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Neuro Omega™

Physiological Navigation System for Neurosurgery and Neurophysiological Research Applications

User Manual
Revision 1.1

To be used in in conjunction with the Neuro Omega User Manual for Medical Applications

CE 0297

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Contents

1 Overview

The Neuro Omega is a physiological navigation system intended for different neurosurgery and neurophysiological clinical applications, including recording from and stimulating brain motor and sensory neurons to accurately navigate for neurosurgery target localization in treatment of movement disorders and to aid in the placement of depth electrodes.

The system records and stimulates brain peripheral-nerve electrical activity from various areas of the brain (deep structures and surface areas).

The device is also designed to measure bioelectric signals produced by muscles (EMG) and stimulate peripheral nerves to aid in the diagnosis and prognosis of neuromuscular disease for target localization surgeries for motor movement disorders or for intra-operative skeletal muscles activity. This can be done with recording or stimulation.

The device may also be used to measure and record the electrical activity of the patient's brain, obtained by placing two or more electrodes on the head (EEG). This is for cortical and surface electrical activity levels of the brain.

The device is also designed for temporary monitoring of brain electrical activity from deep or cortical brain during neurosurgery in the operating room or outside the clinical environment.

1.1 Scope

The purpose of the Neuro Omega User Manual for Research Applications is to provide information for the use of the Neuro Omega system in research facilities. This manual is a supplement for the Neuro Omega User Manual for Medical Applications. As such, it may be used only in conjunction with that manual.

This manual is intended for use in research facilities only.

> **Warning:**
> Do not use this manual for conducting medical treatment.

1.2 Warnings

Warnings:

- Only qualified personnel, who have been trained by Alpha Omega Ltd., should be allowed to operate this equipment.
- Any modifications made to the equipment without explicit approval from Alpha Omega Ltd., voids warranty and service contract obligations, and poses a potential safety threat to both operators and patients.
- Do not install any software packages (Matlab, C++, SDK software or other) on the system unless provided by Alpha Omega Ltd. for the explicit use on the Neuro Omega.
- Neuro Omega system and Neuro Omega drive headstage should be connected to Alpha Omega NeuroProbes for recording and stimulation
- External systems connected to the Neuro Omega must be independently isolated, or powered through the trolley, as this has its own isolation transformer.
- Possible hazard caused by the summation of leakage currents when several items of equipment are interconnected.
- The Neuro Omega system should be placed outside of the patient environment or any area that can, intentionally or unintentionally, come in contact with the patient.
- A thorough understanding of the technical principles, clinical applications, and risks associated with this treatment is necessary before using this system. Please read this entire manual before attempting to activate the system. Completion of the training program is required prior to use of the Neuro Omega system.
- The Neuro Omega does not incorporate means to protect the patient against burns when used with high frequency surgical equipment.
- The analog and digital input output panel (ADIO) is not an applied part, and therefore should not be connected to the patient without proper electrical isolation.

Cautions:

- US federal law restricts the sale of this device to or on the order of a physician.
- Discard according to the local regulations and law.

Notes:

- Some of the Neuro Omega system components can be provided either non-sterile or sterile. Please refer to the Cleaning and Sterilizing the Neuro Omega Components section in the Neuro*Error! Reference source not found.* Omega Medical Manual for detailed sterilization instructions of system and accessories.
- It is the user's responsibility to qualify any deviations from the recommended method of processing.
- There are no expected hazards resulting from simultaneous use of other patient-connected medical electrical equipment, for example, a cardiac pacemaker or other electrical stimulators.
- Please contact the manufacturer or local distributor to request a copy of the insulation diagram if needed.
- The Neuro Omega can be operated normally after the interruption of supply mains.

1.3 Electromagnetic Conformance

The following tables contain information on electromagnetic emissions for guidance and manufacturer's declaration:

- ***Guidance and Manufacturer's Declaration – Electromagnetic Emissions***
- ***Guidance and Manufacturer's Declaration – Electromagnetic Immunity***
- ***Recommended Separation Distances between Portable and Mobile RF Communications Equipment and the Neuro Omega***

Notes:

- This product has been tested and found to comply with the limits for Class A Medical Device according to IEC 60601-1 and IEC 60601-1-2 Standards. The limits for Class A equipment were derived for medical environments to provide reasonable protection against interference with licensed communication and medical equipment.
- This product must be installed and put into service according to the EMC information provided in the tables below.
- Portable and mobile RF communications equipment can affect this product.

Warnings:

- This is a Class A product. This product is intended for use by healthcare professionals only. This equipment/system may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures, such as re-orienting or relocating the Neuro Omega or shielding the location.
- The use of accessories, transducers, and cables other than those specified by the manufacturer may result in increased emissions or the decreased immunity of the Neuro Omega.
- The Neuro Omega should not be used adjacent to or stacked with other equipment. If adjacent of stacked use is necessary, the Neuro Omega should be observed to verify normal operation in the configuration in which it will be used.

The Neuro Omega is intended for use in the electromagnetic environment specified in ***Table 1***. The user of the Neuro Omega should assure that it is used in such an environment.

Table 1: Guidance and Manufacturer's Declaration – Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment Guidance
RF emissions CISPR 11	Group 1	The Neuro Omega uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interferences in nearby electronic equipment.
RF emissions CISPR 11	Class A	The Neuro Omega is suitable for use in all establishments other than domestic, and may be used in 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	Class A	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Complies	

The Neuro Omega is intended for use in the electromagnetic environment specified in ***Table 2***. The customer or the user of the Neuro Omega should assure that it is used in such an environment.

Table 2: Guidance and Manufacturer's Declaration – Electromagnetic Immunity

Immunity Test	IEC 60601 test level	Compliance	Electromagnetic Environment Guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±6kV contact ±8kV air	±6kV contact ±8kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be less than 30%.
Electrostatic fast transient/burst IEC 61000-4-4	±2kV for power supply lines ±1kV for input/output lines	±2kV for power supply lines ±1kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1kV line(s) to line(s) ±2kV line(s) to earth	±1kV line(s) to line(s) ±2kV line(s) to earth	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 for 0.5 cycles 40% *U*T for 5 cycles 70% *U*T for 25 cycles <5% *U*T for 5 s	<5% *U*T for 0.5 cycles 40% *U*T for 5 cycles 70% *U*T for 25 cycles <5% *U*T for 5 s	Mains power quality should be that of a typical commercial or hospital environment. If the user of the Neuro Omega requires continued operation during power mains interruptions, it is recommended that the Neuro Omega be powered from an uninterruptible power supply (UPS) battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Mains power quality should be that of a typical commercial or hospital environment.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	Portable and mobile RF communications equipment should be used no closer to any part of the Neuro Omega, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance: $d=1.2\sqrt{P}$ $d=1.2\sqrt{P}$ *80 MHz to 800 MHz* $d=2.4\sqrt{P}$ *800 MHz to 2.5GHz* 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).

Immunity Test	IEC 60601 test level	Compliance	Electromagnetic Environment Guidance
Radiated RF IEC 61000-4-3			Field strength from fixed RF transmitters, as determined by an electromagnetic site survey,[1] should be less than the compliance level in each frequency range.[2] Interference may occur in the vicinity of equipment marked with the following symbol: 

Notes:

- At 80 MHz and 800 MHz, the higher frequency range applies.
- These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

1. Field strength from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV 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 Neuro Omega is used exceeds the applicable RF compliance level above, the Neuro Omega should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the Neuro Omega.
2. Over the frequency range 150 kHz to 80 MHz, field strength should be less than 3 V/m.

The Neuro Omega is intended for use in the electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Neuro Omega can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Neuro Omega as recommended in ***Table 3***, according to the maximum output power of the communications equipment.

Table 3: Recommended Separation Distances between Portable and Mobile RF Communications Equipment and the Neuro Omega

Rated maximum output power of transmitter W	Separation distance according to frequency of transmitter m		
	150 kHz to 80 MHz $d=1.2\sqrt{P}$	80 MHz to 800 MHz $d=1.2\sqrt{P}$	800 MHZ to 2.5 GHz $d=2.4\sqrt{P}$
0.01	0.12	0.12	0.24
0.1	0.37	0.37	0.74
1	1.2	1.2	2.4
10	3.7	3.7	7.4
100	12	12	24

For transmitters rated at 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.

Notes:

- At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
- These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

2 System Description

The Neuro Omega system consists of the following units:

- ***Main Unit and Trolley***: The Main Unit contains all interfaces with analog and digital inputs and outputs unit, as well as all connections to the different modules. The Main Unit, the screens and speakers, and the computer are all fitted on the trolley.
- ***Drive Headstage Module***: Includes the Drive Headstage, which contains the mechanism that manipulates the electrode, records from the electrode, and provides stimulation
- ***MER Only Headstage Module:*** Includes the MER Only Headstage, which contains the mechanism that records from the electrode and provides stimulation
- ***Headbox Modules***: Four types of Headbox Modules allow for recording and stimulating EMG/ EEG/ECoG signals, and for recording signals from sensors. The Headbox EEG/ECOG/Sensors Modules are the ones supplied with the research system.
- ***Remote Control***: Allows for easy system operation, including manipulating the electrode and providing stimulation through the Drive Headstage

2.1 Headbox Modules

Notes:

- The Headbox modules are electrically classified as type Body Floating (BF). The ground of the module must not be connected to any other ground. These modules are labeled with the following sign:

- The Headbox modules can be used with standard touch proof DIN connector patient electrodes.

2.1.1 For Referential Brain EEG/ECoG Recording/Stimulation

The EEG Headbox module (***Figure 1***) is used for referential brain EEG/ECoG recording and stimulation, and contains the following:

- 16 channels, with one touch-proof connector for each channel
- One **-** (minus) touch-proof connector for global reference
- One ground touch-proof connector (black)

- One global stimulation return touch-proof connector (white)

Figure 1: EEG/ECoG Headbox Module

2.1.2 For Sensor Types

The Sensors HeadBox module is used to connect the applicable sensor types to the Neuro Omega system, and contains the following:

- 16 channels, with one ODU (type no. A10L0C- P04MFG0-3200) connector for each channel.
- Supports four kinds of sensors. One Headbox can be connected to more than one type of sensors.

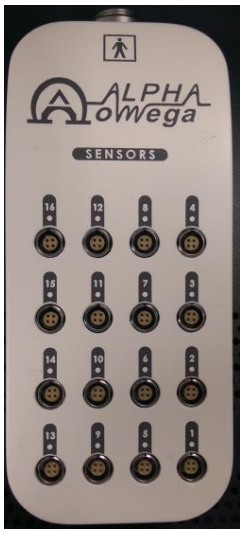


Figure 2: Sensors Headbox

Each Headbox module is supplied with a Velcro strap for easy attachment to the patient settings. The Headbox module, the cable, and the connection on the Main Unit are all color coded, as follows:

- **Gray**: Module 1
- **Blue**: Module 2
- **Yellow**: Module 3
- **White**: Module 4
- **Black**: Module 5
- **Red**: Module 6
- **Green**: Module 7

2.2 Sensor Types

There are four types of sensors that connect directly to Headbox Module:

- 3D Accelerometer. See section 2.2.1
- Goniometer, Single Axis and Twin Axis. See section 2.2.1
- Precision Dynamometer. See section 2.2.3
- Precision Pinchmeter. See section 2.2.4

2.2.1 3D Accelerometer

This procedure describes how to connect the Accelerometer to the Neuro Omega system.

The Accelerometer is used in physiological measurements to detect and monitor acceleration. By assembling the Accelerometer to the body parts, the Neuro Omega system collects the data and displays the results.

- Acceleration of parts of the body is determined, resulting from vibration, motion or shock. Units are [g]≅10*[m/s^2].

> **Note:** Gravity should be considered.

Each Accelerometer has three connections to the sensors Headbox. (Figure 3).

The 3D Accelerometer measures proper acceleration in the range of ±3[g].

To assemble the Accelerometer to the system:

- The sensor cable has three output connectors: X,Y,Z.
- Each connector has a red dot, and each input connector in the Headbox has a white dot.
- Connect the sensor's cable connector to the Headbox connector so that the two dots are aligned.

> **Note:** the connectors are labeled X, Y, Z. Make sure to connect the connectors to the Headbox according to the configuration you choose in the Workspace maker.

Figure 3: 3D accelerometer

2.2.2 Goniometer

This procedure describes how to connect the Goniometer to the Neuro Omega system.

Goniometer measures angles in degrees. By attaching the Goniometer to the body parts, the Neuro Omega system collects the data, and displays the results in degrees.

There are two main types of Goniometer (Figure 4).

- Twin Axis Goniometer.
- Single Axis Goniometer.

Figure 4: Goniometers

Single Axis Goniometer measures angles in one plane, when rotating one endblock in relation to the other. This type of Goniometer is placed on fingers and toes to measure flexion and extension.

> **Warnings: Bending the unit more than ±20° from its neutral position in the wrong axis will result in a reduction of the life of the unit.**

Twin Axis Goniometer measures angles in two planes: flexion/extension and radial/ulnar.
Axis X is measured using the grey plug; axis Y is measured using the green plug. See Figure 5.

Figure 5: Goniometer Connection

> **Note:** The only difference between the various Twin Axis Goniometer models is their physical size.

Table 4: Guidance Table for Goniometers

Joint	Sensor	Measured Output
Finger DIP,PIP,MCP**	F 35	Flexion/Extension
Toe	F 35	Flexion/Extension
Elbow	SG110	Flexion/Extension
Ankle	SG110 or SG110/A	Dorsiflexion/plantarflexion Inversion/Eversion
Neck	SG110	Flexion/Extension

Joint	Sensor	Measured Output
		Lateral flexion
Knee	SG150	Flexion/Extension
Hip	SG150	Flexion/Extension Abduction/adduction.

** DIP-Distal interphalangeal joint.
PIP-Proximal interphalangeal joint.
MCP-Metacarpo-phalangeal joint.

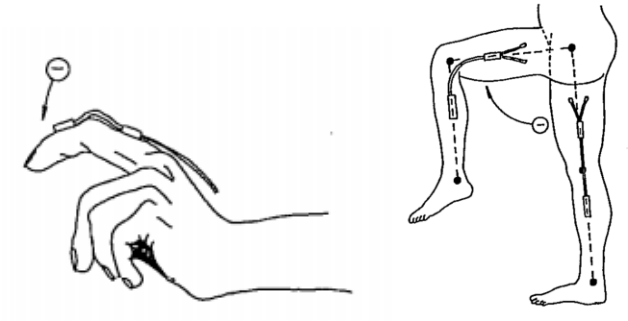
The Goniometer measures proper angle in the range of ±180°.

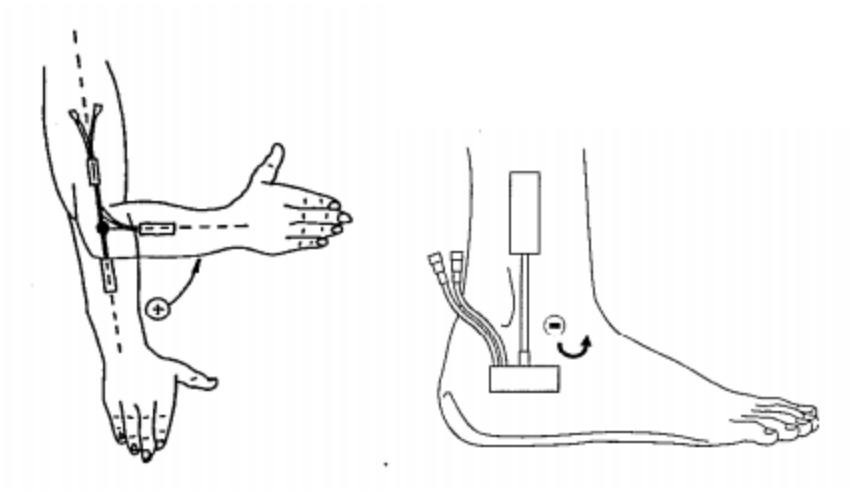
To connect the Goniometer to the system:

- Connect the Goniometer connectors to the extension cables. Each Twin Axis Goniometer connects to two extension cables.
- Each extension cable connector has a red dot, and each input connector in the Headbox has a white dot.
- Connect the extension connector to the Headbox connector so that the two dots are aligned.

Note: Make sure to connect the Goniometer X axis to the X axis channel in the Headbox, and the Y axis to the Y axis channel, according to the Workspace maker adjustment.

Attaching the Goniometers to the body:





2.2.3 Precision Dynamometer

This procedure describes how to connect the Dynamometer to the Neuro Omega system.

The Dynamometer measures force of strength. By gripping the Dynamometer and squeezing (Figure 6), the Neuro Omega system collects the data, and displays the results in Kg.

Figure 6: Dynamometer

The Dynamometer measures proper force in the range of 0→90 Kg.

To connect the Dynamometer to the system:

- Connect the Dynamometer to the extension cable.
- Each connector has a red dot, and each input connector in the Headbox has white dot.
- Connect the extension connector to the Headbox connector, so that the two dots are aligned.

2.2.4 Precision Pinchmeter

The Pinchmeter measures force of pinch. By holding the Pinchmeter and pressing it between thumb and fingers, see (Figure 7), the Neuro Omega system collects the data and displays the results in Kg.

Figure 7: Pinchmeter

The Pinchmeter measures proper force in the range of 0→22 Kg.

To connect the Pinchmeter to the system:

- Connect the Pinchmeter to the extension cable.
- Each connector has a red dot, and each input connector in the Headbox has white dot.
- Connect the extension connector to the Headbox connector so that the two dots are aligned.

2.3 Headbox Modules Assembly

The Headbox EEG/ECoG/Sensors module comprises 16 touch-proof connectors. See section ***2.3.1*** for assembling the EEG/ECoG module.

2.3.1 Assembling the EEG/ECoG/Sensors Module

Warnings:

- The conductive parts of electrodes and their connectors including the neutral electrode, should **not** contact other conductive parts and earth.

This procedure describes how to assemble the EEG/ECoG/Sensors module, for use in advanced research.

Note: The module can be used for either EEG or ECoG signals, not both at the same time.

To assemble the EEG/ECoG/Sensors module:

Figure 8: Red Dot on the Headbox

1. Connect the EEG/ECoG/Sensors module to the like-colored port on the Main Unit, using the like-colored cable.

> **Note:** When inserting the cable, verify that the red dots on the Headbox and on the Main Unit line up with those on the cable (see Figure 8).

2. Connect the electrodes to the EEG/ECoG module.
3. Connect the ground connector.
4. Connect the stimulation global return connector, if needed.

3 Operation of the Neuro Omega System

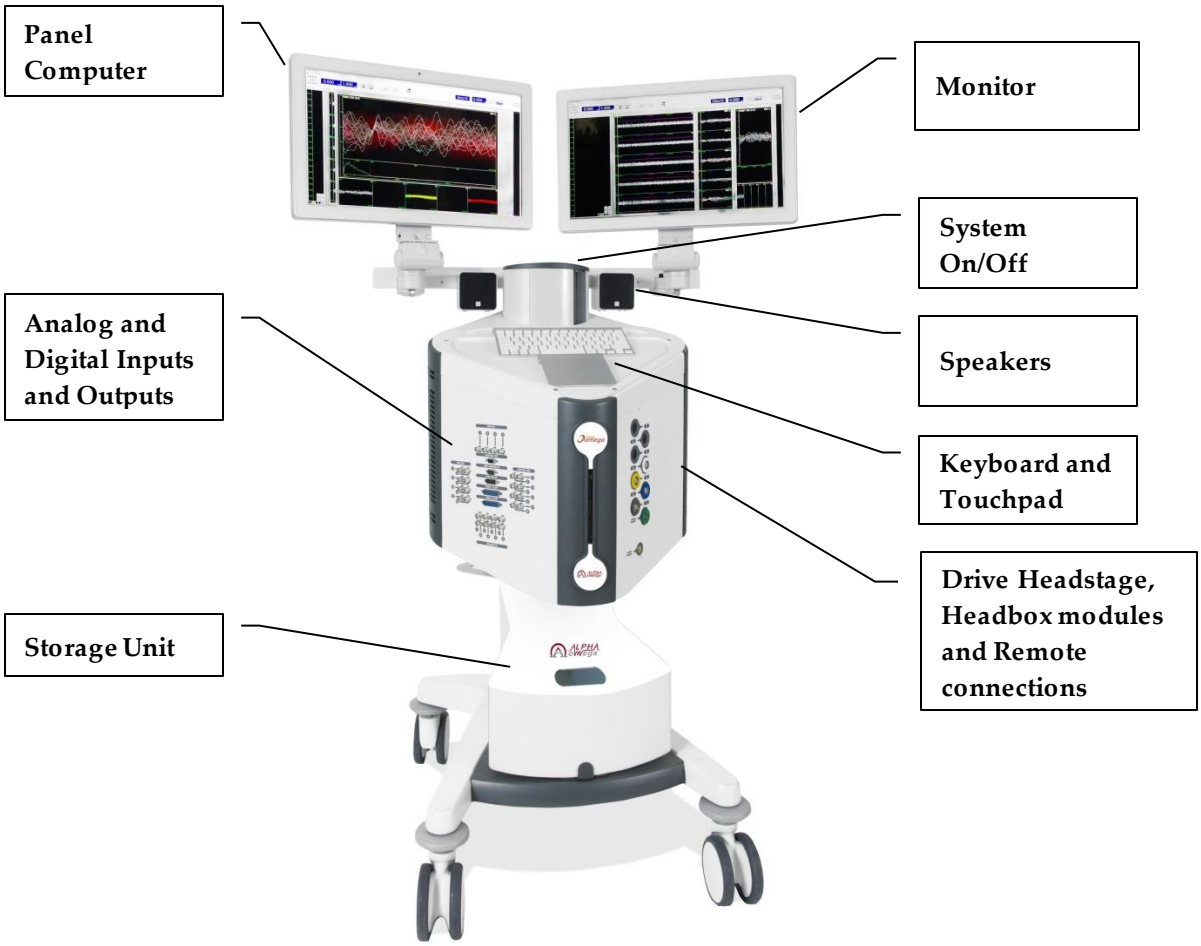


Figure 9: Main Unit and Trolley Front View

3.1 Using the Neuro Omega System

1. Power on the Neuro Omega, as described in section ***3.2***.
2. Do one of the following:
   - If the patient's info has not yet been supplied, then supply the patient's info, as described in section ***0***.
   - If the patient's info was supplied on an earlier occasion, then select the patient, as described in section ***3.6***.
3. Define events, as described in section ***3.7***.

4. Verify diagnostic indicators, as described in section ***3.7***.
5. Check impedance, as described in section ***3.8***.
   - Save data manually to the log file as needed, as described in section ***3.10***.
6. Stimulate motor and sensory neurons, as described in section ***3.11***.
7. Define, and then during stimulation monitor, the potential evoked by stimulation, as described in section ***3.12***.

3.2 Powering On the Neuro Omega

This procedure describes how to power on the Neuro Omega.

To power on the Neuro Omega:

1. Turn on the unit from the trolley (Figure 9).
2. If the **Patient Info** window (Figure 10) does not appear automatically, double-click the Neuro Omega shortcut.

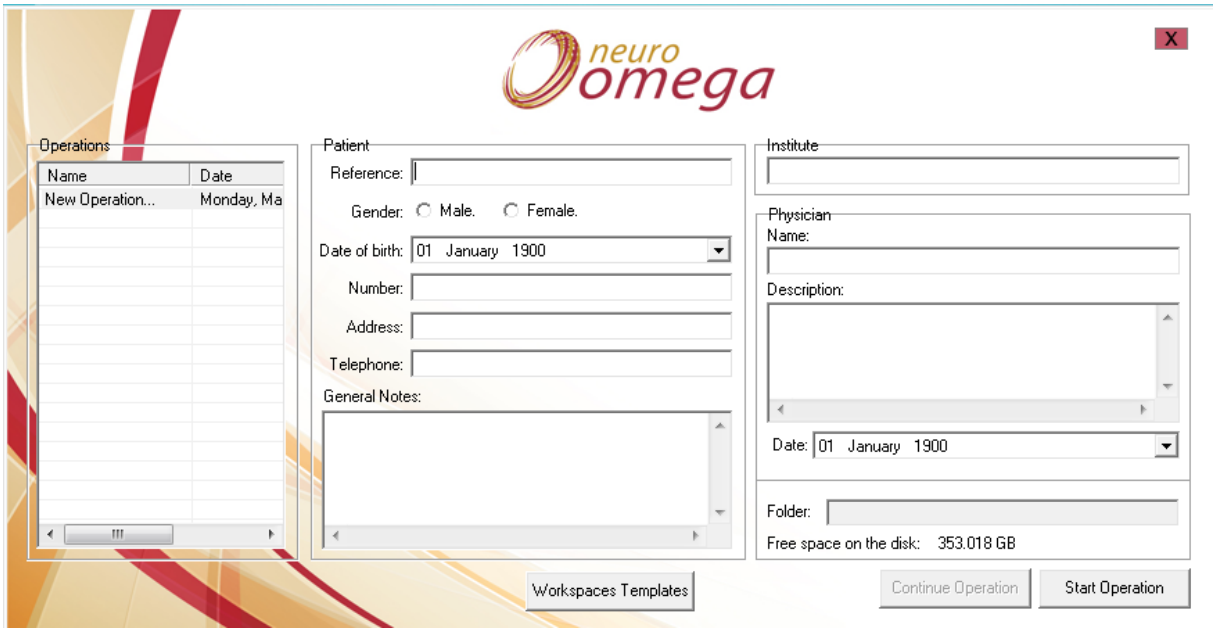


Figure 10: Patient Info Window

3.3 Windows Settings

Workspace maker associates one window to the sensors of each type, as follows.

- For each Accelerometer, the Accelerometer window will contain three channels, X, Y and Z.
- For each Twin Axis Goniometer, the Goniometer window will contain two channels, X and Y.

- For each Single Axis Goniometer, the Goniometer window will contain one channel.
- For each Dynamometer, the Dynamometer window will contain one channel.
- For each Pinchmeter, the Pinchmeter window will contain one channel.

Right-clicking the sensors window, shows a list of the available settings (for example, see Figure 11)

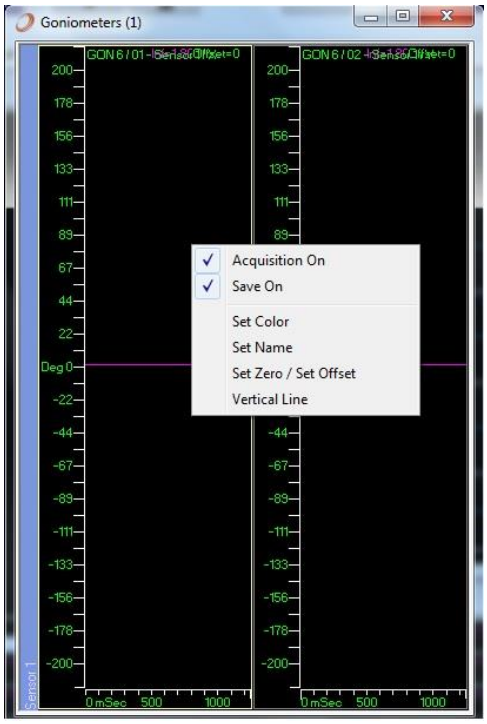


Figure 11: Goniometer settings

- **Acquisition On:** turning the channel on.
- **Save On:** Save the data of the channel.
- **Set Color:** choose color for the displayed data.
- **Set Name:** change the name of the channel.
- **Set Zero/ Set Offset:** you can choose the Offset of the sensor **(**Figure 12**).** Type in the Set Offset field the value needed, Set Zero button gives automatic Offset.
- **Vertical Line:** choose the option to have vertical line.

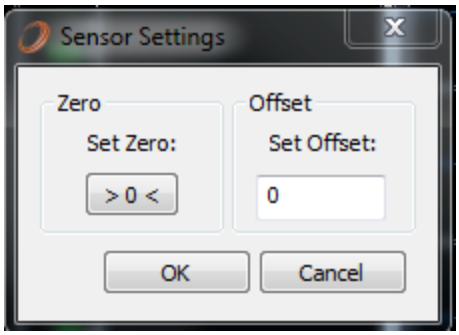


Figure 12: Set Zero/ Set Offset

> **Note:** It is recommended to use Set Zero/ Set Offset before starting using the sensors.

3.4 Workspace Maker

This procedure describes how to use the Workspace maker depending on the surgery and the functions in use.

To choose Workspace:

1. Press the **Workspaces Templates** button in the Patient Info Window.
2. **Workspace Template** displayed (see Figure 13).
3. In order to create a new Workspace, see section 3.4.1
4. In order to edit an existing Workspace, see section 3.4.2
5. In order to delete an existing Workspace, see section 3.4.3
6. For the Windows default, see section 3.4.4

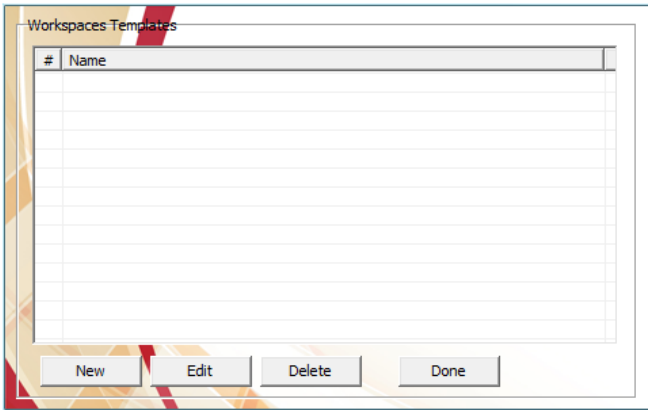


Figure 13 : Choose Workspace Templates Window

3.4.1 Create New Workspace

This procedure describes how to create new Workspace according to the used functions in the surgery.

1. Press the **New** button in the Choose Workspace Templates Window (Figure 13).

   System Modules Window (Figure 14**)** is displayed.

   This window contains all the system modules ports, according to the system configuration. Only the available modules are displayed.

2. Choose in each port the module you want to connect. If the port is not intended for use in this workspace, you can choose the option "Not used".

3. Check the Analog/Digital Input/Output box if you intend to use the ADIO panel.

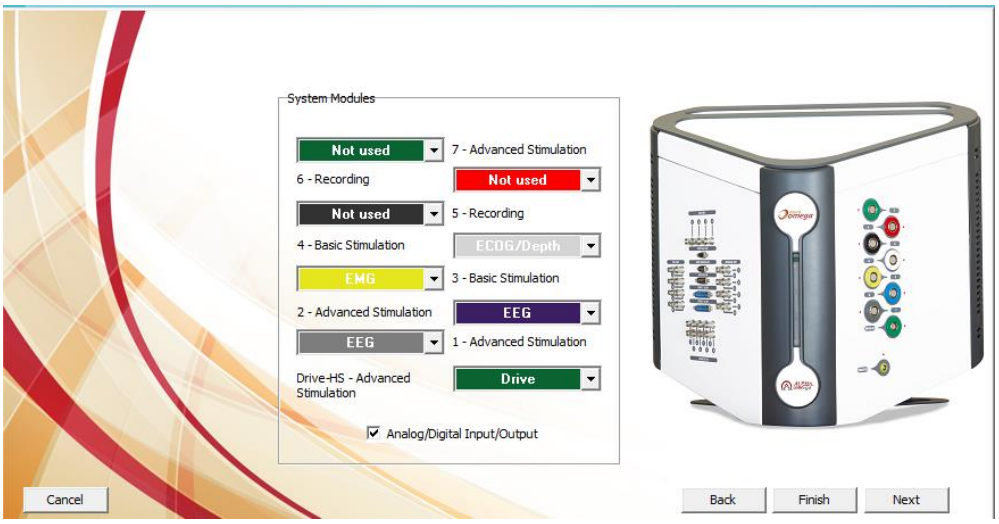


Figure 14: System Modules Window

4. Press **Next** in order to continue setting the channels.

3.4.1.1 EEG Module

This procedure describes how to map EEG contacts according to the map type (Figure 15).

You can choose to use one of two map types:

- EEG map 10-20.
- EEG map extended 10-20.

Note: It is possible to select\unselect contacts you need to use.

1. Map the electrode contacts as required.
   - Each module contains 16 EEG contacts, you can map each available EEG contact as follows:
   - According to EEG location on the map. By pressing **Map Channels** the contacts will be named after the contact location on the map.
   - Default mapping. By pressing Default, the contacts will be named according to the contact type and Headbox number.
   - User defined map, using free text. Click the channel name, and then change it as required.
   - Contacts that are not mapped will be marked as "Not used". Click the contact name and choose "Not used".

> **Note:** If you used all the map locations, the other contacts will be marked as "Not used".

2. Press **Next** to continue with the workspace settings.

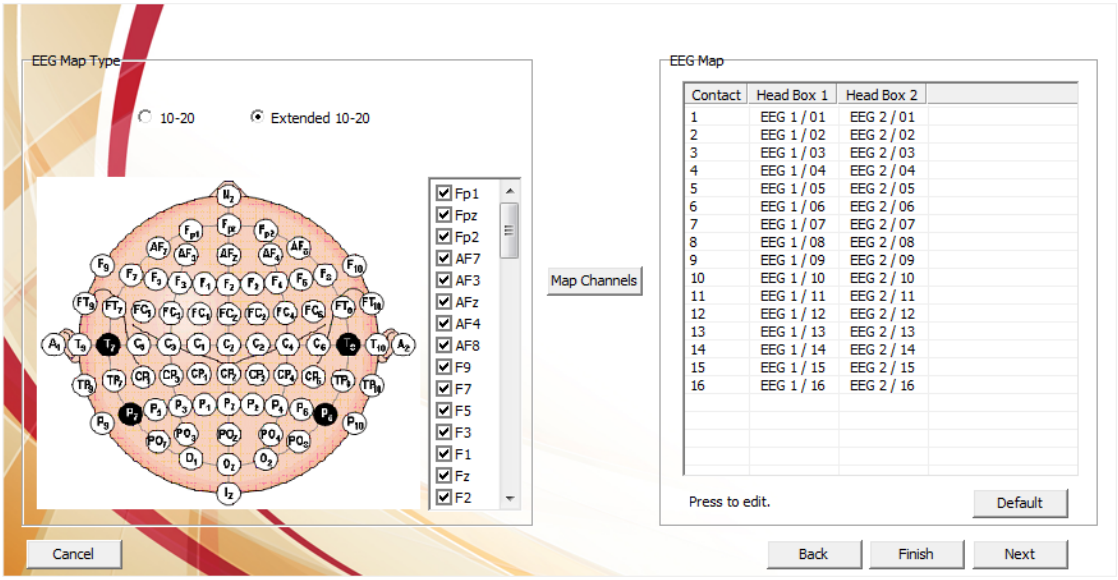


Figure 15: Extended 10-20 EEG Map

3.4.1.2 ECOG/Depth Module

This procedure describes how to map ECOG contacts. **(**Figure 16**).**

1. Add, delete or edit the electrode contacts as required.

Each module contains 16 ECOG/Depth contacts; you can add/delete or edit Arrays as follows:

- Press the **Add** button in order to add an Array.
- The array can be named via the defined map, using free text. Click on the array name and change it.
- The array type can be changed, by clicking the type and choosing Micro or Macro.
- For each array type, choose the filters limits – HF or LF. See spec.
- The array size can be changed by clicking the size value and typing a new one.
- The array starting index can be changed by clicking on the starting index value and typing new one.
- Choose an array and press on **Delete** button in order to delete the array.

2. Map the electrode contacts as required.
   - Default mapping. By pressing Default, the contacts will be named according to the contact type and Headbox number.
   - Press on **Map Channels** button and all the channels will be mapped according to the arrays entries.
   - User defined map, using free text. Click the channel name, and then change it as required.
   - Contacts that are not mapped will be marked as "Not used".

Note: If you used all the map locations, the other contacts will be marked as "Not used".

3. Press **Next** to continue with the workspace settings.

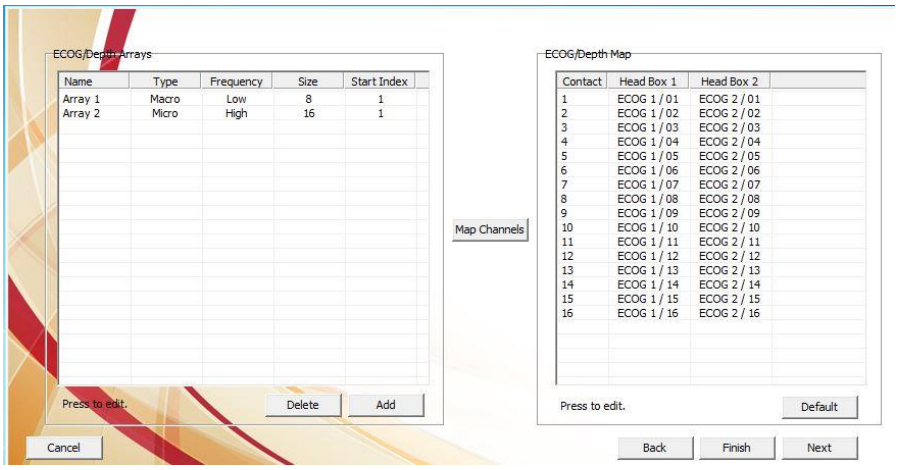


Figure 16: ECOG/Depth Contact Mapping

3.4.1.3 Sensors Module

This procedure describes how to map sensors contacts. (Figure 14)

4. Each module contains 16 contacts; you can add and delete sensors as follows:
   (a) Press the **Add** button in order to add sensor.
   (b) Click on the sensor type in order to choose one of four options, Accelerometer, Goniometer, Dynamometer or Pinchmeter.
5. Map each available contact as following:

(a) Default mapping. By pressing Default, all contacts will be marked as "not used".

(b) You can map each sensor by clicking on the sensor's name in the sensors map window and choose the sensor's number and axis for each contact.

(c) Press on **Map Channels** button and all the channels will be mapped according to the sensors entries.

- Accelerometer will be mapped to three contact; X, Y and Z.
- Goniometer will be mapped to two contacts; X and Y.

Note: In case of Single Axis Goniometer, choose the Y axis channel as not used

- Dynamometer will be mapped to one contact.
- Pinchmeter will be mapped to one contact.

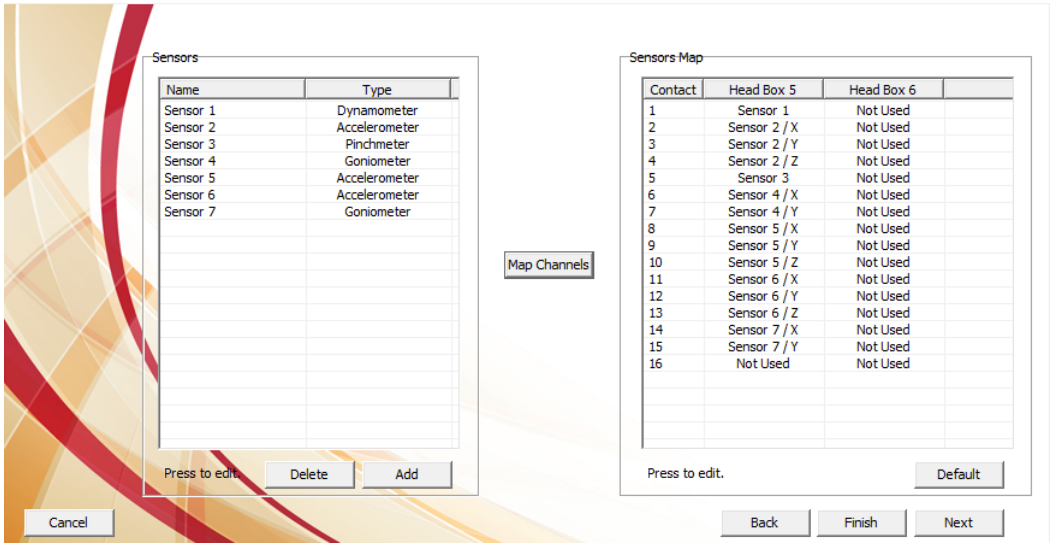


Figure 17: Sensors Contact Mapping

- Press **Next** to continue. A **Save Workspace Window (**Figure 18**)** will appear.
- Write the workspace name in the New Workspace Template File Name.
- Press **Save**.
- **Choose Workspace** Window will appear with all the current workspaces.
- Choose the Workspace you created and press **Done**.

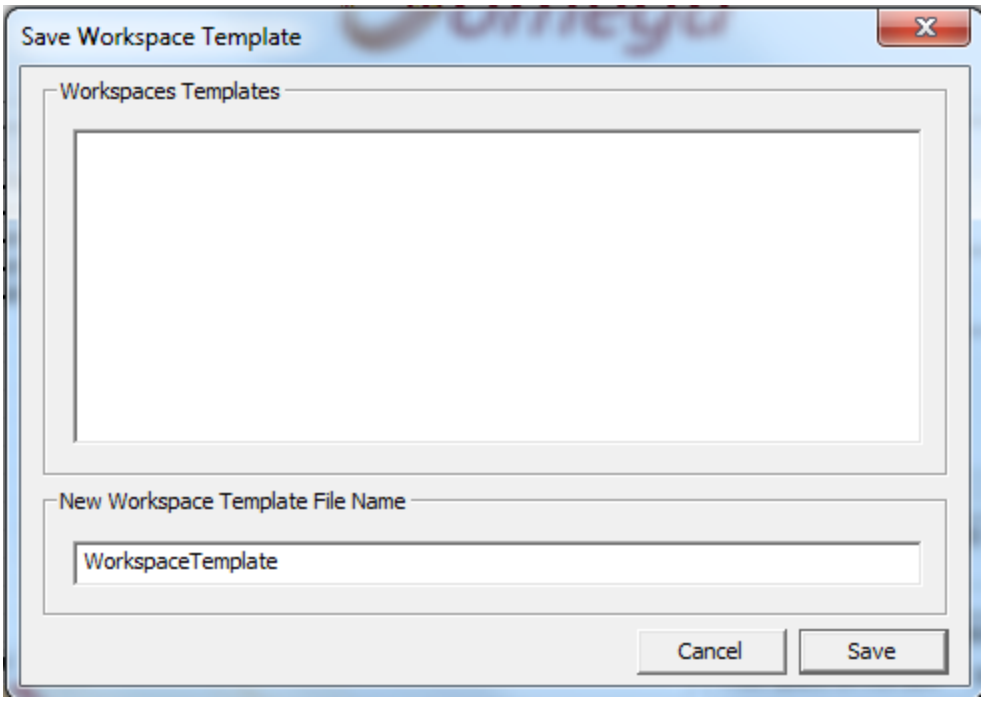


Figure 18: Save Workspace Template

3.4.2 Edit Workspace

This procedure describes how to edit existent Workspace according to the used functions in the surgery.

1. Choose the Workspace you want to edit from Choose Workspace Template (see Figure 13).
2. Press on **Edit** button.
3. **System Modules Window (**Figure 14**)** will appear with all the current Workspace settings.
4. Edit the workspace settings according to section ***(3.4.1).***

   For EEG Module Editing see section (3.4.1.1)

   For ECOG/Depth Module Editing see section (3.4.1.2)

   For Sensors Module Editing see section (3.4.1.3)
5. Press the **Finish** button in case the editing is done.
6. **Save Workspace Window (**Figure 18**)** will appear. You can change the workspace name or write over the current one.
7. Press **Save** button**.**

3.4.3 Delete Workspace.

This procedure describes how to delete existent Workspace.

1. Choose the Workspace you want to delete from Choose **Workspace Template** (Figure 13).
2. Press on **Delete** button.
3. The chosen workspace is deleted.

3.4.4 Windows Default

This section describes which windows will appear according to the Workspace configuration.

Module	Windows
EEG	- Continuous group per all used EEG contacts.
ECOG/Depth	- Continuous group per each Micro/Macro ECOG/Depth array that have ECOG/Depth contact mapped to one of it entries. - Segmented group per each Micro

Module	Windows
	ECOG/Depth contact mapped to one of it entries. - Continuous group per all ECOG/Depth contacts that are mapped not to an array entry.
Sensors	- Continuous group per each type of sensors

Following is a screen example, after sensor mapping:

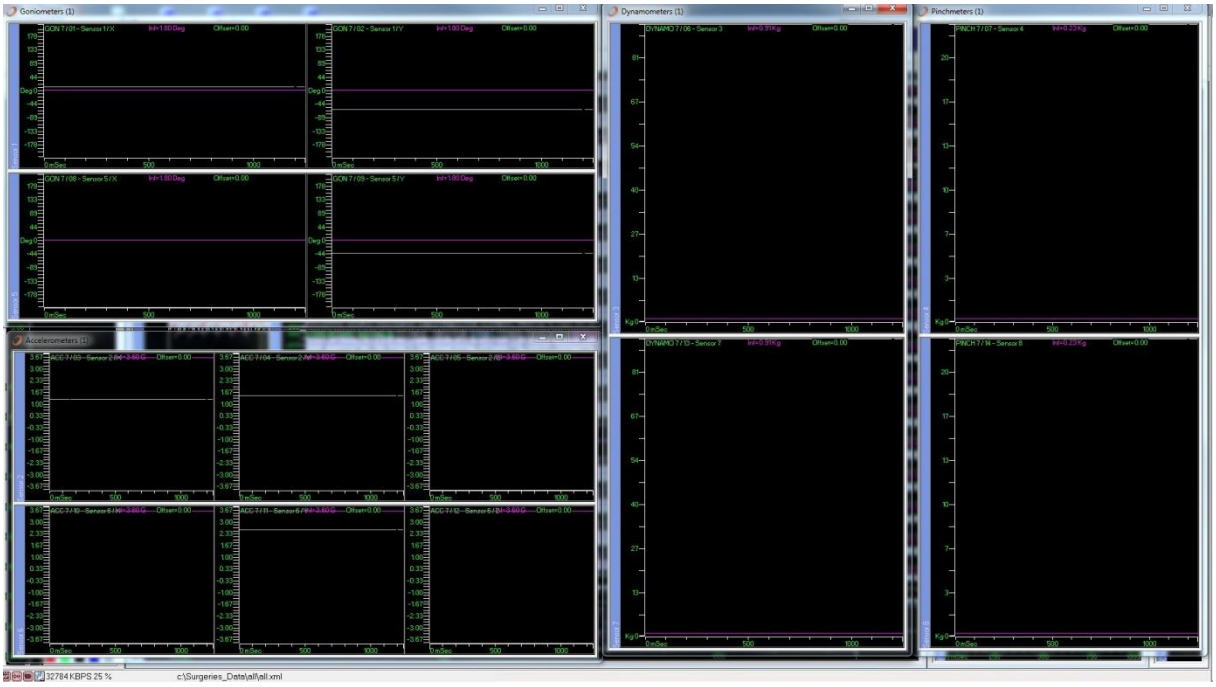


Figure 19: Sensors Mapping

3.5 Supplying Patient Info

This procedure describes how to supply patient info for the patient on whom the procedure is to be performed– it is a prerequisite for recording neural activity for a new patient.

To supply patient info for a new patient:

1. In the **Patient Info** window (see Figure 10), from the **Operations** list, select **New Operation**.
2. In the Patient area, in the **Reference** field, enter the patient's reference. This reference will create a new folder under this name/number for data logging.

Note: For purposes of privacy, the patient's name should not be used.

3. In the **Patient**, **Institute**, and **Physician** areas, enter information as required.
4. Click **Start Operation**.

   The Choose Workspace Template window (Figure 20) is displayed.
5. Choose a Workspace, and press **Start**.

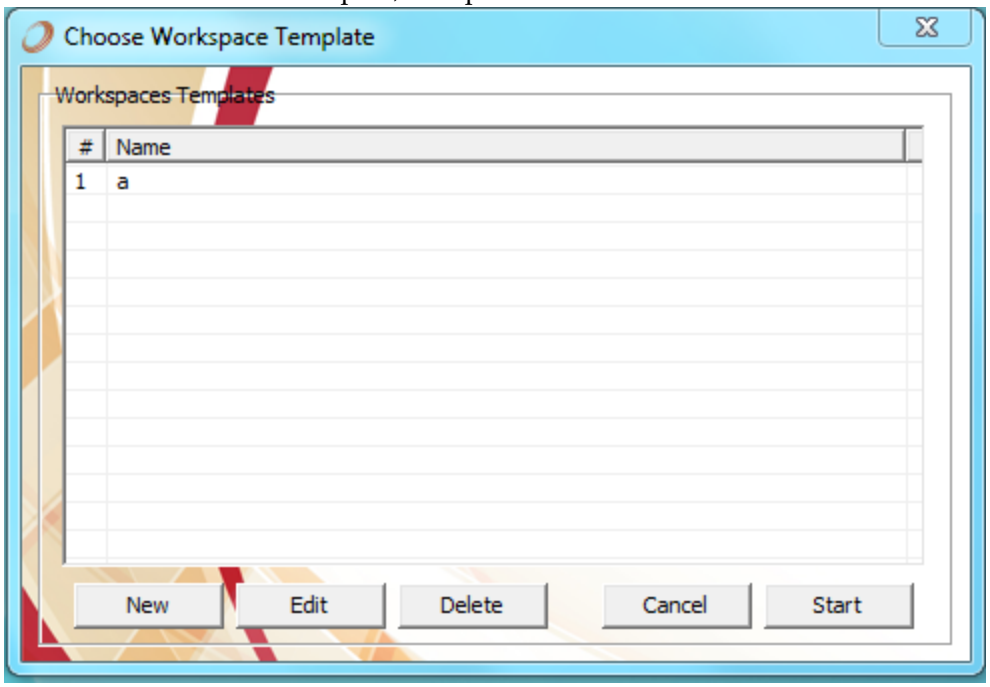


Figure 20: Choose Workspace Template Window

The main window appears.

3.6 Selecting an Existing Patient

This procedure describes how to select a patient on whom the operation is to be performed, whose info was supplied on an earlier occasion. This is a prerequisite for recording neural activity for an existing patient.

To select an existing patient:

1. In the **Patient Info** window (see Figure 10), in the **Operations** list, select the patient's reference on whom the operation is to be performed.
2. Click **Continue Operation**.

   The main window appears.

3.7 Verifying Diagnostic Indicators

This procedure describes how to verify that all Neuro Omega system components are connected and that the Main Unit is reading them correctly.

To verify diagnostic indicators:

1. On the toolbar, check if any diagnostic indicators appear, as follows:
   -  –  : Indicating that the Headbox modules are not functioning or not connected.
2. Fix the connections of any component as required.
3. Verify that no diagnostic indicators appear for the in use modules.

3.8 Checking Impedance

This procedure describes how to check impedance of the electrodes and the modules, which is important to verify their accuracy and integrity.

> **Note:** It is recommended to check impedance immediately after the micro tip has exited the cannula, 3 mm below the starting depth.

To check impedance:

1. In the main window, in the toolbar, click **Imp**.

   The following happens:

   - The **Impedance** dialog box appears.
   - Impedance is recalculated.
   - The **Imp** button is deactivated.

   Impedance measurement for the different contact types is as follows:

   - Impedance for the micro tips is calculated with a 1000 Hz sine wave.
   - Impedance for the macro tips is calculated with a 1000 Hz sine wave.
   - Impedance for the Headbox modules is calculated with a 30 Hz sine wave.

   To recalculate while the window is open, click **Recalculate**.

3.9 Monitoring Activity

The following procedure describes how to perform online monitoring of the electrophysiological activity derived from the Drive Headstage and the modules, for the sake of target localization.

To monitor electrophysiological activity:

- See section ***3.9.1*** for monitoring any of the following channels:
  - **EEG**: Electroencephalography signals
  - **ECoG**: Electrocorticography signals
  - **Micro SPK**: Spike filtered continuous signals from the micro tip
  - **Micro RAW**: Raw continuous signals from the micro tip
  - **Micro SEG**: Spike filtered segmented signals from the micro tip
  - **Macro LFP**: LFP filtered continuous signals from the macro tip
  - **Macro RAW**: Raw continuous signals from the macro tip
  - **Analog In**: 12 bit analog input
- See section ***3.9.1.6*** for monitoring spikes from the micro tip in the spikes raster.
- See section ***3.9.1.6*** for monitoring segmentation spike sorting from the micro tip.
- See section ***3.9.2*** for monitoring Digital input and Port signals from and external digital input system

3.9.1 Monitoring Channels

This procedure describes how to monitor a channel during the target localization process.

To monitor channels:

1. From the **Windows List** button  , select a channel Workspace window.

The window appears (***Figure 21***), with each channel in the window appearing in its own graph.

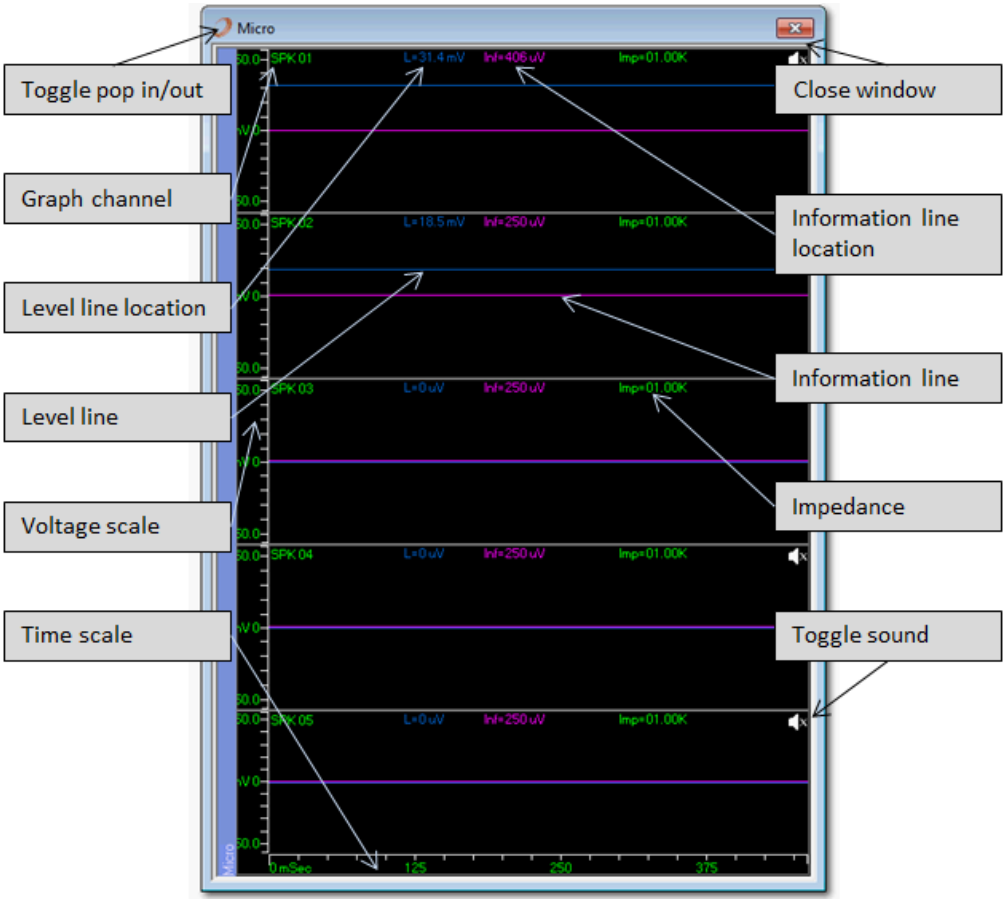


Figure 21: Channel Workspace Window

2. For each graph, do any of the following:

   - Impedance is listed in the upper right corner. To refresh the impedance value, in the toolbar, click **Imp**, and then click **Recalculate**, as described in section ***3.8***.
   - Adjust the channel's voltage or time scales, as described in section ***3.9.1.1***.
   - Listen to a channel's sound, as described in section ***3.9.1.2***.
   - Ground a channel, as described in section ***3.9.1.3***.
   - Make use of the information line by clicking the line and dragging it up or down, as described in section ***3.9.1.4***.
   - Apply a recording reference to the contact, as described in section ***3.9.1.6***.
   - Make use of the level line by clicking the line and dragging it up or down.

> **Note:** The level line is relevant for monitoring micro segmentation spike sorting, as described in section *3.9.3.2*, and monitoring spikes in the spikes raster window, as described in section *3.9.4*.

3.9.1.1 Adjusting Channel Scales

This procedure describes how to adjust the voltage scale and time scale of the graphs in a Workspace window.

To adjust a graph's scales:

1. Adjust the voltage scales of a Workspace window by doing the following:
   - To zoom in, drag up on the scale.
   - To zoom out, drag down on the scale.
   - To offset the voltage access, right-click and drag up to move up, and down to move down.
   - Do the following:
     i. Right-click anywhere in the window, and then select **Set Group Scales**.

        The Set Group Scales dialog box appears.

     ii. In the Voltage Scale area, enter the absolute voltage level for the graphs in microvolts, and then click OK.

        The scales change accordingly.
2. Adjust the time scale of a Workspace window by doing the following:
   - To drill down, drag rightward on the scale.
   - To drill out, drag leftward on the scale.
   - Do the following:
     iii. Right-click anywhere in the window, and then select **Set Group Scales**.

        The Set Group Scales dialog box appears.

     iv. In the Time Scale area, enter the duration that the graphs cover, in milliseconds, and then click OK.

   The scales change accordingly.

3.9.1.2 Toggling a Channel's Sound

This procedure describes how to toggle a channel's sound on and off. The volume for the sound is controlled on the keyboard or through the operating system sounds.

To toggle a channel's sound on and off do the following:

1. From the channel graph, in the upper right corner of the channel, toggle the speaker icon:
   -  indicates that the sound is off.
   -  indicates that the sound is on.
2. From the remote control, do the following:
   - Press the **Micro-Macro** button to select either the micro or macro channel.
   - Press the **Channel** button to select the channel.
   - Press the **Sound** button to turn the sound on or off.

Note: Only one channel's sound can be on at a time. Toggling on the sound of one channel toggles off the channel that was previously on.

3.9.1.3 Grounding a Channel

This procedure describes how to ground a channel, which is helpful, for example, when the channel is especially noisy and entering noise into other channels.

To ground a channel:

1. In that channel's graph, right click, and then select **Ground**.

   The channel is grounded. Data still comes in, but it is with low noise because the channel is grounded at the first amplifier.

Note: To disconnect the ground and return data streaming in the graph, right click again, and then clear **Ground**.

3.9.1.4 Changing a Channel Name

This procedure describes how to change a channel name, which is helpful, for example, to label a channel after the electrode anatomical location.

To change a channel name:

1. In that channel's graph, right click, and then select **Set Name**.
2. Enter the name for the requested channel in the 'Channel New Name' box.

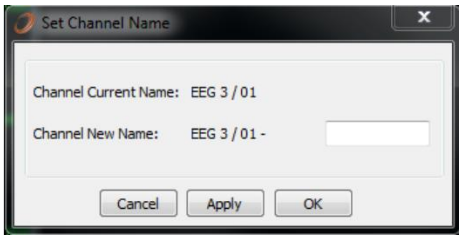


Figure 22: Set Channel Name

3.9.1.5 Using the Information Line

This procedure describes how to use the information line (see ***Figure 21***) in channel graphs, which is informational only. It enables the user to measure the amplitude of the signal. It is a display figure only and has no effect on segmentation.

To use the information line:

- Drag the information line up or down along the graph.

  The amplitude value of the information line appears at the top of the graph.

3.9.1.6 Applying a Recording Reference to a Contact

This procedure describes how to apply a recording reference to a contact in a channel graph as a means to reduce the amount of noise, which is known as flexible referencing.

Consider the following while using the flexible referencing function:

- In general, use an electrode lacking action potential activity as the reference contact.
- All signal types for a specific contact are affected, as referencing is done by means of simple substation on the raw signal before any filtration. This includes RAW, SPK, LFP, SEG, ECoG, and EEG.
- Do not use a contact as a reference that is already referencing another contact.
- Make sure to use reference contacts that are in close vicinity of the referenced contact.

To apply a recording reference to a contact:

1. In the channel graph to which you want to apply a reference, right-click, and then select **Set Group Reference**.
2. Select the contact to use as the reference, and then click **OK**.

   The following occurs:

   - The **Set Group Reference** dialog box closes.
   - The selected contact begins serving as reference.

- In the channel graphs, for each channel, the channel referencing appears, followed by the channel referenced (***Figure 23***).

Figure 23: Macro LFP 01 Referencing Macro LFP 02

3.9.2 Monitoring Digital Input Channels

This procedure describes how to monitor digital input channels.

To monitor digital input channels:

1. From the **Windows List** button , select a digital input Workspace window.

   The window appears (***Figure 24***), with each input bit in the window appearing in its own graph.

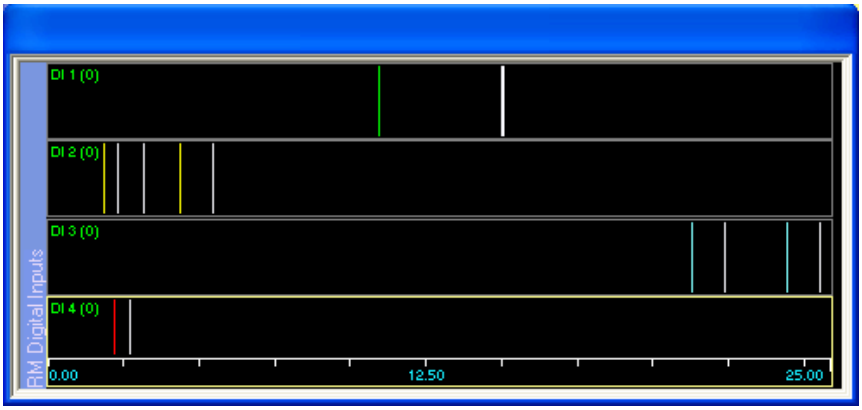


Figure 24: Single-Bit Digital Input Display

For each input bit:

- A colored checkmark indicates the change to active high (1).
- A white checkmark indicates the change to active low (0).
- The last status of every channel is also displayed by the channel label.

For each input bit, do any of the following:

- Adjust the bit's time scales, as described in section ***3.9.1.1***.

3.9.3 Monitoring Micro Segmentation Spike Sorting

This procedure describes how to monitor micro segmentation spike detections by first defining templates to catch the spikes based on the threshold level (level line), and then monitoring the spikes sorted in individual windows per template.

Most of the spike sorting procedure is performed in the main segmentation window, which is described in ***3.9.3.1***.

To monitor the micro segmentation spike detections by template:

1. Set the threshold level line, and then define the spike sorting templates, as described in section ***3.9.3.2***.
2. For each template, define the template variation, as described in section ***3.9.3.3***.
3. For each template, add Include Windows, as described in section ***3.9.3.4***.
4. Monitor the spike segments per template, as described in section ***3.9.3.5***.

3.9.3.1 Main Segmentation Window Navigation

The main segmentation window (*Figure 25*) is divided into three parts:

- **Online sorting graph**, in which the templates are defined from the spikes passing the threshold
- **Template histogram**, containing a histogram of a template when selected
- **Template graphs**, one for each template and one for all spikes passing the threshold

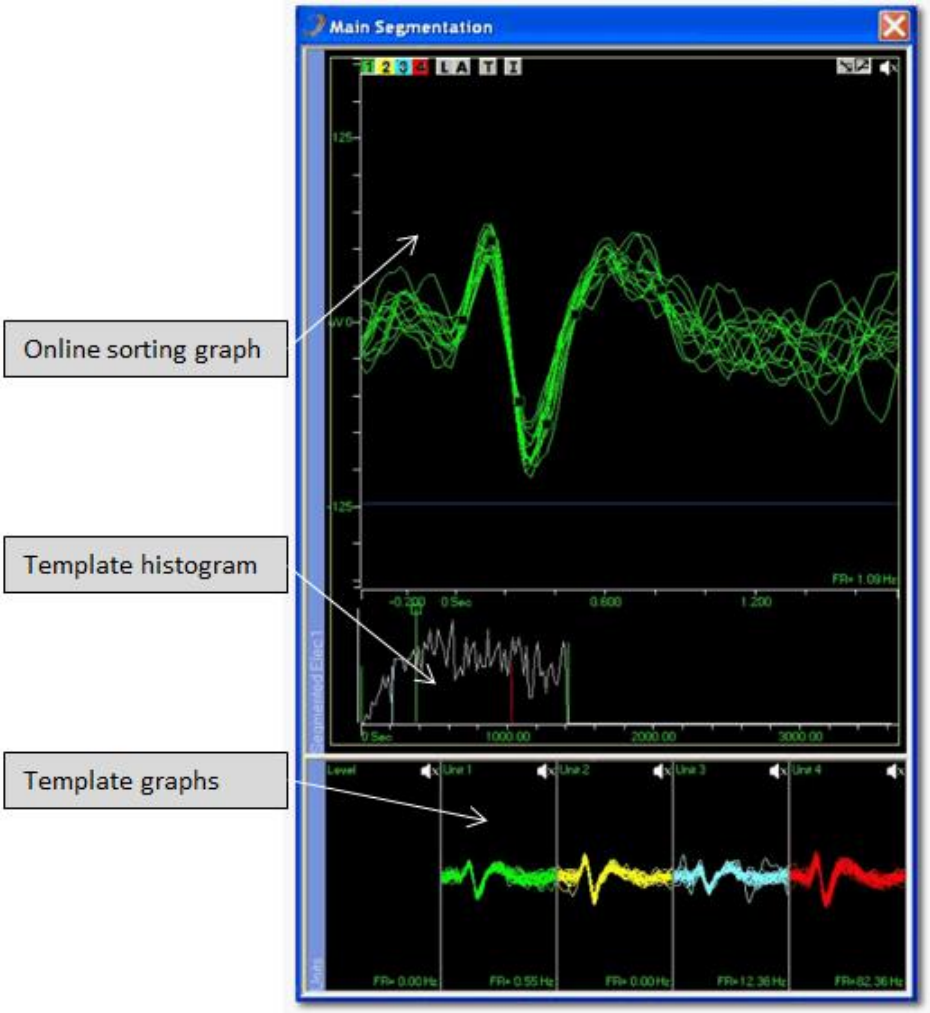


Figure 25: Main Segmentation Dialog Box

The online sorting graph's toolbar (*Figure 26*) contains the following tools:

Figure 26: Online Sorting Graph Toolbar

- 1 (**Template 1**): When selected, only spikes matching template 1, its template points, its window discriminator if active, and its histogram are displayed, in addition to all unsorted spike segments.
- 2 (**Template 2**): When selected, only spikes matching template 2, its template points, its window discriminator if active, and its histogram are displayed, in addition to all unsorted spike segments.

- 3 (**Template 3**): When selected, only spikes matching template 3, its template points, its window discriminator if active, and its histogram are displayed, in addition to all unsorted spike segments.
- 4 (**Template 4**): When selected, only spikes matching template 4, its template points, its window discriminator if active, and its histogram are displayed, in addition to all unsorted spike segments.
- L (**Level**): When selected, only unsorted spikes are displayed. No template points, window discriminator, or histogram are shown.
- A (**All Segments**): When selected, all spike segments are displayed, whether sorted into a template or left unsorted. No template points, window discriminator, or histogram are shown.
- T **(Define Templates**): Freezes the spike segments, and commences template definition mode.
- I (**Inclusion Windows**): Adds the first **Include** window, used for fine tuning the spike selection, or removes all **Include** windows.
- (**Crossing**): Determines whether crossing is on the up or down.
- (**Sound**): Toggles sound on or off.

When a template is selected, the firing rate (FR) of that template is displayed in the bottom right corner of the online sorting graph. When L is selected, the firing rate of the unsorted spikes is displayed. When A is selected, the combined firing rate of all spikes is displayed.

3.9.3.2 Defining Spike Sorting Templates

This procedure describes how to define spike sorting templates. It is the first step in *Monitoring Micro Segmentation Spike Sorting*.

Note: Spike sorting templates are not saved across different trajectories.

To define the spike sorting templates:

1. From the **Windows List** button, select the micro segmentation window.

   The micro segmentation window appears (see ***Figure 21***), with each channel in the window appearing in its own graph.

2. In the graph of the channel whose spikes you want to monitor, do one of the following:

   - If you want to sort the spikes crossing the level line in the rising direction, select the up arrow.
   - If you want to sort the spikes crossing the level line in the falling direction, select the down arrow.

Note: If the down arrow does not automatically appear, select the up arrow first, and it appears.

3. Set the threshold level for the spikes by dragging the level line up or down the voltage scale.
4. From the **Windows List** button, select the main segmentation window.

   The main segmentation window appears, with the online sorting graph displaying in white the spikes passing the threshold set in step *3*.
5. At a point when the spikes separate into groups, from the online sorting window toolbar, click **T**.

   The following occurs:

   - The online sorting graph freezes.
   - Template definition mode commences.
   - The window cursors appear, color coded to correspond to the four templates (***Figure 27***).

Figure 27: Color Coded Window Cursors

   - Saving options appear at the bottom of the graph (***Figure 28***).

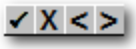


Figure 28: Template Definition Saving Options

   The window cursor provides an automatic approximation of template points. The approximation is based on the signals falling within the window cursor.
6. Define each template as required, by performing steps *7-8*.
7. Move the corresponding window cursor to the segments comprising the template in the following ways:

   - Drag the window cursor.
   - Enlarge the window cursor by dragging one or both of its horizontal ends.

Note: The actual position of the window cursor along the XY axis does not matter. Rather, position the window cursor so as to include the desired spikes.

As the window cursor is moved over the spikes, the spikes are automatically marked with the template points.

> **Note:** To see the template points of a previously-set template, click the template's window cursor.

8. By default, the system puts the first template point at the level crossing line. If necessary, do any of the following:
   - Change which template point is placed on the template in the time axis by using the left (<) and right (>) buttons.
   - Manually move the template points.
9. After all templates have been defined, click ✓ to save.

> **Note:** If necessary, click X to cancel.

The following happens:

- The online sorting graph displays iterating segments for all templates. Spikes falling under a template are displayed in the template color.
- In the template graphs, the spikes are sorted according to template. For example, Template 1 appears in the Unit 1 graph, and the Level graph contains all those spikes not falling under any template.

10. Continue with section ***3.9.3.3*** to define the template threshold for each template.

3.9.3.3 Defining the Template Variation

This procedure describes how to define the template variation for a spike sorting template, as defined in section ***3.9.3.2.*** It is the second step in ***Monitoring Micro Segmentation Spike Sorting.***

The threshold of a template is the similarity a spike must be to that template, in which a low threshold catches more spikes, and a high threshold less.

The template threshold is defined, by using the template histogram (***Figure 29***), which displays the distribution of spike variability.

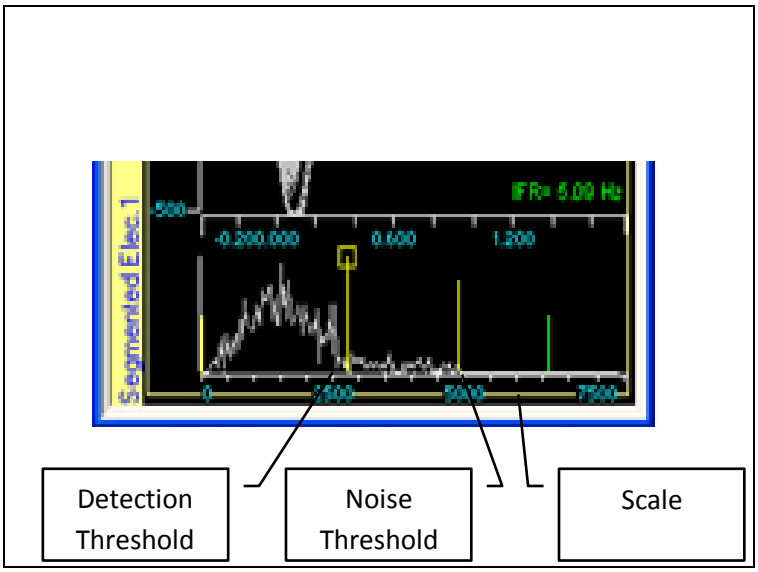


Figure 29: Template Histogram

Spike variability is the sum of the squared differences (SSQ) between a segment and the template, as follows:

- The more similar a spike is to the template, the closer to 0 on the X axis the spike distance appears.
- The time scale portrays the absolute spike variability in the SSQ value.
- The detection threshold defines how similar a spike must be to be considered a template match.
- The noise threshold defines how much of the histogram to display beyond the detection threshold.

To define the variation for a template:

1. From the toolbar of the online sorting graph, select a template (see ***Figure 26***).

   Only that template's spikes appear in the graph, and below the graph the template histogram appears (see ***Figure 29***).

2. Do the following:

   - Drag the X axis to include more or less spike distances. Including more spike distances allows you to lower the threshold more accurately.
   - Drag the noise threshold along the Y axis. The farther it is to 0, the fewer spike variability on the histogram, as more are defined as noise.
   - Drag the detection threshold along the Y axis. The closer it is to 0, the fewer spike variability are defined as matches.

3. Changes made, take effect immediately, but may not be visible for a few seconds.

3.9.3.4 Adding Include Windows

This procedure describes how to add Include Windows to the online sorting graph. This is the third step in ***Monitoring Micro Segmentation Spike Sorting.***

An Include window fine-tunes the accuracy of the template, and is helpful in a situation when a group of spikes matches a template, yet the group's tail differs before or after the template area. When added, spikes are only matched to a template if they pass through the Include window as well.

Up to three include windows can be added for each template.

To add Include Windows to a template:

1. From the toolbar of the online sorting graph, select a template (see ***Figure 26***).

   Only the template spikes appear in the graph. Below the graph the template histogram appears (see ***Figure 29***)

2. From the toolbar of the online sorting graph, click  .

   An Include window, which looks like another window cursor, appears on the level line.

3. Move the Include window to the spikes comprising the template in the following ways:

   - Drag the Include window.
   - Enlarge the include window by dragging one or both of its horizontal ends.

Note: The actual position of the window cursor along the XY axes does not matter. Rather, position the window cursor so as to include the desired spikes.

To add another Include Window, do the following:

1. Right-click on the online sorting graph, and then select **Include >** an Include window.

   Another Include window appears on the level line.

2. Repeat step 3 to move the Include window to the desired position.

   To remove an Include window from a template, right-click on the online sorting graph, select **Include**, and then clear the Include window.

Note: To turn off the Include window, click  .

3.9.3.5 Monitoring the Spike Templates

This procedure describes how to monitor the spikes as they fall into the templates. It is the final step in *Monitoring Micro Segmentation Spike Sorting*.

To monitor the spike templates:

1. In the online sorting graph or the corresponding template graph, toggle the spikes of a template to appear or disappear by right-clicking, and then selecting or clearing the template.
2. To adjust the voltage scales of all of the template graphs, do the following:

(a) In any of the template graphs or the online sorting graph, right-click, and then select **Set Group Amplitude**.

The **Set Group Scale** dialog box appears (***Figure 30***).

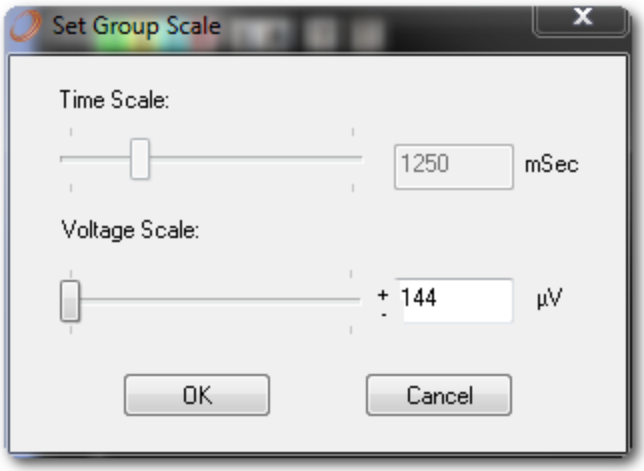


Figure 30: Set Group Scale Dialog Box

(b) Adjust the **Voltage Scale**, and then click **OK**.

The voltage scale is adjusted.

Note: The Spike sorting monitors micro segmentation spike detections

3.9.4 Monitoring Spikes in the Spikes Raster Graph

This procedure describes how to monitor micro segmentation spike detections in a fixed time, in a spikes raster representation. Spikes determined by the threshold set by the level line in the micro segmentation window, or a spike sorting template as defined in section ***3.9.3.2***, compose the raster. One line in the spikes raster graph represents a spike or template match.

> **Note:** The selected spikes raster graph displays only one channel at a time.

To monitor the spikes raster graph:

1. Do one of the following:
   - If you want the spikes raster graph composed of spikes determined by a spike sorting template, then do the following:
     i. Define the template as described in section ***3.9.3.2***.
     ii. Define the template threshold, as described in section 3.9.3.3.
     iii. Continue with step 5.
   - If you want the spikes raster graph composed of spikes determined by the level line in the micro segmentation window, then continue with step **2**.
2. From the **Windows List** button , select the micro segmentation window.
   The micro segmentation window appears (see ***Figure 21***), with each channel in the window appearing in its own graph.
3. In the graph of the channel whose spikes you want to monitor, do one of the following:
   - If you want the raster composed of spikes crossing the level line in the rising direction, select the up arrow .
   - If you want the raster composed of spikes crossing the level line in the falling direction, select the down arrow .

> **Note:** If the down arrow does not automatically appear, select the up arrow first, and it appears.

4. Set the threshold level for the spikes composing the raster by dragging the level line up or down the voltage scale.
5. From the **Windows List** button , select the spikes raster window.
   The spikes raster window appears (***Figure 31***).

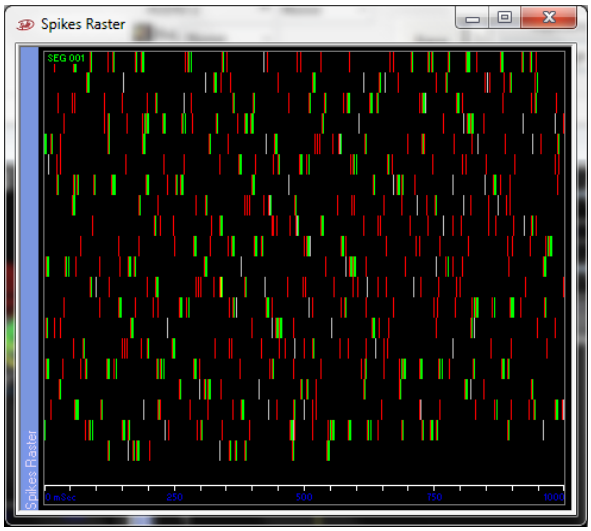


Figure 31: Spikes Raster Window

The level line is white, while the templates match the colors of the template match windows.

(c) Right-click in the graph area, and then verify that **Level Line** is selected.

(d) Right-click again in the graph area, and then select **Options**.

The **Raster Options** dialog box appears (*Figure 32*).

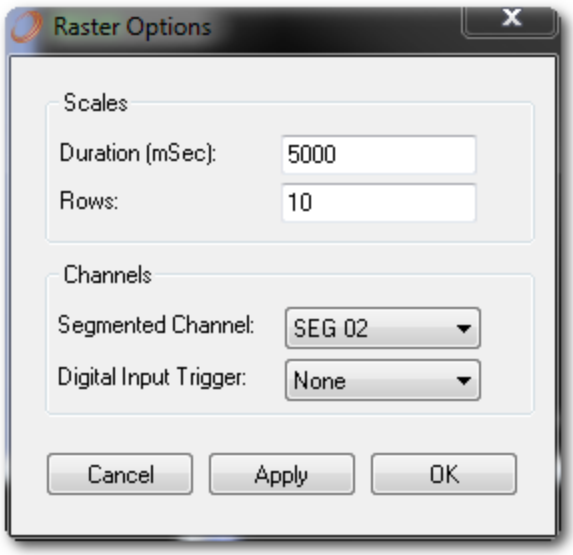


Figure 32: Raster Options Dialog Box

6. Do the following:

- In the **Scales** area, in the **Duration** field, type the amount of time (in milliseconds) for the spikes to appear in one row, in a first-in first-out method.

> **Note:** You can change the duration also in the graph itself, by dragging the time scale at the bottom.

- In the **Rows** field, type the amount of rows that can appear on the screen at one time, in a first-in first-out method.
- In the **Channels** area, from the **Segmented Channel** dropdown list, select the channel whose spikes you want to monitor.
- From the **Digital Input Trigger** dropdown, select the digital input to use as the trigger, as follows:
  - When the digital signal changes state from 0 to 1, this is marked in the raster with an **X**.
  - When the digital signal changes state from 1 to 0, this is marked in the raster with an **O**.

7. Do one of the following:
   - Click **Apply** to apply your settings while keeping the **Raster Options** dialog box open.
   - Click **OK** to apply your settings and close the **Raster Options** dialog box.

3.9.5 Monitoring Spikes in the Interspike Interval (ISI) Graph

This procedure describes how to monitor micro segmentation spike detections which are repeated in a certain frequency (firing rate), in a bins drawing. Spikes determined by the threshold set by the level line in the micro segmentation window, or a spike sorting template as defined in section ***3.9.3.2***, compose the graph. Bins drawing in the graph represents a spike or template match of a certain firing rate.

> **Note:** The selected Interspike Interval graph displays only one channel at a time.

To monitor the ISI graph:

1. Do one of the following:
   - If you want the ISI graph composed of spikes determined by a spike sorting template, then do the following:
     i. Define the template as described in section ***3.9.3.2***.
     ii. Define the template threshold, as described in section ***3.9.3.3***.
     iii. Continue with step 5.
   - If you want the ISI graph composed of spikes determined by the level line in the micro segmentation window, then continue with step **2**.
2. From the **Windows List** button  , select the micro segmentation window.

The micro segmentation window appears (see ***Figure 21***), with each channel in the window appearing in its own graph.

3. In the graph of the channel whose spikes you want to monitor, do one of the following:
   - If you want the ISI composed of spikes crossing the level line in the rising direction, select the up arrow .
   - If you want the ISI composed of spikes crossing the level line in the falling direction, select the down arrow .

> **Note:** If the down arrow does not automatically appear, select the up arrow first, and it appears.

4. Set the threshold level for the spikes composing the raster by dragging the level line up or down the voltage scale.
5. From the **Windows List** button , select ISI window.

   The Interspike Interval window appears (***Figure 31***).

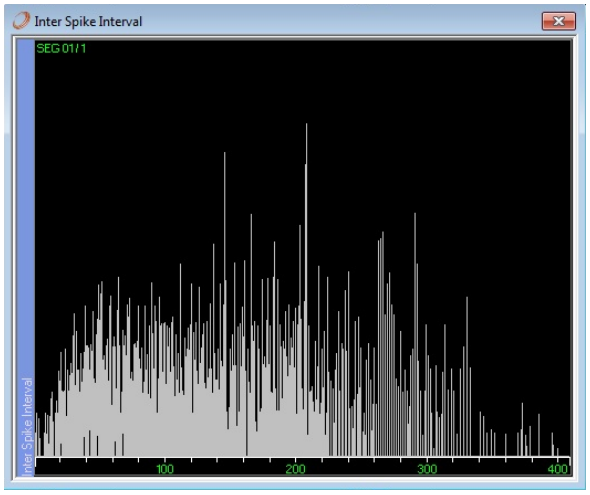


Figure 33: ISI Window

The level line is white, while the templates match the colors of the template match windows.

3.9.6 Monitoring EEG signals in Color Density Spectral Array Graph.

This procedure describes how to monitor Fast Fourier Transform (FFT) of the EEG signal which is calculated for a selected period of time, in a color density drawing. Color is determined by the amplitude, blue color for the smallest values and red color for the biggest. Y axis represent time, X axis represent frequency range of the EEG channel (according to the channel's filters). Spectral edge line can be added to the graph.

Notes:

- The Color Density Spectral Array graph displays only one channel at a time.
- The calculated data of the Color Density Spectral Array is not saved.

To monitor the Color Density Spectral Array graph:

1. From the **Windows List** button , select **Color Density Spectral Array** window.

   The **Color Density Spectral Array** window appears (Figure 34).

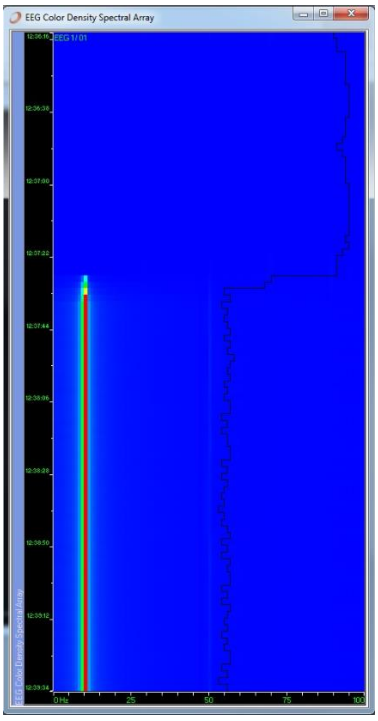


Figure 34: Color Density Spectral Array Window

   The level line is white, while the templates match the colors of the template match windows.

2. Right-click in the graph area, and then select **Options**.

The **Color Density Spectral Array** dialog box appears (Figure 35).

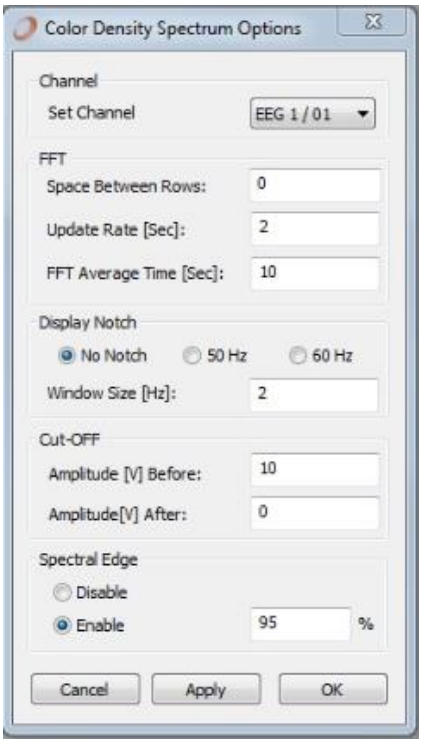


Figure 35: Color Density Spectral Array Dialog Box

3. Do the following:

- In the **Channels** area, from the **Channel** dropdown list, select the channel you want to monitor.
- In the **Space Between Rows** field, type the distance between rows in Pixels.
- In the **Update Rate** field, type the time in seconds for updating the row in the display.
- In the **FFT Average Time** field, type the time in seconds for calculating the average of the FFT.
- From the **Display Notch** field, choose 50Hz or 60Hz to remove from the display.
- In the **Window Size** field, type the band width value of the notch in Hz.
- In the **Amplitude** field, type the maximum value allowed to be displayed (and calculated in the FFT average) in the **Before** field, and type the replacement of these values in the display in the **After** field.
- From the **Spectral Edge** section, set an edge to display the percentage of power under the displayed frequency.

Notes:

- Clear data or changing channel is not reversible, all previous calculations will be lost.

3.10 Saving Data to the Log File

This procedure describes how to save the current data set from the site to the log file, during monitoring, for later review..

Note: The default file location is under the patient reference in the surgeries data folder on C:\.

To save manually:

1. Do any of the following:

- From the toolbar, click **Save**.
- On the the remote control, click the **Save** button.

2. The following happens when saving is activated, either automatically or manually:

- In the **Trajectory** graph:
  - Creates a one-second-trace segment (left pane of the laptop screen)
- Saves the continuous data to the log file

Note: You can save manually even when you have configured automatic saving.

3.11 Stimulation

Perform stimulation after successfully determining placement. The workflow for stimulation is as follows:

1. Set up stimulation for the channel, including defining the waveform, the amplitude, and the return channel, as described in section ***3.11.1***.
2. Apply the stimulation, as described in section ***3.11.2***.
3. Monitor the stimulation with the current monitor, which displays the real injected current value, as described in section ***3.11.3***

3.11.1 Setting Up Stimulation

This procedure describes how to set up stimulation, which is necessary before applying stimulation to the patient. Stimulation setup includes selecting a specific electrode, selecting a defined stimulation pulse or waveform, and defining duration and frequency, among other things.

To set stimulation up:

1. From the toolbar, from the **Stim Channel** dropdown list, select the channel through which to send the stimulation.
2. From the toolbar, select **Stim Setup**.

   The **Stimulation Setup** dialog box appears (***Figure 36***).

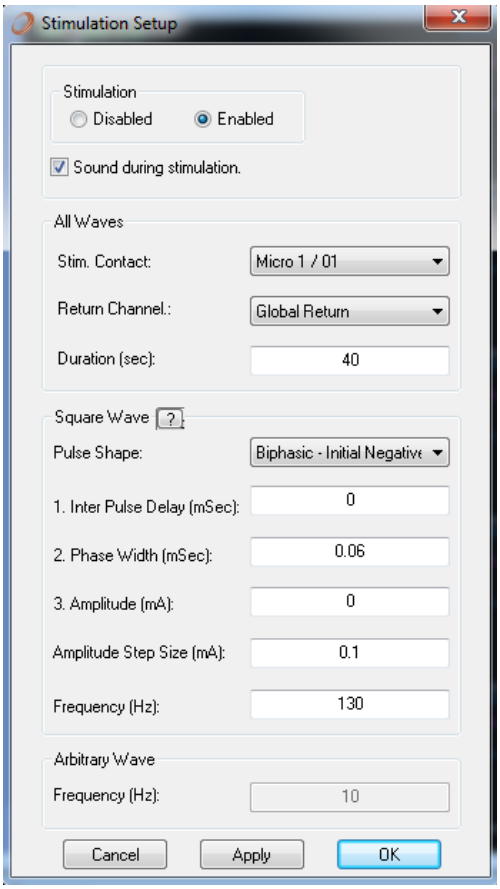


Figure 36: Stimulation Setup Dialog Box

3. In the Stimulation **Setup** dialog box, do the following:
   - Verify that **Stimulation** is **Enabled**.
   - For a beep to sound for the duration of the stimulation, select **Sound during Stimulation**.

Note: The beep is not as loud as the recorded signal. Turn the volume up to hear it.

- In the **All Waves** area, define the following:
  - **Stim. Contact:** This is the required stimulation contact. From the Dropdown box, select any contact available for stimulation.
  - **Return Channel:** From the dropdown list, select the channel to return the stimulation (see section 3.11.2, step 1), by doing one of the following:
    - If you plan to apply the stimulation from an ECoG channel, select another ECoG channel.
    - If you plan to apply the stimulation from an EEG channel, select another EEG channel.
    - Select **Global Return** for the current to return through the global stimulation return.. In the Headbox modules, there is an individual connector (see Headbox Modules Assembly).

Note: You may not return the stimulation by the same channel by which it was applied.

  - **Duration:** This is the duration of one stimulation season.

Note: When applying stimulation, the stimulation lasts for as long as you press the stimulation button, unless the value in the **Duration** field is less.

- In the **Square Wave** area, from the **Pulse Shape** dropdown list, select one of the waveforms:
  - **Biphasic - Asymmetric**
  - **Biphasic – Initial Negative**
  - **Biphasic – Initial Positive**
  - **Monophasic – Initial Negative**
  - **Monophasic – Initial Positive**

Note:

- In the **Biphasic** waveform, each phase has the length of a Duration (one positive and one negative).
- The question mark beside **Square Wave** can be clicked to show the shape and parameters of the selected **Pulse Shape.**

- In the **Inter Pulse Delay** field, type the length of time (in milliseconds) between pulses.
- In the **Phase Width** field, type the duration (in milliseconds) of the phase.
- In the **Amplitude** field, type the pulse phase amplitude (in milliamps) of the stimulation.
- In the **Amplitude Step Size** field, type the step size of the amplitude of the stimulation (in milliamps).
- In the **Frequency** field, type the frequency of the amplitude of the stimulation (in Hertz).

4. Do one of the following:
   - To implement setup and close the **Stimulation Setup** dialog box, click **OK**.
   - To implement setup and leave the **Stimulation Setup** dialog box open, click **Apply**.
5. Define how the evoked potentials upon stimulation are viewed in the evoked potentials window (as required), as described in section ***3.12***.

3.11.2 Applying Stimulation to the Patient from the Toolbar

This procedure describes how to apply stimulation to the patient from the toolbar, and monitor the stimulation.

To apply stimulation to the patient from the toolbar and monitor the stimulation:

1. Do the following:
   - To select the channel from which to send the stimulation:
     - From the toolbar, from the **Stim Channel** dropdown list ,select a channel.
     - From the remote control press the **Micro-Macro** button to select either micro or macro, and then press the arrow buttons to select the channel.
   - If you want to adjust the current amplitude of the stimulation (in milliamps):
     - From the toolbar, in the **Stim Amplitude** field, click the **Up** and **Down** buttons.
     - On the remote control, press the **+** and **-** buttons.
2. To apply the stimulation, do the following:
   - From the toolbar, click and hold down **Stim**.
   - On the remote control, press and hold down the **Stimulation** button.

Stimulation is applied to the patient for as long as you hold down the button, unless the value entered in setting up the stimulation (see section ***3.11.1***) is less.

3. Monitor the stimulation using the **Current Monitor** window, which displays the real injected current value, as described in section ***3.11.3.***

3.11.3 Monitoring Stimulation in the Current Monitor Window

This procedure describes how to monitor stimulation in the current monitor window, which displays the real injected current value.

To monitor stimulation using the current monitor window:

1. From the **Windows List** button  , select the current monitor window.

   The current monitor window appears (***Figure 37***), in which the height of the bar is relative to the stimulus strength, colored as follows:

   - When the bar is green, stimulation is working correctly.
   - When the bar is purple, the measured stimulation value is below the requested value by 30% or more.

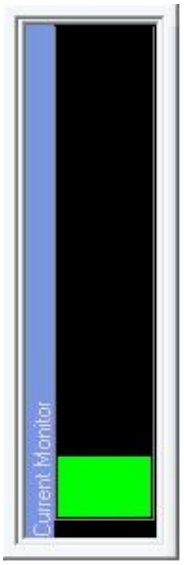


Figure 37: Current Monitor Window

Note: For safety reasons, if the measured value is above the requested value by more than 30%, then the system stops the current and the current monitor bar becomes purple.

3.12 Defining and Monitoring the Evoked Potential

This procedure describes how to define the way in which the potentials evoked upon stimulation are viewed in the evoked potentials window, and then monitor those potentials during stimulation.

The Evoked Potential tool is useful for visualizing the effects of stimulation in one area upon another area recorded by a channel, primarily LFP, EEG, or ECoG. The tool creates time-locked averages to the stimulus event.

To define and monitor the evoked potential:

1. From the **Windows List** button , select the evoked potential window.

   The **Evoke Potential** window appears (***Figure 38***).

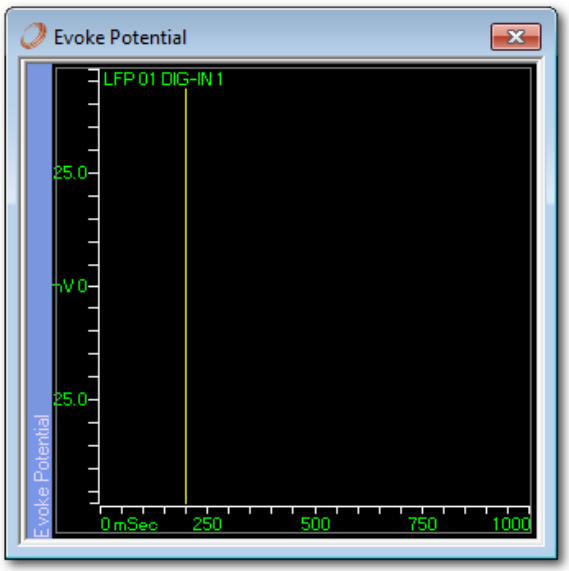


Figure 38: Evoke Potential Window

2. Right-click in the graph area, and then select **Options**.

   The **Options** dialog box appears (***Figure 39***).

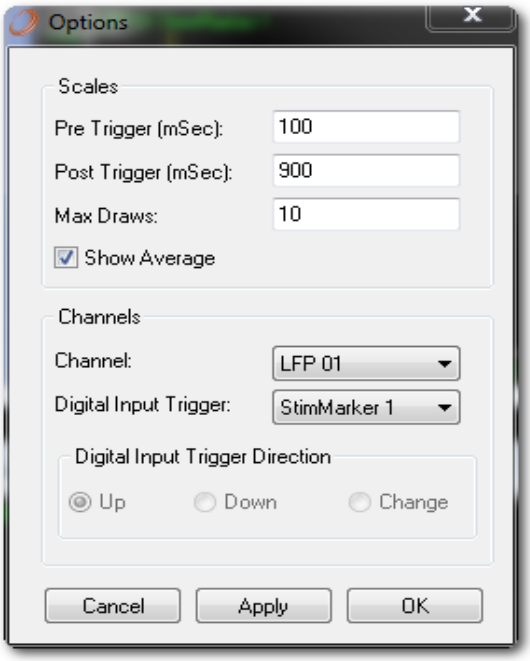


Figure 39: Evoked Potentials Options Dialog Box

3. Do the following:

   - In the **Scales** area, type the amount of time (in milliseconds) in the **Pre Trigger** field to display before the trigger, and in the **Post Trigger** field after the trigger. The total amount of time must be less than 1000 milliseconds.
   - In the **Max Draws** field, enter the number of snapshots appearing in the **Evoke Potential** window around the time-locked event. There is always this number of traces in the window, with the newest one cycling in and the oldest cycling out, working in a first in first out basis.
   - Select the **Show Average** option to show the calculated average of all the snapshots defined in the **Max Draws** field. This is helpful when many stimulus events are occurring per second, as an effect may only appear with the average.
   - In the **Channels** area, from the **Channel** dropdown list, select an **LFP** or **SPK** channel.
   - From the **Digital Input Trigger** dropdown list, select a trigger for the tool to start creating the time-locked averages:
     - Select a digital input trigger.

       The **Digital Input Trigger Direction** area is activated (***Figure 40***).

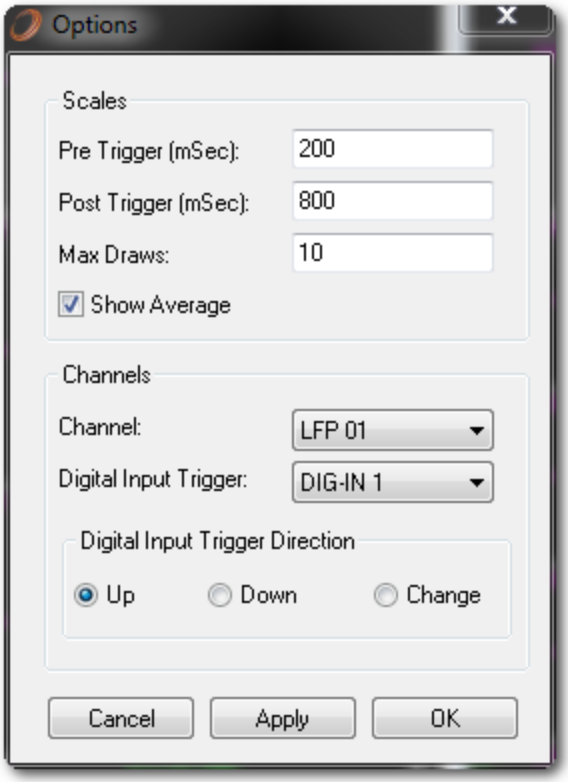


Figure 40: Evoked Potentials Options with DIG-IN Selected

- Select a StimMarker trigger.

  The **Digital Input Trigger Direction** area is inactive.

4. If you selected a digital input trigger, then in the **Digital Input Trigger Direction** area, select one of the following:

   - **Up**: The digital input must be in the high state to trigger the tool.
   - **Down**: The digital input must be in the low state to trigger the tool.
   - **Change**: The tool is triggered regardless of digital input state.

5. Do one of the following:

   - Click **Apply** to apply your settings while keeping the **Evoked Potentials** dialog box open.
   - Click **OK** to apply your settings and close the **Evoked Potentials** dialog box.

6. Do any of the following:

   - To reduce the total amount of time displayed in the graph, drag the time scale to the right.
   - To expand the voltage scale, drag up on the scale.
   - To contract the voltage scale, drag down on the scale.

- To refresh the screen, right-click in the graph area, and then select **Clear**.

7. During stimulation, from the **Windows List** buttor , select the evoked potential window.

   The evoked potential window appears (***Figure 41***), displaying signals based on the stimulation in real time. Above the signals a colored line appears, displaying the average of all of the signals.

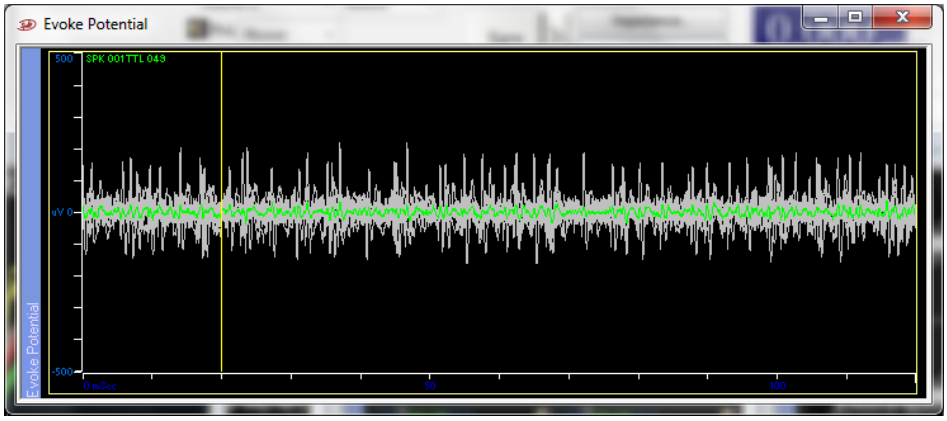


Figure 41: Active Evoked Potential Window

8. Adjust the channel's voltage or time scales, as described in section ***3.9.1.1***..

3.13 Defining and Monitoring the Peristimulus Histogram (PSTH)

This procedure describes how to define the Peristimulus Histogram upon stimulation or Digital input trigger, and then monitor the sorted spikes in response.

The PSTH tool is useful for visualizing the effects of stimulation or digital input in one area upon another area recorded by a channel, for SPK channels. The tool creates time-locked averages to the stimulus or trigger event.

The **PSTH** is divided into two sections:

- **Lower part:** is the part that shows raster of line crossing or template matching with every trigger i.e. digital input or stimulation marker. The yellow line is synchronized with the given trigger.
- **Upper part:** draws a histogram of the averages of the sorted spikes.

To define and monitor the PSTH:

1. From the **Windows List** button , select the ISI window (refer to section 5.6.5 in order to create window).

   The **PSTH** window appears (***Figure 38***).

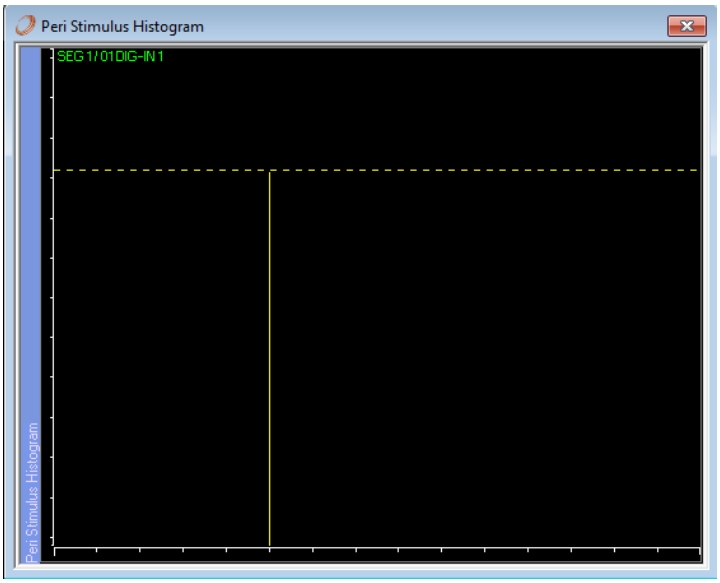


Figure 42: PSTH Window

2. Right-click in the graph area, and then select **Options**.

   The **Options** dialog box appears (***Figure 39***).

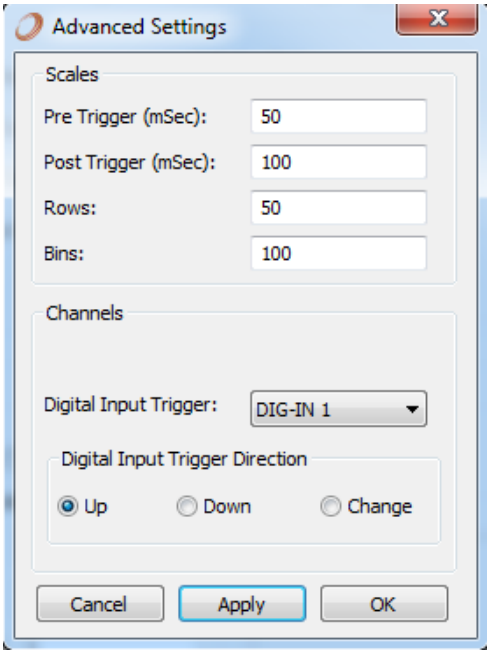


Figure 43: Evoked Potentials Options Dialog Box

3. Do the following:

   - In the **Scales** area, type the amount of time (in milliseconds) in the **Pre Trigger** field to display before the trigger, and in the **Post Trigger** field after the trigger. The total amount of time must be less than 1000 milliseconds.

- In the **Rows** field, enter the number of raster rows in the **PSTH** lower part of the window. There is always this number of rows in the window, with the newest one cycling in and the oldest cycling out, working in a first in first out basis. The amount of rows must be between 1 -100.
- In the **Bins** field, enter the number of bins that can be drown on every row in the **PSTH** lower part of the window. The amount of bins must be between 1 -100.
- From the **Digital Input Trigger** dropdown list, select a trigger for the tool to start creating the trigger-locked averages:
  - Select a digital input trigger.

    The **Digital Input Trigger Direction** area activated
  - Select a StimMarker trigger.

    The **Digital Input Trigger Direction** area is inactive.
- If you selected a digital input trigger, then in the **Digital Input Trigger Direction** area, select one of the following:
  - **Up**: The digital input must be in the high state to trigger the tool.
  - **Down**: The digital input must be in the low state to trigger the tool.
  - **Change**: The tool is triggered regardless of digital input state.

4. Do one of the following:
   - Click **Apply** to apply your settings while keeping the **PSTH** dialog box open.
   - Click **OK** to apply your settings and close the **PSTH** dialog box.
5. Do any of the following:
   - To reduce the total amount of time displayed in the graph, drag the time scale to the right.
   - To clear the screen for a fresh start, right-click in the graph area, and then select **Clear**.
6. During stimulation, from the **Windows List** button  , select the **PSTH** window.

   The **PSTH** window appears (***Figure 41***), displaying signals based on the triggering in real time.

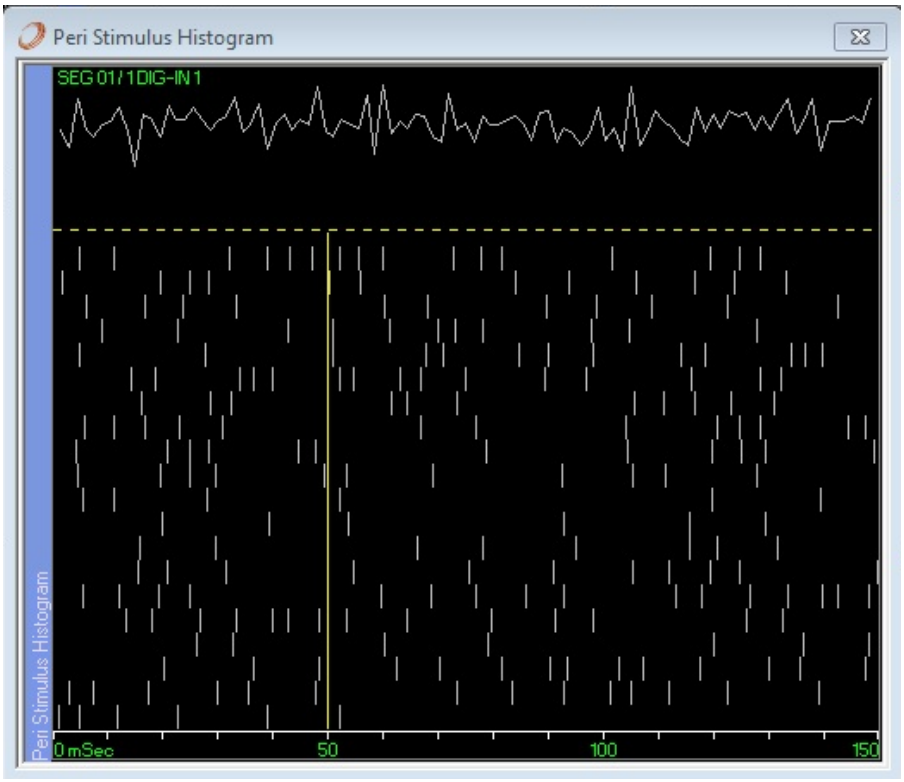


Figure 44: Active PSTH Window

7. Adjust the channel time scales, as described in section ***3.9.1.1***.

4 Advanced Capabilities

4.1 Advanced Overview

More advanced capabilities are as follows:

- Defining filtering and sampling properties, described in section 4.2.
- Defining options for the log files generated by the system during recording, described in section 4.3.
- Editing a contact channel, described in section ***4.4***.

4.2 Filtering and Sampling Properties

Channel properties are used to see and set the different digital filter values and sampling rates for different signal types, where possible, for the signals coming from the electrodes. It also allows turning the acquisition on or off for certain signal types.

You can control the filtering and sample properties of the following contacts:

- For EEG, see section ***4.2.1***.
- For ECoG, see section ***4.2.2***.

You can also change a channel name, as described in section 4.2.3.

4.2.1 Controlling EEG Filtering and Sampling Properties

This procedure describes how to control filter settings, grounding, referencing, and sampling properties, for editing channels derived from the EEG contact.

To control EEG filtering and sampling properties:

1. Press **CTRL+SHIFT+M** to open the system menu.
2. Select **Options > EEG Settings**.

   The **Channels Settings (EEG)** dialog box appears (***Figure 45***), displaying relevant information on all of the channels derived from the micro contact type.

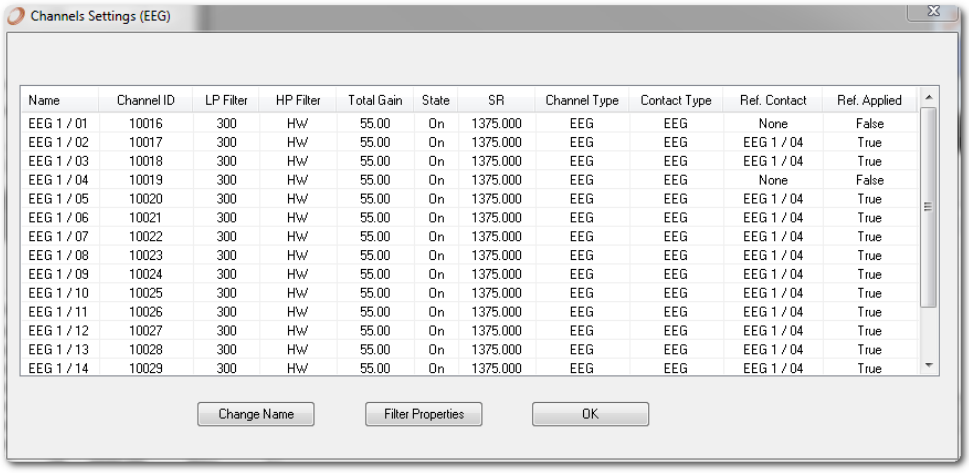


Figure 45: Channel Settings Dialog Box (EEG)

3. Select the channels whose properties you want to edit, and then click **Filter Properties**.

   The **Filter Properties (EEG)** dialog box appears (Figure 46).

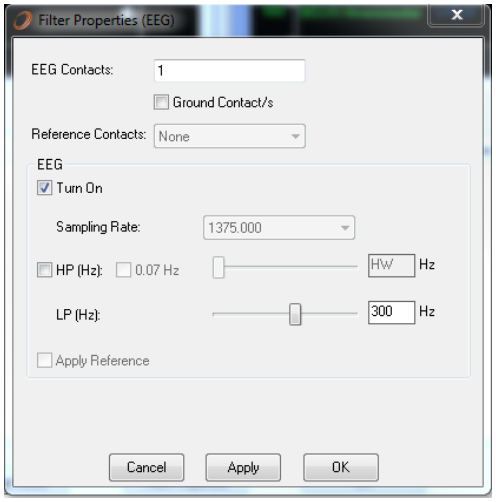


Figure 46: Filter Properties Dialog Box (EEG)

4. Do the following:

   - In the **EEG Contacts** field, enter the contacts you want to edit, either a single contact number or a range of contacts separated by a comma. For example selecting electrodes 1, 3, 4, 5, and 7 is done by specifying 1, 3-5, 7. It is also possible to pre-select electrodes from the **Channels Properties** window.
   - From the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***3.9.1.6*** for more information on flexible referencing.

- Select **Ground Contact/s** if you want the contacts entered in **EEG Contacts** grounded. See section ***3.9.1.3*** for more information on grounding a contact.
- In the **EEG** area, do the following:
  - Select **Turn On** to enable the acquisition of EEG signals.
  - View the **Sampling Rate** field, which shows the EEG signal sampling rate.
  - From the **HP (Hz)** slider bar, select the high pass filter for the EEG signals. If the box is not checked, it will be only HW filters.
  - From the **LP (Hz)** slider bar, select the low pass filter for the EEG signals.

5. Do one of the following:
   - Click **Apply** to apply the new settings, while keeping the dialog box open.
   - Click **OK** to apply the new settings and close the dialog box.

4.2.2 Controlling ECoG Filtering and Sampling Properties

This procedure describes how to control filter settings, grounding, referencing, and sampling properties, for editing channels derived from the ECoG contact.

To control ECoG filtering and sampling properties:

1. Press **CTRL+SHIFT+M** to open the system menu.
2. Select **Options > ECoG Settings**.
3. Choose the configuration wanted :
   - ECoG Micro HF
   - ECoG Micro LF
   - ECoG Macro HF
   - ECoG Macro LF

   The **Channels Settings (ECoG)** dialog box appears (same layout as example below), displaying relevant information on all of the channels derived from the micro contact type.

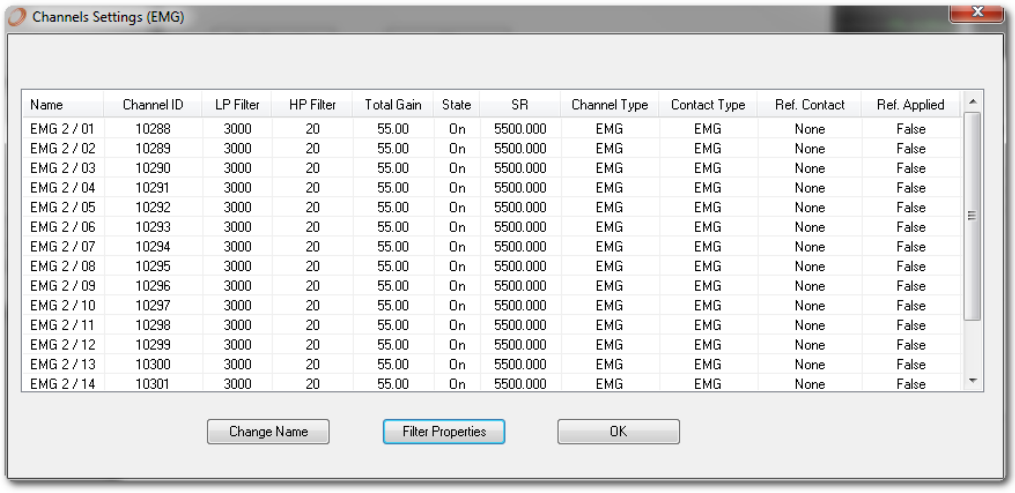


Figure 47: Channel Settings Dialog Box (EMG)

4. Select the channels whose properties you want to edit, and then click **Filter Properties**.

   The **Filter Properties (ECoG)** dialog box appears.

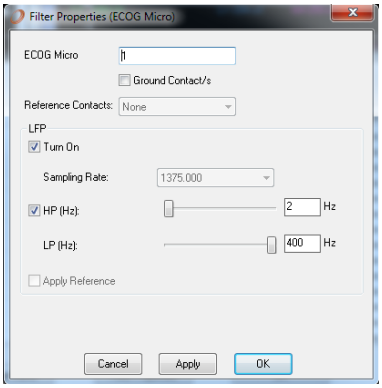


Figure 48: Filter Properties Dialog Box (ECoG)

5. Do the following:

   - In the **ECoG Contacts** field (EMG Contacts in this example), enter the contacts you want to edit, either a single contact number or a range of contacts separated by a comma. For example selecting electrodes 1, 3, 4, 5, and 7 is done by specifying 1, 3-5, 7. It is also possible to pre-select electrodes from the **Channels Properties** window.
   - In the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***3.9.1.6*** for more information on flexible referencing.

- Select **Ground Contact/s** if you want the contacts entered in **ECoG Contacts** grounded. See section ***3.9.1.3*** for more information on grounding a contact.
- In the **ECoG** area (EMG area in this example), do the following:
  - Select **Turn On** to enable the acquisition of ECoG signals.
  - From the **Sampling Rate** dropdown list, set the ECoG signal sampling rate.
  - From the **HP (Hz)** slider bar, select the high pass filter for the ECoG signals. If the box is not checked, it will be only HW filters.
  - View the **LP (Hz)** the low pass filter for the ECoG signals.

6. Do one of the following:
   - Click **Apply** to apply the new settings, while keeping the dialog box open.
   - Click **OK** to apply the new settings and close the dialog box.

4.2.3 Changing Channel Names

This procedure describes how to change the name of a channel. By default, it comprises of the channel signal type and number.

To change the name of a channel:

1. Press **CTRL+SHIFT+M** to open the system menu.
2. Select **Options**, and then the contact containing the channel whose name you want to change.

   The settings dialog box of the contact appears (see Figure 51 for example).
3. Click **Change Name**.

   The **Channels Properties** dialog box appears (***Figure 49***).

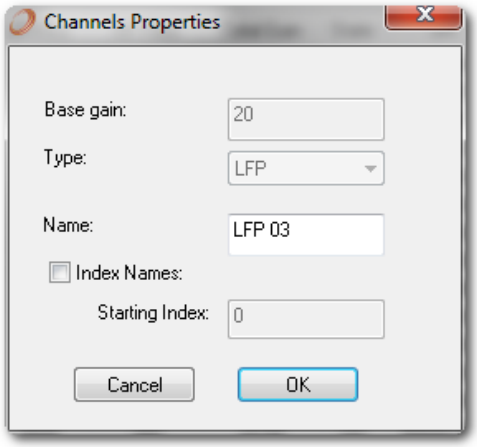


Figure 49: Channels Properties Dialog Box

4. In the **Name** field, enter the new name of the channel.
5. Select the **Index Name** option if you want subsequent channels named incrementally.
6. Click **OK**.

   The changes are saved.

4.3 Logging Options

Logging options are used to define what is saved to data files and how it is saved.

Neuro Omega saves files in the *.mpx format, which is Alpha Omega's proprietary binary format. For each recording session, which starts when the Neuro Omega software opens, an *.lsx file is also saved. This is a text files that lists all the files saved in the recording session.

MapFile Convertor, which is provided with the system, allows you to convert the log file to a Matlab file or a text file, among others. See the MapFile Convertor instruction manual for details.

4.3.1 Defining Logging Options

This procedure describes how to define logging options for a channel.

To define logging options for a channel:

1. Press **CTRL+SHIFT+M** to open the system menu.
2. Select **Options > Logging Options**.

   The **Logging Options** dialog box appears (***Figure 50***).

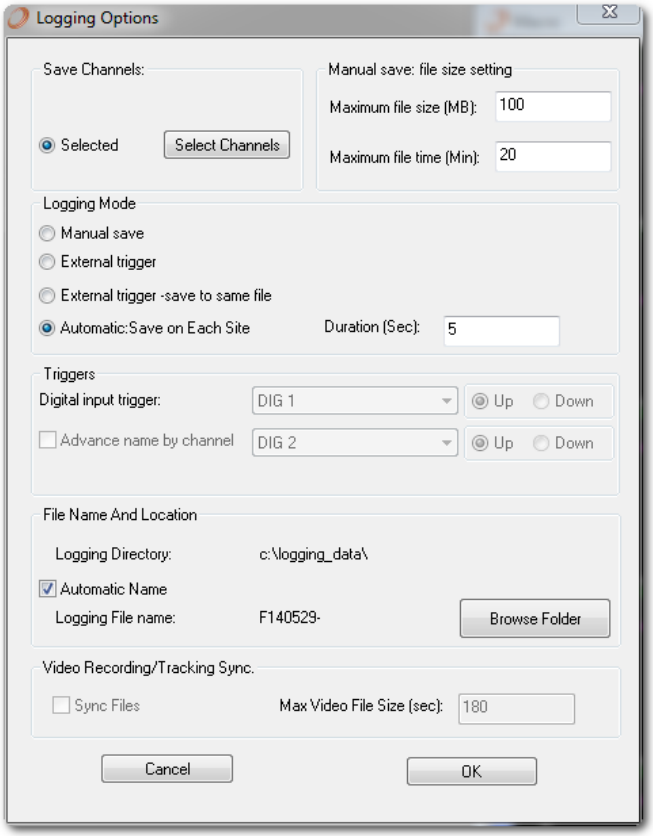


Figure 50: Logging Options Dialog Box

3. In the **Save Channels** area, select the channels you want to save, by doing the following:

   (a) Click **Select Channels**.

   The **Saving Channels** dialog box appears (***Figure 51***).

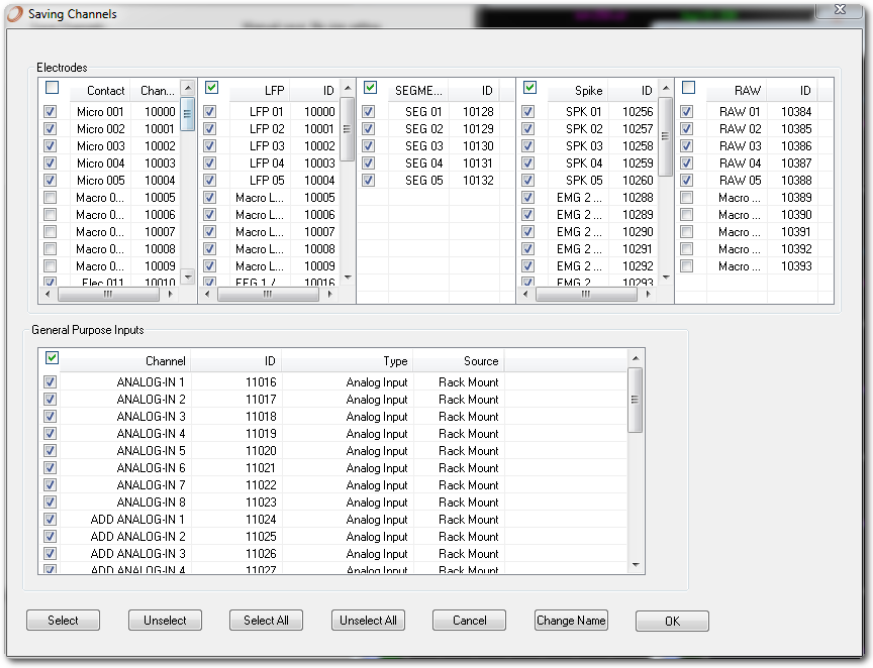


Figure 51: Saving Channels Dialog Box

(b) In the **Electrodes** area, do the following:

- In the **Contact** list, select the analog contacts that you want to save.
- The respective channels are selected in the LFP, SEG, Spike, and Raw lists.
- In the LFP list, select the LFP and EEG channels that you want to save.
- In the SEG list, select the SEG channels that you want to save.
- In the Spike list, select the SPK (micro), and ECoG channels that you want to save.
- In the Raw list, select the micro and macro RAW channels that you want to save.

Note: Before selecting the RAW channels to save, you must verify that the acquisition of raw signals is enabled. This is done when defining the micro filtering and sampling settings. See the Neuro Omega User Manual for Medical Applications for more information.

(c) In the **General Purpose Inputs** area, select the input channels that you want to save, as follows:

- ANALOG-IN
- ADD ANALOG-IN
- PORT
- UD InPort

- DIG-IN
- UD
- Stim Marker
- DIG-OUT

(d) Click **OK**.

The new settings are applied, and the **Saving Channels** dialog box closes.

4. In the **Logging Options** dialog box, in the **Manual Save** area, set the file size limit, as follows:

   - **Maximum file size** (MB): When the data file size reaches the value specified here, the file is closed and a new file is opened automatically. The new file will have the same name as the one that was closed, but with an incremental running index.
   - **Maximum file time** (min): When the lapsed time since opening the current file exceeds the value defined here, the program closes the current file and begins saving data in a new file as above. If the value in this field is 0, the program does not check the saving time.

> **Note:** The size limits indicated apply only when manual or automatic logging is in progress. When logging is triggered by an external trigger, these limits do not apply.

5. Select the logging mode, as follows:

   - **Manual Save**: When the user presses **Save** in the application banner, the button changes color to red and logging data begins immediately. Logging stops when the user presses the **Save** again.
   - **External Trigger**: When the user presses **Save**, the program then waits for a trigger on the specified digital input. When **Save** is pressed, it changes to the **Save Wait** mode, and the program begins logging after receiving the value 1 on the selected digital input channel, and stops saving after receiving the value 0.

     If selected, the **Triggers** area is activated (***Figure 52***).

Figure 52: Triggers Area Activated

The logging by trigger behavior is illustrated in ***Figure 53***.

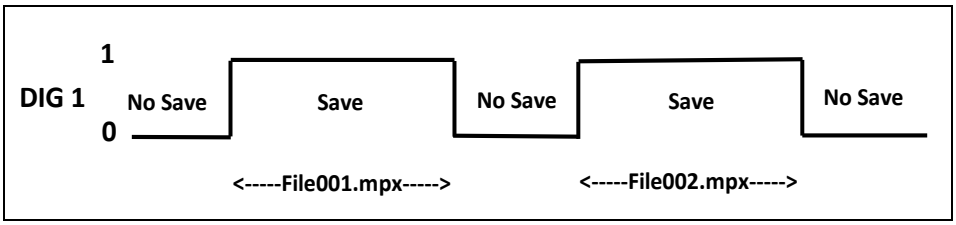


Figure 53: Logging by External Trigger Behavior

- **External Trigger – Save to Same File**: Similar to the **External Trigger** option, but data is saved into the same file. The figure below lays out the logging behavior after **Save** is pressed.

  If selected, the **Triggers** area is activated (***Figure 54***).

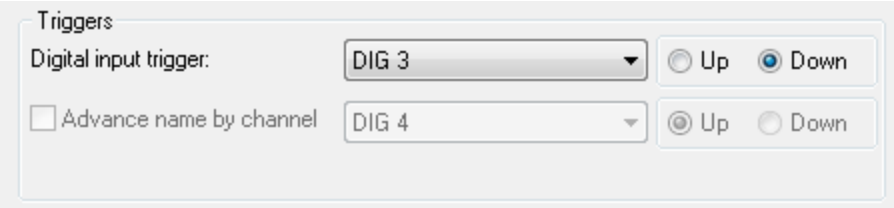


Figure 54: Triggers Area Activated - Save to Same File

The logging by trigger behavior is illustrated in ***Figure 55***.

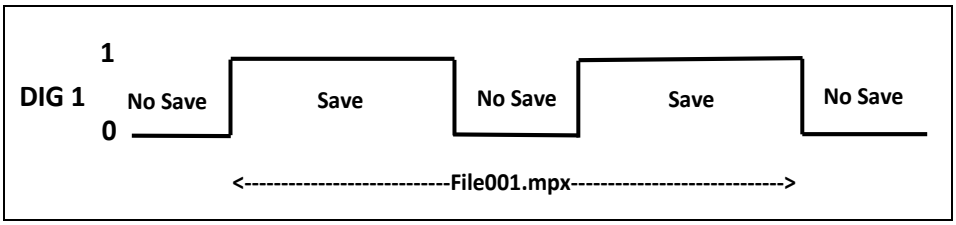


Figure 55: Logging by External Trigger Behavior - Save to Same File

6. If you selected any of the **Triggers** options in the **Logging Mode** area, complete the **Triggers** area, as described in section ***4.3.2***.
7. To change the logging filename and/or saving folder, do one of the following:
   - Select the **Automatic Name** option, click **Browse Folder**, and then select the folder in which to put the files.

     The automatic name is comprised as follows:

     <brain hemisphere><trajectory number><trajectory depth><incremental index starting with 001>

     For example:

     RT1D1.500F0001

> **Note:** The default file location is under the patient reference in the surgeries data folder on C:\Surgeries_data.

- Clear the **Automatic Name** option, click **Browse**, and then select the file named as you want the log files named.

  The naming convention is as follows:

  <selected file><incremental index starting with 001>

> **Note:** If one or more files exist in the folder using the same name, the program automatically looks for the highest existing index and starts logging with the following index.

4.3.2 Saving Files by Digital Triggers

This procedure describes how to define the triggers for the commencement of data logging, which is a part of ***4.3.1***, and relevant when one of the trigger options is selected (step ***6***).

To control the commencement of data logging by digital triggers:

1. Connect the digital input trigger on the Input/Output panel., as described in Connecting External System in the Neuro Omega User Manual for Medical Applications.
2. In the **Digital Input Trigger** dropdown list, select the start saving/stop saving trigger.
3. If you selected **Triggers**, then select the **Advance Name by Channel** option if you want the current file to close and a new file open every time the specified digital channel goes to active high if **Up** was selected or low if **Down** was selected.

> **Note:** The digital channel used in **Advance Channel by Name** must be different than the digital channel specified in the **Digital Input Trigger** field, and it has an effect only while logging is on.

4.4 Editing a Channel Contact

This procedure describes how to edit a contact channel.

To edit a contact channel, do any of the following:

- Edit filtering and sampling for any of the channels, as described in section 4.2.
- Edit logging options for any of the channels, as described in section 4.3.
- Edit impedance settings, as described in section ***4.5***.

4.5 Defining Impedance Settings

This procedure describes how to define impedance settings, which are used to define the sine wave used to test the impedance of the recording electrodes.

To define impedance settings:

1. Press **CTRL+SHIFT+M** to open the system menu.
2. Select **Options > Impedance Settings**.

   The **Impedance Settings** dialog box appears (***Figure 56***).

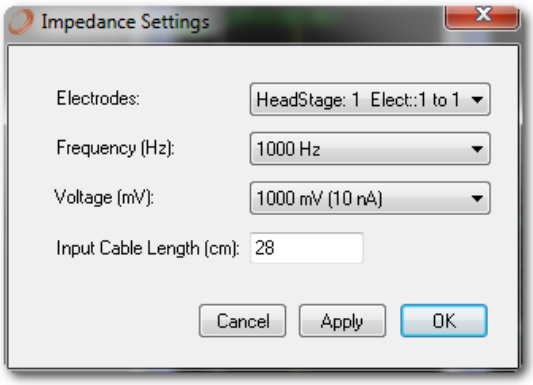


Figure 56: Impedance Settings Dialog Box

3. Do the following:
   - In the **Electrodes** dropdown list, do one of the following:
     - Select which set of electrodes to set. Electrode sets are in modules of 16 channels.

> **Note: Headstage: 1** refers to the Drive Headstage, while **Headstage: 2** refers to Headbox module 1.

     - Select **ALL Electrodes** for the settings to apply to the Headstage and all of the Headboxes.
   - In the **Frequency** dropdown list, select the sine wave frequency with which the impedance will be checked.
   - In the Voltage dropdown list, select the voltage of the sine wave with which the impedance will be checked.
   - In the Input Cable Length, define the length of the wire used before the first amplifier.
4. Do one of the following:
   - Click **Apply** to apply the new settings.
   - Click **OK** to apply the new settings and close the dialog box.

5 Technical Specifications

Specifications for the Neuro Omega system appear in the following sections:

- *General*
- *Configuration*
- *Sorting*
- *Configuration*

❖ *Number of channels*	configuration	Limitation
10	MER (5 Micro and 5 Macro)	-
26	EEG/EMG/ECoG Micro/ECoG Macro	-
42	EEG/EMG/ECoG Micro/ECoG Macro	-
58	EEG/EMG/ECoG Micro/ECoG Macro	-
74	EEG/EMG/ECoG Micro/ECoG Macro	-
90	EEG/EMG/ECoG Micro/ECoG Macro	In case the configuration is 90 ECoG Micro channels, the maximum number of Templates that can be reached is 290
106	EEG/EMG/ECoG Micro/ECoG Macro	In case the configuration is 106 ECoG Micro channels, the maximum number of Templates that can be reached is 260
122	EEG/EMG/Macro ECoG	The configuration of the system can't be 122 channels of ECoG Micro

5.1 Sorting

Parameter	Value
Segmentation	■ Method: Level Threshold ■ Segment length: 96 samples at 44 KHz ■ Crossing Point: 18th sample
Online Sorting	■ Method: 8 point template match ■ Templates per channel: 4 ■ Segment length: 2.15mSec (96 samples, 44 KHz, template points are 5 samples apart starting in sample 18)

- ***Headbox Modules***
- ***Sensors***

5.2 General

Parameter	Value
Operating System	Windows 7 64bit
Computer	Touch screen PC
Power	100V-240V, 50 Hz-60 Hz
Trolley Connectors	4 USB ports
Main Unit system connectors	■ Ethernet ports (1 GB) ■ 1 Remote port (USB) ■ 2 Audio out (3.5 mm stereo)
Communication	Ethernet protocol
Peripherals	Microsoft Wireless keyboard and mouse

5.3 Configuration

Number of channels	configuration	Limitation
10	MER (5 Micro and 5 Macro)	-
26	EEG/EMG/ECoG Micro/ECoG Macro	-
42	EEG/EMG/ECoG Micro/ECoG Macro	-
58	EEG/EMG/ECoG Micro/ECoG Macro	-

Number of channels	configuration	Limitation
74	EEG/EMG/ECoG Micro/ECoG Macro	-
90	EEG/EMG/ECoG Micro/ECoG Macro	In case the configuration is 90 ECoG Micro channels, the maximum number of Templates that can be reached is 290
106	EEG/EMG/ECoG Micro/ECoG Macro	In case the configuration is 106 ECoG Micro channels, the maximum number of Templates that can be reached is 260
122	EEG/EMG/Macro ECoG	The configuration of the system can't be 122 channels of ECoG Micro

5.4 Sorting

Parameter	Value
Segmentation	■ Method: Level Threshold ■ Segment length: 96 samples at 44 KHz ■ Crossing Point: 18th sample
Online Sorting	■ Method: 8 point template match ■ Templates per channel: 4 ■ Segment length: 2.15mSec (96 samples, 44 KHz, template points are 5 samples apart starting in sample 18)

5.5 Headbox Modules

5.5.1 EEG/ECOG Module

Parameter	Value
Number of Electrode Physiological Inputs	16 per module
Input Connector	Touch proof DIN connector
First Amplifier Input Impedance	100 GΩ || 2 pF
Hardware Filter	0.075 Hz - 3.5kHz

Parameter	Value
Gain	55
Dynamic Input range	±23mV
Input Type	Referential (EEG/ECoG)
A/D Converter Input Range	± 1.25 Volts
A/D Resolution	16 bits
Input Bit Resolution	0.7 uV
Sampling Rate at HS	44kHz Samples per Sec
Sampling Rate	■ EEG: 1.375 Ks/Sec (fixed) ■ ECOG Micro HF / ECOG Macro HF : 22Ks/Sec ■ ECOG Micro LF / ECOG Maceo LF: 1.375Ks/Sec *Notes:* *Systems with more than 2 EMG/EEG Modules, the sampling rate will be 22ks/sec* ■
Software Filters	■ EEG: HPF: 0.07,2-45 Hz LPF: 200-400 Hz ■ ECOG Micro HF: HPF 1-600 Hz LPF 9000 Hz ■ ECOG Micro LF: HPF 2-45 Hz LPF 200-400Hz ■ ECOG Macro HF: HPF 1-600 Hz LPF 9000 Hz ■ ECOG Macro LF: HPF 2-45 Hz LPF 200-400Hz
Noise	<20µV peak-to-peak @ 1 KΩ
Stimulation Sources	2 Options: ■ 1 source for basic stimulation ■ 16 sources, 1 per channel for advanced stimulation

Parameter	Value
Stimulation Pulse	Square Pulses: ■ Phase Width : 0.01 ms - 0.5 ms ■ Biphasic : 0 -> ±15 mA (up to ±50V) ■ Step size Resolution 0.001 mA ■ Frequency - up to 300 Hz *Notes:* *Amplitude tolerance within 10%.* *Pulses width above 0.3mSec, the pulse may get overshoot of 10% and after 50uSec the amplitude will be within the normal tolerance.*
Stimulation Artifact	The stimulation artifact is defined as the time from the end of the stimulation pulse until the specific channel base line becomes different from the base line before the stimulation by less than +-10%. EEG/ECOG Stimulation: Stimulation artifact on other EEG/ECOG Recoding channels is up to 25mSec.
Stimulation to Recording Switching Artifact	The switching artifact is defined as the time from the moment when a channel is switched from recording to stimulation or back until the specific channel base line becomes different from the base line before the switch by less than +-10% EEG/ECOG Stimulation: ■ Switching artifact on other EEG/ECOG Recoding channels is up to 3Sec. ■ Switching artifact on the same channel is up to 3Sec. *Note:* *With Offline processing capability the Signals can be extracted out on the Same channels 1-3mSec after switching back to recording, and 200-250uSec on other recording channels* *If HW filter is used, the switching artifact on the EEG/ECOG Stimulation channel is up to 13Sec.*
Impedance Check	30Hz

Operating Environment	Value
Maximum operating temperature:	41°F to 104°F, 5°C to 40°C
Humidity:	15 to 80 % RH non-condensing
Recommended operating conditions:	59°F to 95°F or 15°C to 35°C
Humidity	20 to 80%RH non-condensing

Storage temperature	-40°F to 140°F, -40°C to 60°C
Input power	±5 VDC
Class	I
Type	BF

5.5.2 Sensors Headbox

Parameter	Value
Number contacts	16 per module
Input Connector	ODU (type no. A10L0C- P04MFG0-3200)
First Amplifier Input Impedance	100 GΩ || 2 pF
Hardware Filter	DC-5 KHz
Gain	■ Accelerometer: 0.5 ■ Goniometer :50 ■ Pinchmeter: 50 ■ Dynamometer: 50
Dynamic Input range	■ Accelerometer: -0.42 mV → -2.5 mV ■ Goniometer : ±8.1 mV ■ Pinchmeter: 0→ 6.72 mV Dynamometer: 0→ 6.72 mV
Input Type	Differential
A/D Converter Input Range	± 1Volts
A/D Resolution	16 bits
Input Bit Resolution	■ Accelerometer:0.03 uV ■ Goniometer : 0.2 uV ■ Pinchmeter: 0.1 uV ■ Dynamometer: 0.1 uV
Sampling Rate at HS	44kHz Samples per Sec
Sampling Rate	2.75 KHz
Noise	<20µV peak-to-peak @ 1 KΩ

Operating Environment	Value
Maximum operating temperature:	41°F to 104°F, 5°C to 40°C
Humidity:	15 to 80 % RH non-condensing
Recommended operating conditions:	59°F to 95°F or 15°C to 35°C
Humidity	20 to 80%RH non-condensing
Storage temperature	-40°F to 140°F, -40°C to 60°C
Input power	±5 VDC
Class	I
Type	BF

5.6 Sensors

5.6.1 3D Accelerometer

Operating Environment	Value
Measurement range	±3.6g typical, ±3g minimal
corrective equation	V=1.5 V+0.3 A
Nonlinearity	±0.3% of all scale
Cross Axis Sensitivity	±1%
Sensitivity at X_{out},Y_{out},Z_{out}	300 mV/g ±10%
0 g Voltage at X_{out},Y_{out},Z_{out}	1.5V±0.3 V
0 g temperature drift	±1 mg/℃
Supply current	370 µA
Frequency bandwidth X_{out},Y_{out}	1600 Hz
Frequency bandwidth Z_{out}	550 Hz
Operating temperature range	-25-70 ℃
Size Sensor	13 mm x 10 mm x 5 mm
Weight Sensor	2 gram
Total weight	15 gram
Sensor outer material	POM/Epoxy
Cable outer material	PVC
Color	black

5.6.2 Goniometer

Operating Environment	Value
Measurement range	± 180°
corrective equation	V=0.0045*Angle [mV]
Current	4mA/supply
Sensitivity	10µV/degree angle/supply volt
Accuracy	±2° measured over a range of ±90°
Repeatability	1° measured over a range of 90°
Operating temperature range	+10°C to +40°C
Temperature zero drift	0.15 degrees angle/°C

5.6.3 Precision Dynamometer

Operating Environment	Value
Measurement range	0 - 90 Kg
corrective equation	$V = \frac{25}{336} * Kg\ [mV]$
Rated load (RL)	200 lbs or 90.72 Kg
Accuracy	Better than ±1%RL
Input Impedance	200Ω
Output Impedance	200Ω
Supply voltage	■ Maximum 10 VDC ■ Minimum 1 VDC
Sensitivity	1.5 mV/V differential output
Output with no load	± 10%RL
Current	3.5 mA/V
Mass	550 gram

5.6.4 Precision Pinchmeter

Operating Environment	Value
Measurement range	0 - 22 Kg

Operating Environment	Value
corrective equation	$V = \frac{25}{84} * Kg\ [mV]$
Rated load (RL)	50 lbs or 22.68 KG
Accuracy	Better than ±0.5%RL
Input Impedance	900 Ω
Output Impedance	700 Ω
Supply voltage	■ Maximum 10 VDC ■ Minimum 1 VDC
Sensitivity	1.5 mV/V differential output
Output with no load	± 10%RL
Current	1 mA/V
Mass	65 gram
Overall diameter	48 mm
Diameter of button	18 mm
Overall height	7 mm
Material	Stainless steel