warranty and Service Contracts

Your Cadwell Sierra System is covered by a one-year limited warranty at the time of purchase. Additional one-year service contracts may be purchased from Cadwell Laboratories before the warranty period or previous service contract expires. All warranties are non-transferable.

Cadwell has a variety of service contracts to suit any need. Contact us for detailed information or to request a proposal. Service contracts are non-transferable and non-refundable.

Toll-Free within the United States: 800-245-3001

Phone: 509-735-6481

Fax: 509-783-6503

Email: **contracts@cadwell.com**

Monday-Friday

8 a.m. - 5 p.m. PT

Limited Warranty

Cadwell warrants for a period of one year from the date of purchase, the system listed against defects in material and workmanship. Notice of a defect and an explanation of circumstances concerning any claim that the system has proven defective in material or workmanship shall be given to Cadwell Laboratories, Inc. within two (2) working days of the discovery of the defect in the system. Upon such notice, Cadwell will follow the company service procedures outlined on page 1 (of the warranty).

Cadwell agrees to retrofit equipment. If the company makes standard improvements to components of the equipment covered under this agreement during the term of the warranty and if such improvements are compatible with the equipment located on the customer’s premises, then Cadwell will retrofit such physical equipment at no additional charge. Cadwell reserves the right to make changes in specifications, construction or design of its products at any time in such a manner as it may consider necessary or advisable.

Preventative Maintenance

When equipment is delivered at customer's expense during the term of the warranty to Cadwell Laboratories, Cadwell will take the action necessary to insure performance to specifications, including cleaning as necessary, checking, calibrating, and verifying operation. Preventative maintenance must be scheduled with Cadwell.

Warranty Exclusion

- Except as expressly set forth herein, there is no warranty, expressed or implied as to fitness for any particular purpose, nor to anything else unless contained on the face of this Agreement. All other warranties, expressed or implied, including, but not limited to, any IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE, ARE HEREBY DISCLAIMED.
- Cadwell Laboratories shall be under no obligation to furnish, repair or replace any part which has been damaged, abused or misused through no fault of Cadwell Laboratories, or if unauthorized attempts to modify, repair or service equipment have impaired the performance of the equipment.

Oral Statements Do Not Constitute Warranties

Representatives of Cadwell are not authorized to make warranties about the merchandise described in this Agreement. These representatives' ORAL STATEMENTS DO NOT CONSTITUTE WARRANTIES, shall not be relied upon by the customer and are not part of the contract. The entire contract is embodied in this writing and NO OTHER WARRANTIES are given beyond those set forth in this contract. This writing constitutes the final expression of the parties' agreement, and it is a complete and exclusive statement of the terms of that agreement.

Sole Purpose

The sole purpose of the exclusive remedy shall be to provide the customer with free repair and/or replacement of defective parts in the manner provided herein. This exclusive remedy shall not be deemed to have failed of its essential purpose so long as the company is willing to repair or replace defective parts in the prescribed manner.

Indemnification

Customer agrees to indemnify Cadwell and hold it harmless from any and all demands or claims of any nature whatsoever arising out of the use of the equipment, including product liability or physical injuries to person or property, loss of life, or other claims or damages.

Business Use

Except as expressly provided by Cadwell in writing, all goods sold hereunder are intended for the ultimate use by a commercial user and for operation by persons trained and experienced in the use and maintenance of such equipment. Cadwell's warranty does not extend to any consumer. Customer acknowledges that it is purchasing the equipment for a business use and for no other.

Exclusive Remedy and Limitations of Damages

The parties agree that the customer's SOLE AND EXCLUSIVE REMEDY against Cadwell shall be for repair and/or replacement of defective parts as provided herein. Customer agrees that NO OTHER REMEDY SHALL BE AVAILABLE to them and that the company shall not, in any event, be liable for incidental damages or consequential damages, including loss of income, loss of time, lost sales, injury to person or personal property, liability customer had with respect to any other person, or for any other type of formal consequential damage or economic loss.

Severability

If any provision or clause of this Contract or the application thereof to any person or circumstance is held invalid or unconscionable, such invalidity or unconscionability shall not affect other provisions or applications of the Contract which can be given without the invalid or unconscionable provision or application, and to this end the provisions of this Contract are declared to be severable.

Cost of Legal Action

In the event any action shall be instituted for the failure to perform the terms and conditions of this Agreement, the prevailing party shall be entitled to recover costs, including attorney's fees.

Time Limit on Customer Commencing Legal Actions

An action by the customer for breach of this Agreement or any other action by customer otherwise arising out of this transaction must be commenced within one year from the date the right, claim, demand or cause of action shall first accrue, or be barred forever.

No Waiver

If Cadwell at its option agrees to a waiver of any of the terms and conditions recited herein, such waiver shall not for any purpose be construed as a waiver of any succeeding breach of the same or any other terms or conditions of this Agreement; nor shall such a waiver be viewed as a course of performance.

CUSTOMER AGREES TO BE BOUND BY ALL OF THE ABOVE TERMS AND FURTHER AGREES THAT THEY CONSTITUTE THE COMPLETE AND EXCLUSIVE STATEMENT OF THE AGREEMENT BETWEEN THEM WHICH SUPERSEDES ALL PROPOSALS, ORAL OR WRITTEN AND ALL OTHER COMMUNICATIONS BETWEEN THEM RELATING TO THE SYSTEM AND WARRANTY THEREON.

THIS AGREEMENT WILL BE GOVERNED BY THE STATE OF WASHINGTON AND SHALL NOT BE MODIFIED, AMENDED OR OTHERWISE AFFECTED EXCEPT BY A WRITING SIGNED BY BOTH PARTIES.

Customer Support

Application Support

Contact numbers

In the U.S.

Voice: 1-800-245-3001

Fax: 1-509-783-6503

Outside the U.S. :

Local Distributor or 1-509-735-6481

Email: applications@cadwell.com

Support hours

Application support 6:30 am to 5 pm PST (Pacific Standard Time)

To contact Cadwell for a problem

1. Have the person who normally operates the equipment in front of the Sierra Wave prepared to speak to a support person. This person should be able to provide an accurate description of the situation.
2. Call the customer support number and ask for application support.

Service Department

Contact numbers

In the U.S. :

Voice: 1-800-245-3001

Fax: 1-509-783-6503

Outside the U.S. :

Local Distributor or 1-509-735-6481

Email: service@cadwell.com

Support hours

Service Department support 7 am to 5 pm PST

To contact Cadwell for a problem

1. Have the person who normally operates the equipment in front of the Sierra Wave prepared to speak to a Service Technician. This person should be able to provide an accurate description of the situation.
2. Call the customer support number and ask for the Service Department.

The Cadwell Service Technician will determine if an exchange or repair of parts is necessary and instruct you on appropriate shipping arrangements.

Cleaning and Disinfecting

Recommendations

Perform cleaning and disinfection procedures on a periodic basis to ensure the safe operation of your Sierra Wave system. As you clean, visually inspect the instrument and its components for damage or wear. Contact Cadwell if you notice damage to the exterior of the instrument.

While the Sierra Wave EMG/EP system has been carefully designed and manufactured to be as reliable and durable as possible, regular cleaning and inspection of the system components can help the long term trouble free operation of the system. Try to avoid extremes of physical stress such as dropping the unit or exposing it to extreme temperatures. If you suspect a problem, contact the Cadwell Service Department at 800-245-3001.

Cadwell recommends that you refer to the *AAMI Standards and Recommended Practices for Sterilization in Health Care Facilities,* or equivalent standard text for detailed disinfection instructions.

These standards may be ordered by calling the Association for Advancement of Medical Instrumentation at 1-800-332-2264, ext. 250.

 **Turn off and disconnect all Sierra components before cleaning. Do not attempt to service or repair damaged or inoperable equipment.**

Wave Base Unit

Use a soft cloth to wipe away any dust that has collected on the instrument casing. You can dampen the cloth slightly in a mild soap-and-water solution or ammonium based surface disinfectant such as Envirocide® (active ingredients - Diisobutylphenoxyethoxyethyl dimethyl benzyl ammonium chloride 0.28%, Isopropanol 17.20%). Isopropyl Alcohol may also be used to clean the exterior of the unit.

A soft brush or pressurized air duster can also be used to remove dust from hard-to-access areas such as the custom keyboard, alphanumeric keyboard, and between connectors on the side and rear panels. To clean dust from monitor's screen, wipe it with a soft cloth or cloth dampened with a non-ammoniated glass cleaner.

 **Turn off the base unit and disconnect the AC power before cleaning. Disconnect all peripheral components before cleaning. Keep**

all cleaning fluids away from electrical connectors. Do not let solutions seep inside the base unit. Do not use abrasive cleansers.

Gloves should be worn when using environmental disinfectants.

Do not use acetone to clean the surface of the Sierra Base Unit.

Avoid letting liquid seep into any of the internal electronics.

Amplifier

Use a soft cloth to wipe away any dust that has collected on the amplifier casing. You can dampen the cloth slightly in a mild soap-and-water solution or ammonium based surface disinfectant such as Envirocide® (active ingredients - Diisobutylphenoxyethoxyethyl dimethyl benzyl ammonium chloride 0.28%, Isopropanol 17.20%). Isopropyl Alcohol may also be used to clean the exterior of the amplifier.

Do not use acetone to clean the surface of the Amplifier.

Gloves should be worn when using environmental disinfectants.

Avoid letting liquid seep into any of the internal electronics.

Stimulators

Visually inspect the stimulator for unusual wear or damage prior to each use. If you notice damage, disconnect the stimulator immediately and contact Cadwell.

Use a soft cloth to clean stimulator parts that come in contact with the patient after each use (e.g., electrical stimulator probes, earphones, and LED goggles). Properly dispose of the foam tips used with the insert earphones after each use. You can dampen the cloth slightly in a mild soap-and-water solution or ammonium based surface disinfectant such as Envirocide® (active ingredients - Diisobutylphenoxyethoxyethyl dimethyl benzyl ammonium chloride 0.28%, Isopropanol 17.20%). Isopropyl Alcohol may also be used to clean the exterior of the stimulators.

In cases requiring the full sterilization regimen, the electrical stimulator probes (removed from the stimulator) can be steam autoclaved at 250 °F (121 °C) and 15 psi for 15 minutes, or the standard recommended temperature, pressure, and time for rubber products.

Turn off and disconnect stimulators before cleaning. Keep all cleaning fluids away from electrical connectors. Do not let solutions seep inside the stimulators. Do not use abrasive cleansers.

Gloves should be worn when using environmental disinfectants.

Interface Cables and Power Cords

Visually inspect the interface cables and power cords that are used with components, stimulators, and accessories. If you notice unusual wear or breakage, disconnect the cable or cord immediately and contact Cadwell.

Use a soft cloth to clean interface cables and power cords. You can dampen the cloth slightly in a mild soap-and-water solution or ammonium based surface disinfectant such as Envirocide® (active ingredients - Diisobutylphenoxyethoxyethyl dimethyl benzyl ammonium chloride 0.28%, Isopropanol 17.20%). Isopropyl Alcohol may also be used to clean cables.

Gloves should be worn when using environmental disinfectants.

Recording Electrodes

The quality of signal acquisition is affected by the condition of your recording electrodes. Routine inspection, careful handling, frequent cleaning, and proper storage are essential practices for properly maintaining them.

The following maintenance procedures apply to nonspecialized electrodes:

- Inspect electrode leads for breaks, rust, corrosion, and debris prior to use.
- Handle electrodes carefully, and do not pull on the leads.
- Clean electrodes in warm water, using a toothbrush to scrub the surface of the electrode. If necessary, soak electrodes to loosen debris. (Using a file or steel wool to scrub electrodes may lead to contamination of electrode metal. This can result in signal artifact.)
- For proper sterilization techniques refer to the electrode manufacturer's instructions.
- If necessary, dry electrodes thoroughly to prevent corrosion from hard water deposits.
- Store electrodes in a clean, dry place.

- Do not tangle or kink electrode leads.
- Properly discard disposable electrodes after each use (e.g., disposable needle electrodes and disposable surface electrodes).

 Specialized electrodes are often more complex and require special care. Anyone using them should consult the manufacturer for proper maintenance and handling techniques.

Patient Safety

Operating Limits

Operational Limits (ambient conditions)

Rating: 100-240VAC 50-60 Hz 2A max

Temperature: +10º C (+50º F) to +40º C (+104º F)

Relative Humidity: 30% - 75%

Atmospheric Pressure: 700 hPa to 1060 hPa

Hazardous Operating Conditions

- If needle electrodes are used for stimulation, the current at the tip may be high enough to cause arcing and possible local tissue damage.
- Patients who are unresponsive or cannot communicate, lack sensation, or are anesthetized may be injured by prolonged high-intensity stimulation.
- Injury may occur if the stimulating electrode is directly applied to muscle, nerve, brain, spinal cord, or other exposed tissue.

Warnings and Precautions

- Avoid trans-thoracic stimulation.
- If discrete wire electrodes are used, place the stimulus and return electrodes in close proximity or on the same limb.
- Use a low-current stimulator with needle electrodes and in surgery to avoid injury
- Permanently applied surface electrodes should be at least 0.5 cm in diameter.
- Current densities for any electrode exceeding 2 mA r.m.s./cm2 may require the special attention of the operator.
- Avoid prolonged, high-current, high-repetition-rate stimulation.
- Avoid stimulation near implanted electronic devices (e.g., pacemakers).

- Do not stimulate a patient with an implanted electronic device unless a specialist medical opinion has first been obtained.
- Electrodes should be considered a possible return path for electro-cautery under certain fault conditions, and should be positioned to avoid burns or damage to the equipment.
- This equipment should not be used within 5 meters of therapeutic microwave or shortwave equipment.
- A video VEP monitor which does not meet IEC 60601-1-1 should have a protective earth connection.
- Avoid accidental electrical contact between stimulators, amplifiers, sensors and other isolated components and the computer, cart, and other grounded or non-isolated components.
- Disconnect isolated components for storage or when contact with non-isolated components is possible.
- Do not wrap amplifiers in blankets or other insulators that impede cooling.
- Do not place amplifiers or stimulators against the patient for prolonged periods.
- To avoid excessive auditory stimulation, ensure that the stimulus intensity never exceeds 75 dB above the hearing threshold.
- Portable and Mobile RF communications equipment can affect medical electrical equipment.
- Sierra Wave should not be used adjacent to or stacked with any other equipment. If adjacent or stacked use is necessary, performance of the Sierra Wave should be observed to verify normal operation in the configuration in which it will be used.
- Do not immerse system components in liquid.
- No user serviceable parts inside. Service by Cadwell Laboratories, Inc. and other authorized bodies only.
- Use extreme caution when electro-cautery or similar equipment is used as burns may appear under electrodes as current seeks an alternate return path.
- The operator must be trained to be able to recognize the difference between signal artifacts and valid bio-signals caused by movements, interference, or misplacement of sensors or electrodes.
- The proper use of this device for its intended purpose can only be assured once all instructions have been read and understood. If there are any

questions regarding the operation of the Sierra Wave EMG/EP system, contact Cadwell Laboratories.

- The system is not defibrillator proof.
- Do not use the system in an MRI environment.
- Cleaning instructions in this manual need to be strictly adhered to. Always disconnect equipment from power source and patient before cleaning.
- The system is not designed to operate in an explosive environment.
- The system is designed to be used with one patient at a time. Do not connect multiple patients to one amplifier.
- The Help Topics provide an operational summary for the Sierra Wave system. It does not provide clinical training. It is assumed that the user has adequate clinical training to perform procedures.
- Sierra Wave system patient connections are type B Floating.

Auditory Stimulation:

The auditory stimulator (headphones of both the cup and insert type) output a 100µS square wave (pulse) which is heard as a click. The output level is user adjustable from -10 to 95 dB nHL. Contralateral masking is also available and is user is adjustable from 0 to 80 dB below stimulus level. Extended exposure to high sound pressure levels can result in permanent hearing loss. While the effect of high sound pressure levels differ greatly between individuals it is possible that exposure to levels of 75dB nHL for several hours can cause permanent hearing loss. As the sound pressure levels go up the acceptable exposure time goes down. Where possible avoid stimulating at high levels for extended periods of time.

Photic (Flash) Stimulation:

The photic stimulator using flash tube technology outputs a pulse of white light with a pulse width of approximately 10uS. The flash can be manually triggered or set to flash repeatedly at a rate between 1 and 25 Hz. The flash energy is 1.5 million candle or less. UV energy is blocked by a protective filter incorporated into the lens. While there are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. They have been proven to be safe when used at distances of 18 inches or more on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

The photic stimulator using LED technology outputs a pulse of white light with a pulse width of several milliseconds. The flash can be manually triggered or set to flash repeatedly at a rate between 1 and 60 Hz. The LED produces no UV energy. The flash energy is much less that output by a flash tube stimulator and the pulse width is adjusted to give the same perceived brightness. While there

are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. They have been proven to be safe when used at distances of 18 inches or more on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

The photic stimulator goggles use LED technology and output a pulse of red light (650nm nominal wavelength) with a pulse width of 10 milliseconds. The flash can be manually triggered or set to flash repeatedly at a rate up to 10 Hz. The LED produces no UV energy. The flash energy is in accordance with EN 60825-1 which covers the safety of laser and LED products. While there are no industry or other standards established for EEG flash stimulators these parameters are all within the range used by the major EEG manufactures. The goggles have been proven to be safe when used on a patient with eyes closed. If used on an anesthetized patient a means should be provided to ensure that the eye lids remain closed.

 **Avoid prolonged use of high sound pressure levels or light output which may cause permanent hearing or visual impairment.**

Electrical Stimulator Characteristics

The Sierra Wave contains one constant-current electrical stimulator. The output generates a monopolar output. The maximum outputs (which cannot occur simultaneously) are:

380 volts
100 mA
1000 microseconds pulse width
90 pulses per second
0.3 Watts r.m.s.
1.6 mA r.m.s.

Continuous, fast repetition rates and high currents will cause the output voltage to droop as a safety measure, stabilizing at the smaller of the rated r.m.s. wattage or r.m.s. current.

The stimulator contains fault detectors that monitor for current delivered when no stimulus is requested, for current that is higher than requested, and for other conditions. The fault detector will disable the high voltage, and/or clamp the outputs until reset.

The maximum deliverable current for a single stimulus is a function of electrode impedance, and is calculated as:

I (ma) = 380 volts / R (kOhms), or R = 380 / I

Current	Maximum Resistance
10 mA	38 kOhm
20 mA	19 kOhm
50 mA	7.6 kOhm
100 mA	3.8 kOhm

Electrode gel and/or abrasive skin preparation should be applied as needed.

If the specified current cannot be delivered, a **"Z"** symbol appears on the screen for approximately 1 second each time the stimulator is fired.

Transport and Storage Limits

Transport and Storage Limits (ambient conditions)

The Sierra Wave system should be stored in a clean, dry place. Handle the system with care.

Temperature: Do not expose to temperatures below -20º C (-4º F) or above 65º C (149º F)

Relative Humidity: Do not expose to relative humidity below 10% or above 90% non-condensing

Atmospheric Pressure: 500 hPa to 1060 hPa

Electromagnetic Compatibility

6.8.2.201 a1) This medical electrical equipment needs special precautions regarding Electromagnetic Compatibility (EMC) and needs to be installed and put into service according to the EMC information provided below.

6.8.2.201 a2) Portable and Mobile RF communications equipment can affect medical electrical equipment.

6.8.3.201 a1) List of cables and accessories.

Sierra Wave 2 channel base – 100813-200 Sierra Wave 4 channel base – 100814-200 Sierra Wave 4 channel amplifier – 190216-200 Sierra Wave 2 channel amplifier – 190215-200 Sierra Wave software – 369030-200	TDH-39 adult headphones – 199219-200 TDH-39 lightweight headphones – 199220-200 Insert earphones – 291151-000 Foot switch – 190218-200 Sierra Wave electrical stimulator – 190217-200 VEP LED module – 199217-200 LED goggles – 199218-200 Power com module – 197145-200 Flash stimulator – 190182-200 Skin temp probe – 199210-200 External speaker – 190200-200 Isolation transformer – 197205-200

6.8.3.201 a2) Use of accessories and cabling other than those specified in 6.8.3.201 a1 above, with the exception of those sold by Cadwell as replacement parts, may result in increased emissions or decreased immunity of Sierra Wave systems.

6.8.3.201 a3) Table 201- electromagnetic emissions

Guidance and manufacturer's declaration – electromagnetic emissions		
Sierra Wave EMG/EP systems are intended for use in the electromagnetic environment specified below. The customer or the user of the Sierra Wave should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment – guidance**
RF Emissions CISPR 11	Group 1	Sierra Wave uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment
RF Emissions CISPR 11	Class B	Sierra Wave is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC 61000-3-2		
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

6.8.3.201 a4) Sierra Wave should not be used adjacent to or stacked with any other equipment. If adjacent or stacked use is necessary, performance of the Sierra Wave should be observed to verify normal operation in the configuration in which it will be used.

6.8.3.201 a5) Immunity justification

Refer to EN60601-1-2 test report summaries above.

6.8.3.201 a6) Table 202 –electromagnetic immunity.

Guidance and manufacturer's declaration – electromagnetic immunity			
Sierra Wave EMG/EP systems are intended for use in the electromagnetic environment specified below. The customer or the user of the Sierra Wave should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Electrostatic discharge at ANY level will produce noise glitches on the Sierra II display screen and may temporarily saturate amplifier inputs. These noise glitches and saturation are easily differentiated from biopotential input signals. ESD noise is unavoidable in high static environments due to the high input sensitivity of the equipment. To minimize electrostatic effects, floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±1 kV for power supply lines ±1 kV for input/output lines	EFT's above 1 kV cause events in the display waveforms. This is an unavoidable phenomenon due to the high input sensitivity of the equipment. These waveform disturbances can be differentiated from physiological events. To minimize these effects, mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV differential mode ±1 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.

Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 0.5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 sec	Complies at all line input voltages Complies at 240 V 50 Hz. Turns off at 120 V 60 Hz. Complies at all line input voltages Sierra II turns off. Restart of software required.	Mains power quality should be that of a typical commercial or hospital environment. If the user of the Sierra Wave requires continued operation during power mains interruptions, it is recommended that the Sierra Wave be powered from an uninterruptible power supply.
Power frequency (50/60 Hz) magnetic field	3A/m		Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

6.8.3.201 b) Table 204 –electromagnetic immunity

Guidance and manufacturer's declaration – electromagnetic immunity			
Sierra Wave EMG/EP systems are intended for use in the electromagnetic environment specified below. The customer or the user of the Sierra Wave should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	V_1 = 3 V	Portable and mobile RF communications equipment should be used no closer to any part of the Sierra Wave, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance $d = [\frac{3,5}{V_1}]\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	E_1 = 3 V/m	$d = [\frac{3,5}{E_1}]\sqrt{P}$ 80 MHz to 800 MHz $d = [\frac{7}{E_1}]\sqrt{P}$ 800 MHz to 2,5 GHz Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range. [b] Interference may occur in the vicinity of equipment marked with the following symbol 
Note 1 At 80 MHz and 800 MHz, the higher frequency applies. Note 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the Sierra Wave is used exceeds the applicable RF compliance level above, the Sierra Wave should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the Sierra Wave.

[b]Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [v1] V/m.

6.8.3.201 b) Table 204 –electromagnetic immunity

Recommended separation distances between portable and mobile RF communications equipment and the Cadwell Sierra Wave

Sierra Wave EMG/EP systems are intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Sierra Wave can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Sierra Wave as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter **W**	**Separation distance according to frequency of transmitter m**		
	150 kHz to 80 MHz $d = [\frac{3.5}{V_1}]\sqrt{P}$	**80 MHz to 800 MHz** $d = [\frac{3.5}{E_1}]\sqrt{P}$	**800 MHz to 2.5 GHz** $d = [\frac{7}{E_1}]\sqrt{P}$
0.01	d = 0.12 m	d = 0.12 m	d = 0.23 m
0.1	d = 0.38 m	d = 0.38 m	d = 0.73 m
1.0	d = 1.2 m	d = 1.2 m	d = 2.3 m
10	d = 3.8 m	d = 3.8 m	d = 7.3 m
100	d = 12 m	d = 12 m	d = 23 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

NOTE 3 Stated separation distances will assure safe operation of the Sierra Wave. However, some noise may present on displayed waveforms.

Isolation Transformer Configurations

ELECTRICAL SAFETY REQUIREMENTS & ALLOWABLE IEC 60601-1-1 SYSTEM CONFIGURATIONS

GENERAL DISCUSSION

The application of modern electronic technologies in medical practice has led to systems of medical and non medical electrical equipment being used together for the diagnosis and monitoring of patients.

MEDICAL ELECTRICAL EQUIPMENT complying with IEC 60601-1 such as Cadwell equipment and accessories are often connected to other, non medical electrical equipment such as computers and printers. Non-medical electrical equipment may fully meet the requirements applicable in their specific field, but may not comply with isolation or leakage requirements for medical electrical equipment and thereby impact the safety of the entire MEDICAL ELECTRICAL SYSTEM.

The following configurations ensure that combinations of Cadwell devices and non-medical electrical equipment comply with the electrical safety requirements for MEDICAL ELECTRICAL SYSTEMS.

ALLOWABLE CADWELL SYSTEM CONFIGURATIONS

1. All Cadwell equipment and accessories are permissible in the PATIENT ENVIRONMENT without incorporating a SEPARATING TRANSFORMER.

2. A double insulated Laptop Computer powered from Cadwell equipment is permissible in the PATIENT ENVIRONMENT without incorporating a SEPARATING TRANSFORMER.

3. Other computing devices (i.e. desktop computer, monitor, printer, camera, IR illuminator etc.) are NOT allowed in the PATIENT ENVIRONMENT unless a SEPARATING TRANSFORMER is used to power those devices.

4. Non medical devices (examples in #3 above) may be used outside the PATIENT ENVIRONMENT within the MEDICALLY USED ROOM without incorporating a SEPARATING TRANSFORMER, provided each individual device is plugged into a FIXED MAINS SOCKET OUTLET. Otherwise a SEPARATING TRANSFORMER must be incorporated.

5. MULTIPLE PORTABLE SOCKET OUTLETS (power strips) are not permitted in a MEDICALLY USED ROOM unless connected to the output of a SEPARATING TRANSFORMER.
6. Connection to hospital networks is allowed without incorporating a SEPARATING DEVICE as long as the network server and the MEDICAL ELECTRICAL SYSTEM are connected to circuits powered from and grounded to the same electrical service entrance.

SYSTEM REQUIREMENTS

1. Non medical electrical equipment used in MEDICAL ELECTRICAL SYSTEMS must meet their respective IEC electrical safety requirements, i.e. IEC 950 for computing devices.
2. ENCLOSURE LEAKAGE must not exceed 500uA in any SINGLE FAULT condition within the PATIENT ENVIRONMENT.
3. ENCLOSURE LEAKAGE must not exceed 100uA in normal condition.
4. EARTH LEAKAGE must not exceed 500uA in any single fault condition within the PATIENT ENVIRONMENT.
5. The MEDICAL ELECTRICAL SYSTEM must provide a minimum of 1500 volts isolation between patient and earth.
6. The MEDICAL ELECTRICAL SYSTEM must provide a minimum of 4000 volts isolation between patient applied parts and mains voltage.
7. The MEDICAL ELECTRICAL SYSTEM must provide a minimum of 1500 volts isolation between non-patient contact parts of the SYSTEM and mains voltage.

GENERAL WARNINGS AND PRECAUTIONS

1. DO NOT place ISOLATION TRANSFORMERS or MULTIPLE PORTABLE SOCKET OUTLETS on the ground.
2. DO NOT connect MULTIPLE PORTABLE SOCKET OUTLETS (power strips) to the system, unless connected downstream of an isolation transformer.
3. DO NOT connect items which are not specified as part of or for use with the SYSTEM.

4. DO NOT exceed the medical isolation transformer placarded maximum load.
5. DO NOT use medical isolation transformer provided with the system to power non-system components as this can overload the transformer, or defeat the separation by providing additional leakage sources.
6. DO NOT plug non medical electrical equipment intended for use in the PATIENT ENVIRONMENT directly into a wall outlet as this can potentially result in excessive leakage current present in the patient environment.

DEFINITIONS

1. MEDICAL ELECTRICAL EQUIPMENT: Electrical equipment, provided with not more than one connection to a particular supply mains and intended to diagnose, treat, or monitor the patient under medical supervision and which makes physical or electrical contact with the patient and/or transfers energy to or from the patient and/or detects such energy transfer to or from the patient.
2. MEDICAL ELECTRICAL SYSTEM (SYSTEM): combination of items of equipment, at least one of which must be MEDICAL ELECTRICAL EQUIPMENT and interconnected by functional connection or an ISOLATION TRANSFORMER.
3. PATIENT ENVIRONMENT: any volume of space (area) in which intentional or unintentional contact can occur between PATIENT and parts of the SYSTEM or between PATIENT and other persons touching parts of the system. For practical purposes this is an area 1.5 meters or 5 feet beyond reach of the patient.
4. MEDICALLY USED ROOM: the room in which the PATIENT ENVIRONMENT is located.
5. SEPARATING TRANSFORMER: medical ISOLATION TRANSFORMER designed to limit transfer of unwanted leakage current and allow non-IEC 60601-1 devices to be located in the PATIENT ENVIRONMENT.
6. SEPARATING DEVICE: a component or arrangement of components with input parts and output parts that, for safety reasons, prevent a transfer of unwanted voltage or current between parts of the MEDICAL ELECTRICAL SYSTEM.
7. FIXED MAINS OUTLET: permanently installed (hard wired) grounded outlet in a facility.

8. MULTIPLE PORTABLE SOCKET OUTLET (power strips): a combination of two or more socket-outlets intended to be connected to, or integral with, flexible cables or extension cords.
9. SINGLE FAULT: Condition in which a single means for protection against a safety hazard in the SYSTEM is defective or a single external abnormal condition is present.

Contact Cadwell Quality/Regulatory department at 509-735-6481 with any questions regarding these requirements.

Wave File Extensions and Locations

Installation Folders and File Extensions

The default installation folder is **C:\Cadwell\Sierra Wave**. The program's application files are located here.

Two sub-folders are created within the Sierra Wave folder; **Data** and **Setup**. The Window's username is added to the end of the Data and Setup folder names.

 Computers purchased through Cadwell Laboratories will typically be pre-configured with a Windows XP username of "Cadwell". Therefore, the Data and Setup folders will default to **Data.Cadwell** and **Setup.Cadwell** respectively.

The Data folder is typically where patient data files and stored reports are located. The Setup folder is where settings and preserve files are located.

The following extensions are located in the user's Data folder. **C:\Cadwell\Sierra Wave\Data.*username***

.sd – Patient data file, format is (Lastname, Firstname, date, and time)

.doc - Stored report document (Word 2002 & 2003)

.docx - Stored report document (Word 2007 & 2010)

.pdf - Stored report in Adobe format (Word 2007 &2010)

.cpi - Stored patient information file, created using the Close & Save button in the Patient Information window.

.db – Directory file, used by the Review and Resume windows.

The following extensions are located in the Users Setup folder.
C:\Cadwell\Sierra Wave\Setup.*username*

.prs – Preserve File, contains all of a user's test protocol settings and all report templates.

.wsm – Study Menu file, contains current study lists.

.stm – Test Protocol menu, contains current parameters, nerve, and muscle lists for all test protocols.

.stp – Saved Test Protocol, created using the Save Test button in the Test Menu Setup window.

.xml - Configuration files used by the AnatomyVIEW, DataLAB, and Sentence Generator.

Sierra Wave Specifications

Amplifier

Channels: 2 or 4.

Sensitivity: 2, 5, 10, 20, 50, 100, 200, 500 µV/div; 1, 2, 5, 10, 20 mV/div.

(Additional sensitivity values of 0.05, 0.5, 0.2, 0.1 in NCV protocol)

Highcut filters: All modes.

2-pole (12 dB/octave) filter.

Selectable at 30, 50, 100, 200, 300, 500 Hz; 1, 1.5, 2, 3, 5, 10, kHz.

Lowcut filters: 1-pole filter.

Selectable at 0.04, 0.32, 1, 10, 20, 30, 100, 500 Hz; 1, 2 kHz.

Notch filter, 50 or 60 Hz.

Connection types: 1.5-mm, touchproof connector or 5-pin DIN connector.

Input impedance: > 1000 M (common mode).

Noise: Channels 1,2: <2 uV rms

Common recording reference input (4 channel only).

Temperature probe input. 21° to 44°C ± 5°C.

Impedance of active and reference inputs.

A/D Converter

16-bit, analog-to-digital conversion.

76.8-kHz sampling rate per channel (2-channel mode).

38.4-kHz sampling rate per channel (4-channel mode).

Averager

Number of averages per channel: 1 to 10,000.

Artifact reject: Rejects signals that exceed 95% of full scale. On or off for all channels.

Sweep speeds: 0.5 to 1000 ms/div in 19 steps.

Isolation Transformer

Refer to Cadwell document 309002-000 to determine if an isolation transformer is required.

Mechanical

Base dimensions: 1.8 H x 12 W x 13 D in. Weight: 6 lbs. (2.7 kg)

Electrical

100-240 vac, 50-60 Hz, 2A max.

Auditory Output

Built-in 2-way speaker.

Stimulators

Repetition rates: 0.5 to 90 pps depending on stimulus type, sweep speed, and protocol.

Electrical Stimulator

Type: Hand-held, constant-current electrical stimulator with stimulus intensity dial, stim and store buttons on handle.

Pulse duration: 50 to 1000 µs width, adjustable in 50-µs increments.

Electrical range: 0 to 100 mA, 380 V maximum voltage.

Resolution: 0.1 mA.

Safety features: Over current fault detection.

Auditory Stimulators

Headphones: TDH-39, 10-ohm. Available in acoustically shielded and non-shielded models.

Ear inserts: TDH-39, 10-ohm compatible transducers.

Presentation: Left, right, both, or neither ear.

Intensity units: nHL/SPL.

Stimulus types: Click, Tone Burst, Tone Pip.

Clicks: 100-µs square wave clicks. Rarefaction, condensation, or alternating polarity.

Tone Burst: 10-30-10 ms. (250, 500, 750, 1k, 2k, 3k, 4k, 6k, 8k Hz)

Tone Pip: 2-0-2 and 2-1-2 cycles. (250, 500, 750, 1k, 2k, 3k, 4k, 6k, 8k Hz)

Decibel range: -10 to 95 dB nHL.

White noise masking: Contralateral masking from 0 to 80 dB below stimulus level.

Visual Stimulators

VEP Video CRT Monitor: NTSC or PAL (Discontinued October 2010)

Monochrome VEP video for black and white, pattern-reversal checkerboard stimulation. Features center fixation target, independent quadrant and half-field stimulation. Square sizes: 1, 2, 4, 8, 16, 32, 64 or 128 checks across the horizontal axis. Combination of Sierra Wave and monitor must meet requirements of EN60601-1-1.

VEP Video LCD Television Monitor:

15.6 inch monochrome VEP video for black and white, pattern-reversal checkerboard stimulation. Features center fixation target, independent quadrant and half-field stimulation. Square sizes: 1, 2, 4, 8, 16, 32, 64 or 128 checks across the horizontal axis. Combination of Sierra Wave and monitor must meet requirements of EN60601-1-1.

3-in (8-cm) LED Stimulator: Pattern-reversal checkerboard stimulator with 0.25-in (6.4-mm) red and black square.

LED goggles: Flash pattern stimulus selectable for right, left, or both eyes.

Flash Stimulator: Flash rates from 1-25 Hz. 0.72 J/flash.

External Speaker Specifications

Units purchased before November 2003:

Connecting Non-Cadwell Devices to the External Speaker Jack

Introduction

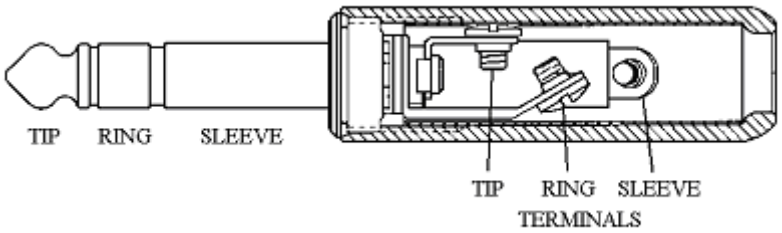
The Sierra Wave provides a jack for connection to an external speaker. Cadwell sells a high quality magnetically shielded speaker with cable for use as an external speaker. Connecting other devices to this external speaker jack is possible but standard audio equipment cannot be plugged directly into the jack. This technical note describes the speaker output and how to interface non-Cadwell equipment to it.

Background

When an external speaker is used with the Sierra Wave it is connected in parallel with the existing dual speaker system contained in the base unit. Standard audio equipment cannot be directly connected to this external speaker jack due to its unique pin out configuration. The Sierra Wave uses an audiophile quality class D audio amplifier. This same amplifier is used in high-end televisions and audio equipment. The class D amplifier allows good volume levels with a simple power supply and minimum power usage. This makes it ideal for use in lightweight portable medical devices such as the Sierra Wave. However, in order to obtain this improved performance the amplifier drives both speaker wires in a push pull configuration. Most older single ended audio systems have one wire driven and the other wire connected to ground and most auxiliary audio equipment such as headphones and recorders are built to handle this type of connection.

External Speaker Jack Connections

The Sierra Wave external speaker jack is a standard 3.5mm (about 1/8 inch) three-conductor phone jack. This is the same jack used by portable / personal stereo equipment for the headphone connector. A typical plug that is used with such a jack is shown below.

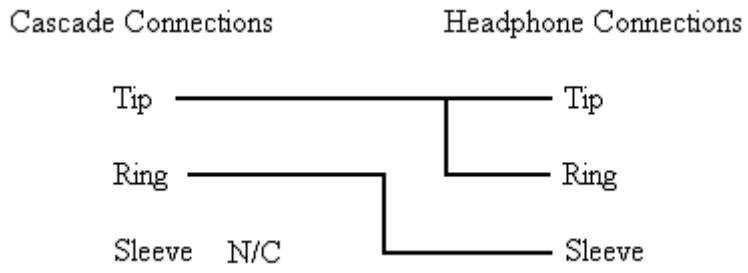


The Sierra Wave connects the two driven speaker outputs to tip and ring. The sleeve is connected to earth ground. The two speaker outputs are 180 degrees out of phase and centered at 6 VDC. Full volume swing is 0 to 12 VDC.

Connecting Stereo Headphones to the External Speaker Jack

The 6 VDC bias prevents the direct connection of a 3.5mm stereo headphone to the external speaker jack. This 6-volt bias would overdrive and possibly destroy the headphone speaker elements. Placing a capacitor in line with each of the speaker outputs would eliminate the bias but would result in the left and right sides being out of phase The out of phase signals result in an unnatural presentation of sound that most people find unpleasant.

Because the sound from the Sierra Wave is monaural an adapter will provide the same signal to each side of the stereo headphone. Connecting the right and left headphone speakers in parallel as shown in the following figure does this.

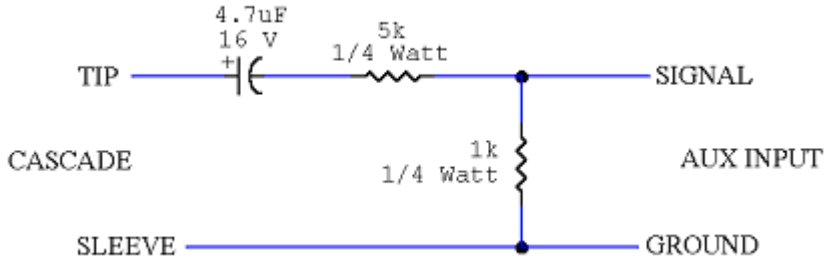


Headphone Adapter Circuit

Connecting the External Speaker Jack to the Auxiliary Input of Audio Equipment

Audio equipment auxiliary inputs such as amplifiers or recorders are most commonly designed for a single ended 1-volt peak to peak audio signal centered on ground. The Sierra Wave outputs a maximum signal level of almost 12 volts peak to peak centered at 6 volts DC. Therefore, both the signal amplitude and DC level must be modified before the Sierra Wave external speaker jack can be connected to audio equipment.

The following circuit reduces the amplitude of the speaker signal and shifts the DC level for use with audio equipment auxiliary inputs. Several assumptions have been made to keep the circuit as simple as possible: First, the Sierra Wave volume will seldom if ever be set to deliver more than a 6 volts peak to peak signal. Second, the auxiliary input will have impedance of at least 10K ohms. Third, the auxiliary input will not place any DC bias on the input signal. With these three conditions met the circuit is very simple. A schematic representation is as follows:



Circuit for connecting an external amplifier or recorder to the Sierra Wave external speaker output.

An additional challenge is presented by the volume control. The signals used by conventional auxiliary inputs do not normally change in level intensity with the volume control. The output of the Sierra Wave is affected by the volume control. So an auxiliary recording device must have an automatic gain control or the recording level of the device will need to be adjusted whenever the volume on the Sierra Wave is adjusted.

Units purchased after November 2003:

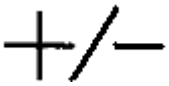
The external speaker circuit was changed on November 26, 2003. This change now allows the Cadwell speaker (mentioned above) and standard PC speakers to be connected to the circuit.

Recommendations for use of "PC" Speakers.

- Purchase a high quality magnetically shielded speaker.
- If you desire the remote speaker to have a volume level at or above that of the base unit purchase an amplified speaker and leave the volume of the base unit low (but not off) and adjust the volume on the remote speaker as desired.
- Purchase a pair of speakers where the slave speaker (the one without the computer connection) can be disconnected. Disconnect and do not use the slave speaker. (It does not matter if the slave is the left or the right speaker.) A single speaker will not have "out of phase" problems and will therefore sound better than the pair.

Labels and Symbols

Symbol	Title/Meaning	Reference
	Attention, consult accompanying documents. Attention, consulter les documents d'accompagnement.	IEC UL
	Caution. To reduce the risk of electric shock, do not remove cover or back.	UL
	Danger. Explosion risk if used with flammable anesthetics.	UL
	Dangerous voltage Tension dangereuse	IEC
	Power ON Marche (mise sous tension)	IEC UL
	Power OFF Arrêt (mise hors tension)	IEC UL
	Equipotentiality Equipotentiálite	IEC UL
	Warning. Replace fuse as marked.	UL
	Type B equipment. Ordinary, non-isolated patient connection. Appareil de type B.	IEC UL
	Type BF equipment. Isolated patient connection. Appareil de type BF.	IEC UL

	Alternating current Courant alternatif	IEC UL
	Output Sortie	IEC
	Input Entrée	IEC
	Variability in steps Variabilité par échelons	IEC
	Reverse Polarity reverse polarite	Cadwell Convention

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