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Neuro Omega™

Physiological Navigation System for Neurosurgery and Neurophysiological Medical Applications

User Manual
Revision 1.4.2

CE 0297

March 2016

PROPRIETARY NOTICE

For additional information on the device, including questions on infection control procedures, please contact:

	EC REP
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CHAPTER 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 Medical Manual is to provide information for the use of the Neuro Omega system in medical treatment.

> **Warning:**
> Do not use this manual for conducting research procedures.

1.2. REGULATORY

1.2.1. Adverse Effects

The possible adverse effects relating to Stereotactic Neurosurgery are:

- The possibility of intracranial hemorrhage associated with the introduction of probes into the brain.
- Visual field impairment with optic tract injuries.

- Contra lateral motor deficit with corticospinal injury.

1.2.2. FDA System Classification

- **Product Code**: GZL
- **Subsequent Product Code**: GWF, IKN, GWQ
- **CFR Section**: 21 CFR 882.1330
- **Regulation Name**: Depth electrode
- **Subsequent Regulation Names**:
  - Electroencephalograph
  - Stimulator
  - Electrical
  - Evoked response
  - Electromyography
  - Diagnostic
- **Trade Name**: Neuro Omega System
- **Common Name**: Intraoperative neurophysiological recording and stimulating device
- **Classification**: Class II

1.3. INTENDED USES

The Neuro Omega System is intended for the following:

- Assisting neurosurgeons in the operating room during functional neurosurgery.
- Recording from and stimulating brain motor and sensory neurons to aid in the placement of depth electrodes.
- Monitoring, recording, and displaying the bioelectric signals produced by muscles.
- Stimulating peripheral nerves.
- Monitoring, recording, and displaying the electrical activity produced by nerves (EMG) for aiding the clinician in the diagnosis and prognosis of neuromuscular disease.
- Measuring and recording the electrical activity of the patient's brain obtained by placing two or more electrodes on the head (EEG).

1.4. CONDITIONS OF USE

The device may be used by medical personnel within a hospital, laboratory, clinic, or nursing home setting, or outside of a medical facility under direct supervision of a medical professional. The device may also be placed in the intensive care unit or operating room for continuous recording.

The following are the Neuro Omega system use conditions:

- **Environment**:
  - Conditions of visibility:
    - Ambient luminance range: Normal
    - Viewing distance: N/A
    - Viewing angle: N/A
  - **Physical**:
    - Temperature range: 0°C to +40°C
    - Relative humidity range: 10% - 80%, non-condensing
    - Ambient pressure range: 500 hPa to 1060 hPa
    - Background sound pressure level: Normal
- **Frequency of Use**: As per specific case
- **Mobility**: Mobile

1.5. 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 ***Preparing the Neuro Omega System*** 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.

1.6. 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 0.5 cycles 40% *U*T for 5 cycles 70% *U*T for 25 cycles	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.

	<5% *U*T for 5 s	<5% *U*T for 5 s	
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 Radiated RF IEC 61000-4-3	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). 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.

CHAPTER 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***: Of two types. One allows for recording EMG signals, and one allows for recording EEG signals.
- ***Remote Control***: Allows for easy system operation, including manipulating the electrode and providing stimulation through the Drive Headstage.

2.1. MAIN UNIT AND TROLLEY

The Main Unit is the processing core of the system, and is attached to the trolley. The Main Unit is comprised of the following three panels:

- The front panel (***Figure 1***) houses LEDs to display Neuro Omega's power state. When functioning properly, the green LED on the top is lit and there are at least 3 cyclically flashing lights in the center of the panel.

Figure 1: Front Panel

- On the right side is the Modules panel (***Figure 2***), which houses the following connections:

Connection	Location	Reference
Drive Headstage / MER Only Headstage	green	See section 2.2 for information about the Drive Headstage and the Drive Headstage module. See section 2.3 for information about the MER Only Headstage.
Headbox modules according to configuration	cascading up, multicolored	See section 2.4for information about the Headbox modules.
Remote	Small, yellow	See section 2.5 for information about the remote.

Figure 2: Modules Panel

- On the left is the Analog/Digital Input/Output panel (ADIO panel) (***Figure 3***), which houses the external connections, through BNC and D-Type, as follows:
  - ANALOG-IN: Eight analog input ports, sampled in 12-bit ADC, and acquired in continuous mode
  - ANALOG-OUT: Eight analog output ports, sampled in 16-bit DAC, for rerouting any signal to an external device
  - DIG-IN: Four digital input ports, sampled as single bits or 16-bit ports
  - DIG-IN: Two digital input ports, sampled as 16-bit ports
  - DIG-OUT: Eight digital output ports for future use

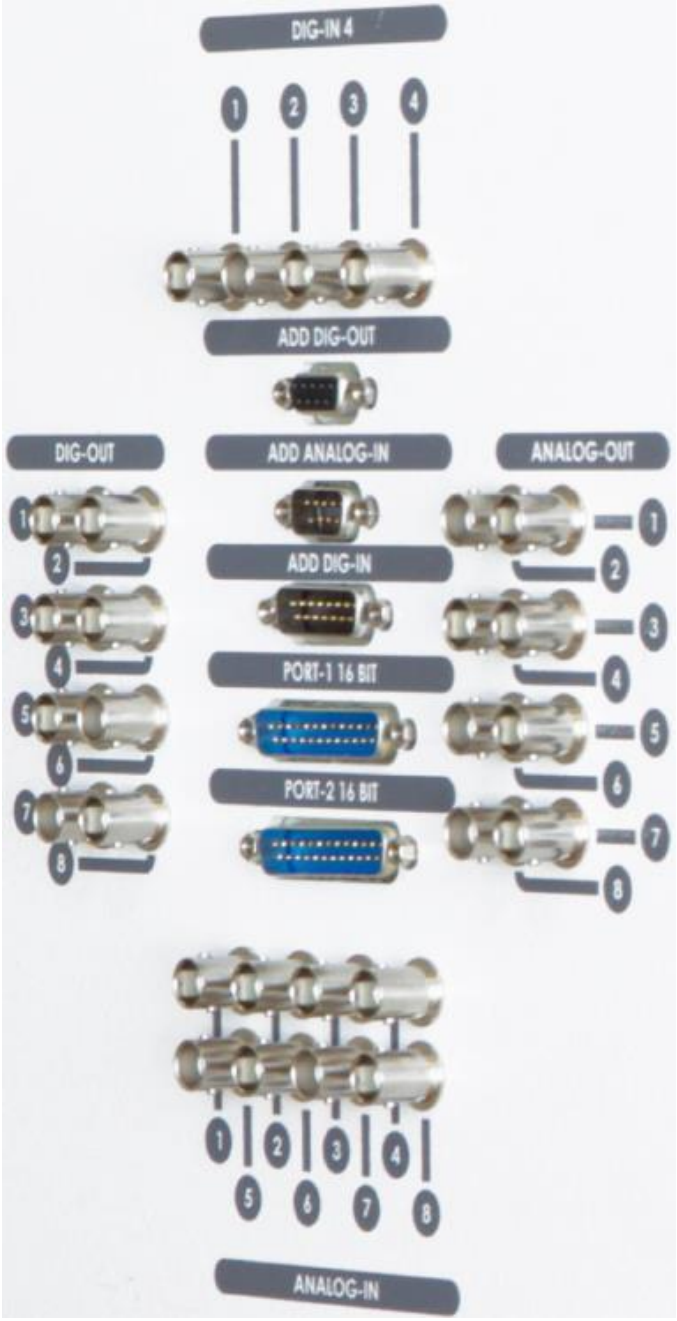


Figure 3: ADIO Panel

The bottom of the Main Unit (***Figure 4***, as seen from under the main unit) houses the following connections:

- Three Ethernet connections for communication between the Main Unit and the computer
- Connection to the computer for the remote control via USB
- Two audio output connections
- Power switch for main unit

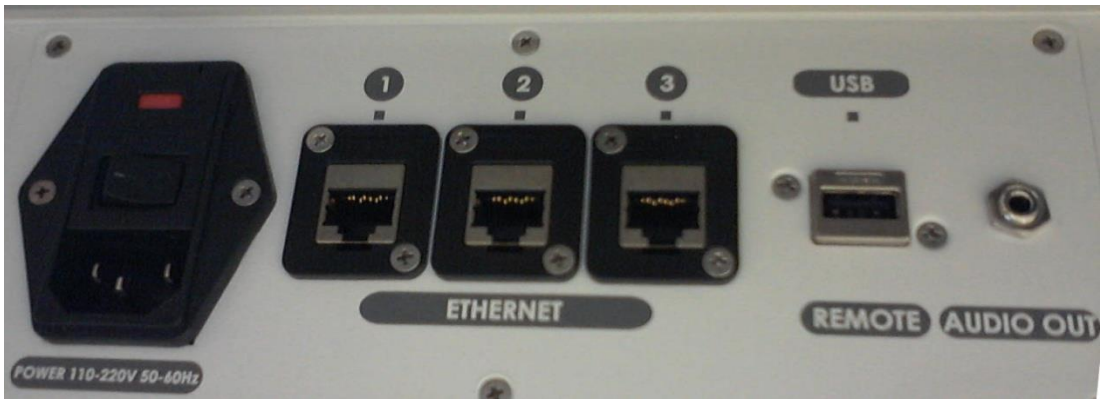


Figure 4: Bottom of Main Unit

The trolley (***Figure 5***, ***Figure 6***, and ***Figure 7***) is utilized as follows:

- On the left, the computer, a panel PC connecting to the Main Unit via Ethernet
- System On/Off switch
- On the right, a second monitor
- Two speakers
- The Main Unit
- Above the Main Unit, resting on the outer surface, the keyboard and mouse
- Below the Main Unit, a standalone storage box
- Storage arms for cable wrapping
- Rear:
  - Handle
  - Holders for Headbox modules
  - Holder for the remote control

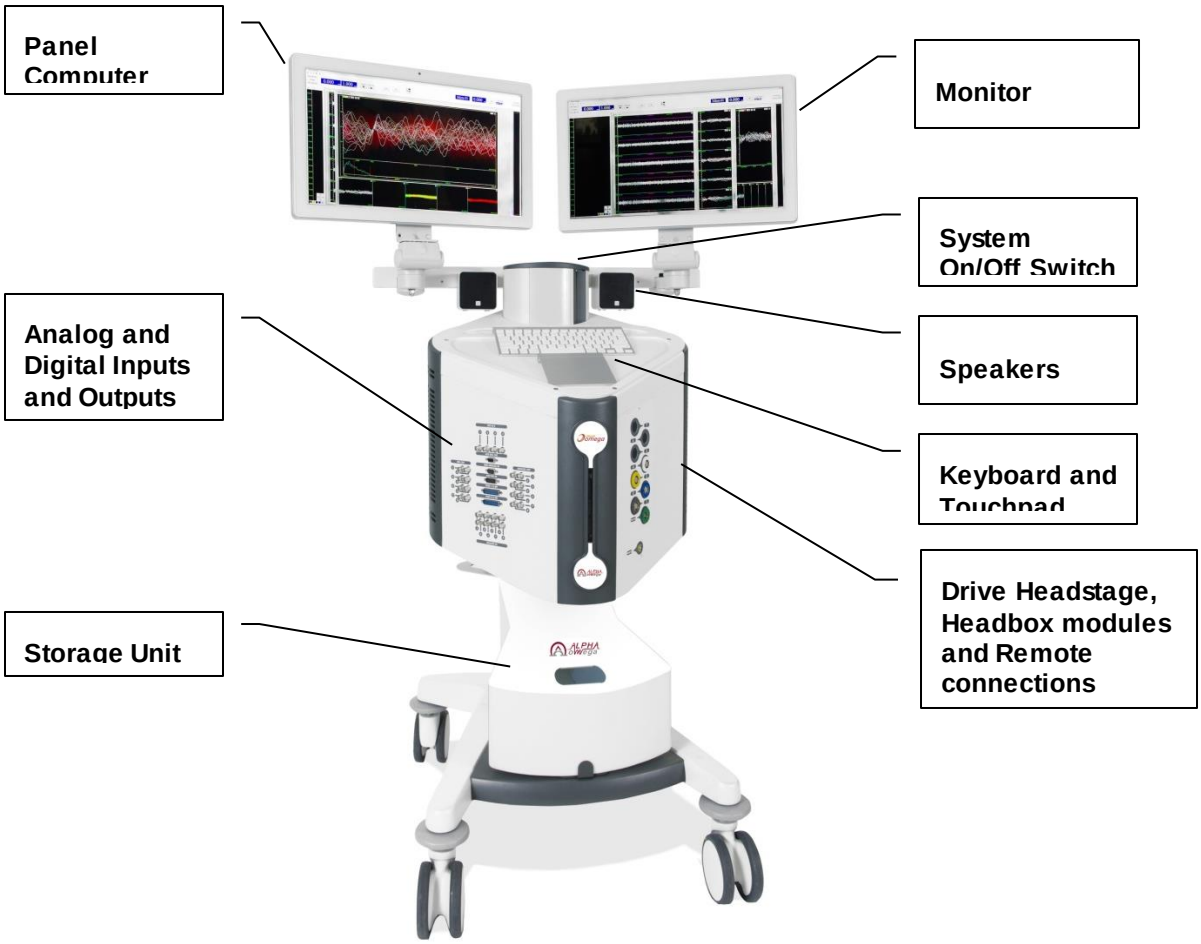


Figure 5: Main Unit and Trolley Front View

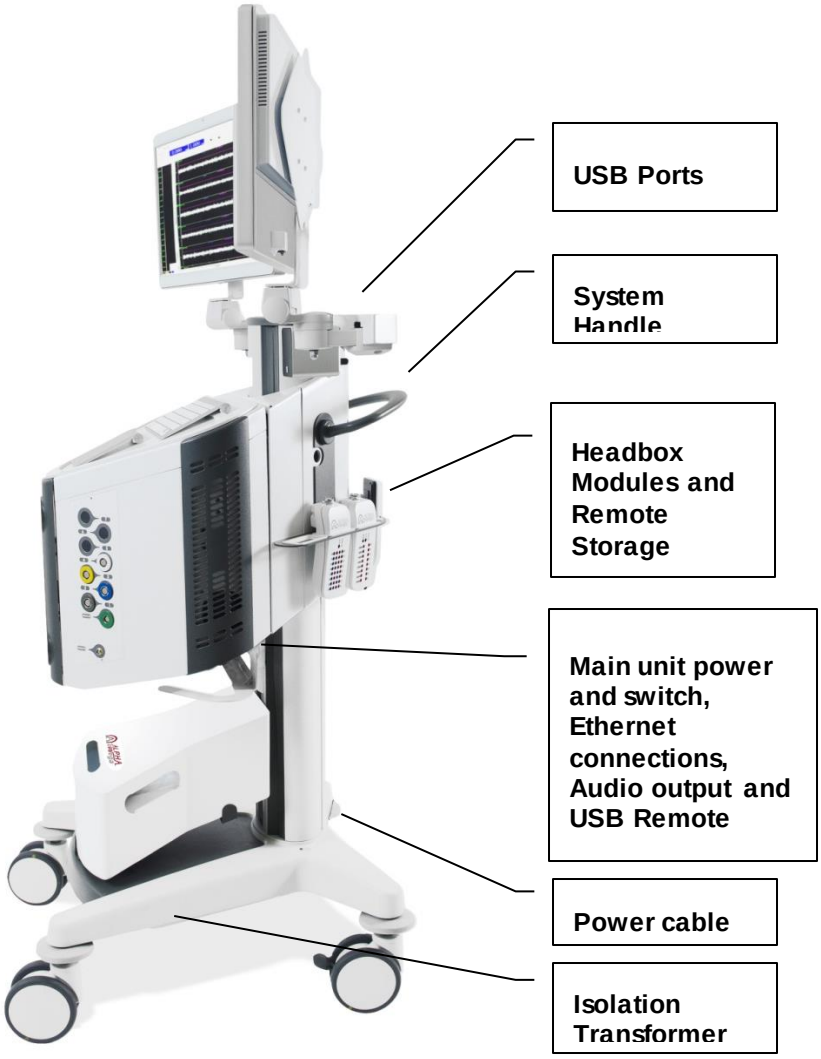


Figure 6: Main Unit and Trolley Side View

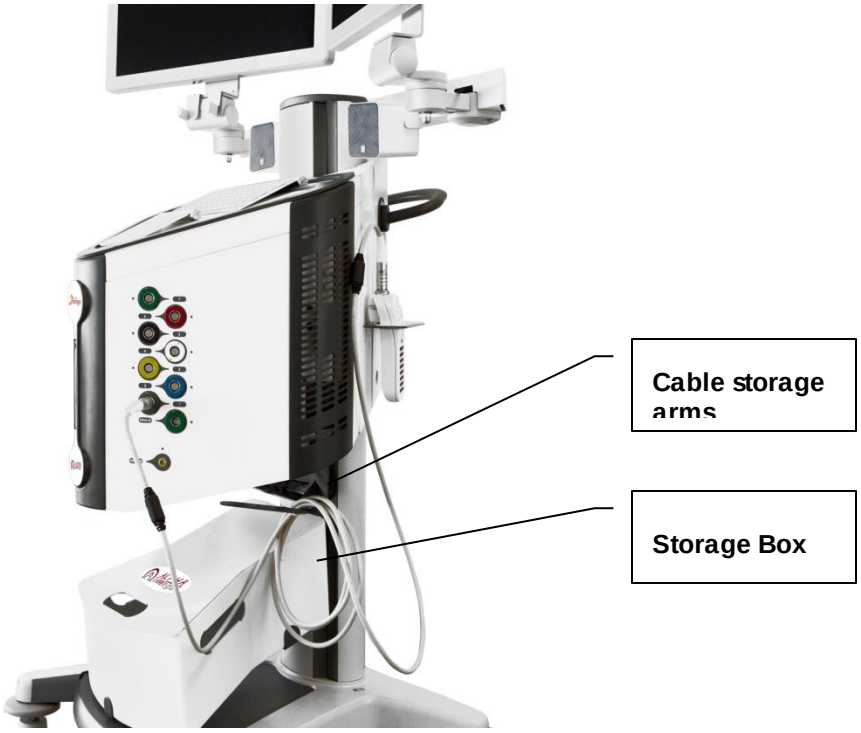


Figure 7: Side View of Cable Storage

2.2. DRIVE HEADSTAGE MODULE

> **Note:** This section does not apply for the MER Only Headstage.

The Drive Headstage module is mounted on either a Stereotactic frame or frameless systems, and provides the framework for recording and stimulating from up to five electrodes. The Neuro Omega records the data from each of up to five micro contacts and five macro contacts as separate channels.

The Drive Headstage module is comprised of the following components:

- *Drive Headstage*
- *Electrode Holder and Bengun*
- *Frame Adaptor*
- *Electrodes*
- *Electrode Input Cable*
- *Cannulas*

The Drive Headstage and the components comprising the Drive Headstage module appear in *Figure 8*.

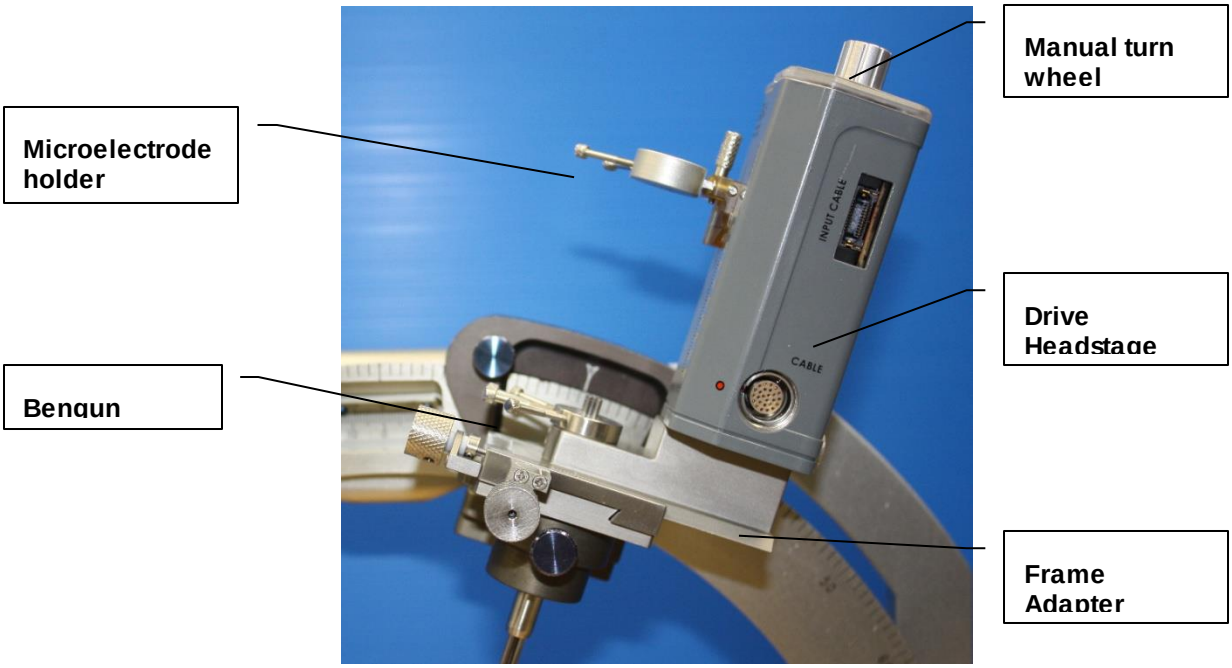


Figure 8: Drive Headstage Module

2.2.1. Drive Headstage

The Drive Headstage (***Figure 9***) contains the mechanism that manipulates the electrodes, digitizes the acquired signals and provides stimulation.

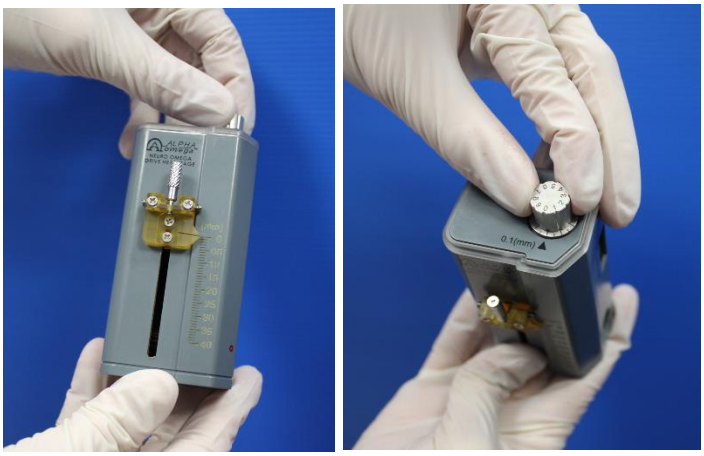


Figure 9: Drive Headstage

This mechanism is made up of the following components:

- The drive motor, which uses its own scale to measure depth
- An external scale, calibrated from 0-40 mm with 1 mm resolution, which does the following:
  - Helps you monitor Headstage movement accuracy

- Enables you to compare the depth data as displayed by the software with the depth from the drive motor scale

- A turn wheel and scale, with 0.1 mm resolution, which is used to advance the Headstage manually.
- A digitizing amplifier, which does the following:
  - Amplifies, filters, and converts the signal collected from the microelectrode from analog to digital
  - Enables the measurement of the electrode's impedance
- Data acquisition and processing boards
- Electrode positioning control board, for up to five electrodes in tandem

2.2.2. Electrode Holder and Bengun

The Bengun (***Figure 10***) attaches to the frame adaptor, and holds the cannula stationary so that the electrode can advance up and down. You can place up to five cannulas in the Bengun at a time. Each outside hole is 2 mm away from the center hole.

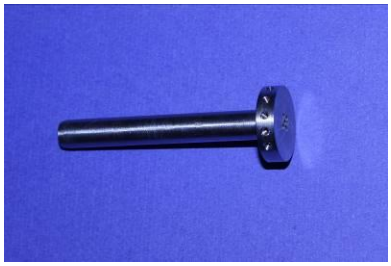


Figure 10: Bengun

The electrode holder (***Figure 11***) attaches to the scale of the Drive Headstage, and holds the electrode in place within the respective cannula. The electrode is manipulated up and down by the drive motor. You can place up to five electrodes in the holder at a time, all moving in tandem by the same motor.

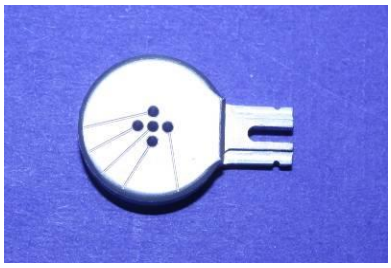


Figure 11: Electrode Holder

The Bengun can be attached according to two layouts, depending on the orientation of the five holes relative to the midline. Layout 1 is referred to as **X**, and layout 2 is referred as **+** (***Figure 12***). The electrode holder comes in both these layouts separately. When you

attach the Bengun and the electrode holder, you must verify that both are according to the same layout.

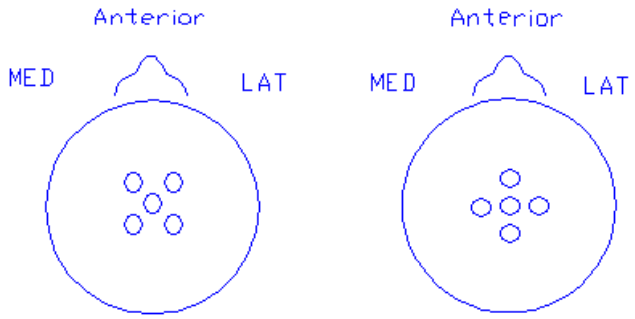


Figure 12: Layout 1 (X) on Left, Layout 2 (+) on Right

2.2.3. Frame Adaptor

The frame adaptor fits onto the Stereotactic frame and serves as the base on which to attach the Drive Headstage.

The Drive Headstage uses various frame adaptors to attach to any of several Stereotactic frames, such as CRW's Radionics and Leksell's Elekta. It can also be mounted on other, frameless systems such as NexFrame by Medtronic and Starfix by FHC, using adaptors provided by Alpha Omega. Other configurations can be easily customized upon request.

2.2.4. Electrodes

Neuro Omega uses electrodes with two possible micro to macro tip distances, as seen in ***Table 4***.

Table 4: Tip Distances

Electrode Model No.	Electrode Type	Micro to Macro Tip Distance (mm)
STR-007080-10	Shielded	3
STR-000079-10	Non-shielded	3
STR-001080-10	Non-shielded	10
STR-00081-10	Shielded	27

Micro to macro tip distance is important for configuring settings, section ***4.9***.

Electrodes can be either shielded or unshielded, depending on user preference. For more electrode types and preferences, see the Neuroprobe user manual.

2.2.5. Electrode Input Cable

The electrode input cable is the interface between the Drive Headstage and the electrodes. This cable allows for recording and stimulation from five electrodes simultaneously through the five micro tips and five macro tips. This cable is one time use only.

Red color connectors are for the micro contact and yellow color for the macro contact. Both the red and yellow connectors are labeled one through five for identification and connection. In addition, this cable has a ground clip for the recording and stimulation ground.

2.2.6. Cannulas

Neuro Omega uses a number of cannula models of differing lengths. The electrode within the cannula is inserted based on length, thereby affecting its starting depth and distance from target, as seen in ***Table 5***. Measurements are in millimeters.

Table 5: Cannula Models

Frame	Cannula Catalogue No.	NeuroProbe Compatibility	Cannula Length*	Starting Depth on Drive	Distance to Target	Target Depth on Drive
CRW/Leksell	STR-000021-10	Shielded	167	0	25	25
CRW/Leksell	STR-007721-10	Shielded	177	10	15	25
CRW/Leksell	STR-008221-10	Shielded	182	15	10	25
CRW/Leksell	STR-000076-10	Non-shielded	167	0	25	25
Nexframe/Starfix	STR-020121-10	Shielded	201.5	5	15	20

* Including 5 mm stopper above Bengun

Starting depth is important when setting the starting depth, described in section ***3.2.1***.

For more information, see the Cannula user manual.

Distance to target is important for configuring settings, described in section ***4.9***. The distance to the target is the distance from the tip of the cannula (where the electrode starts) to the center of the frame (target).

Calculations for determining the distance from the target appear in the following sections:

- ***Using CRW and MicroMar Frames***
- Using ***Leksell and Libenger Frames***
- ***Using Nexframe Frames***
- ***Using Starfix Frames***

2.2.6.1. Using CRW and MicroMar Frames

Figure 13 shows a distance of 25 mm from the tip of the cannula to the target. The arc of the CRW is 160 mm to the target.

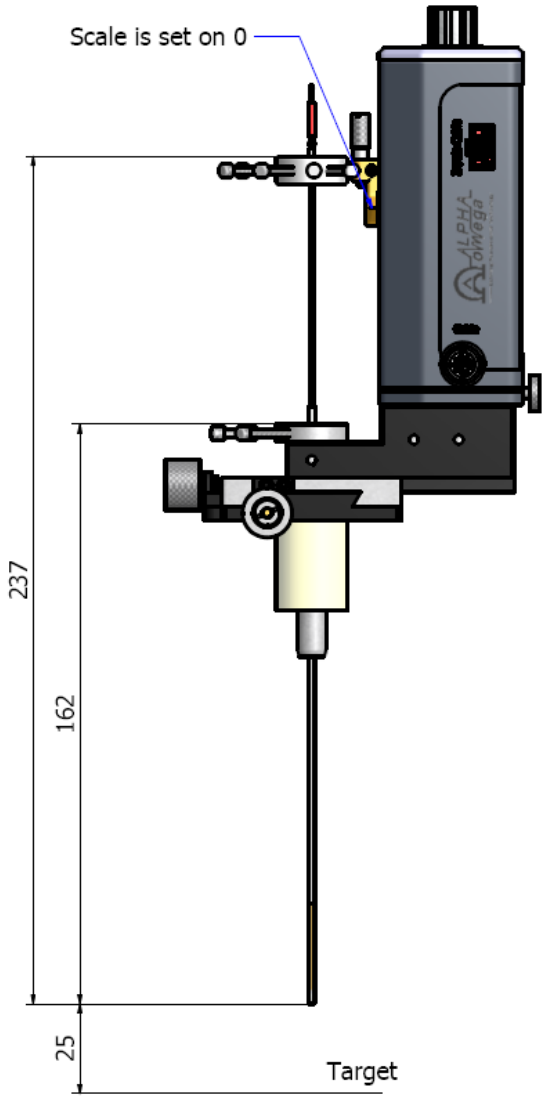


Figure 13: Using CRW and MicroMar Frames

2.2.6.2. Using Leksell and Libenger Frames

Figure 14 shows a distance of 25 mm from the tip of the cannula to the target. The arc distance to target is 30mm larger than the CRW/MicroMar frames and therefore the instrument stop holder should be used to offset the drive Headstage assembly.

Note: Make sure to set the instrument stop holder (bracket) to +30mm

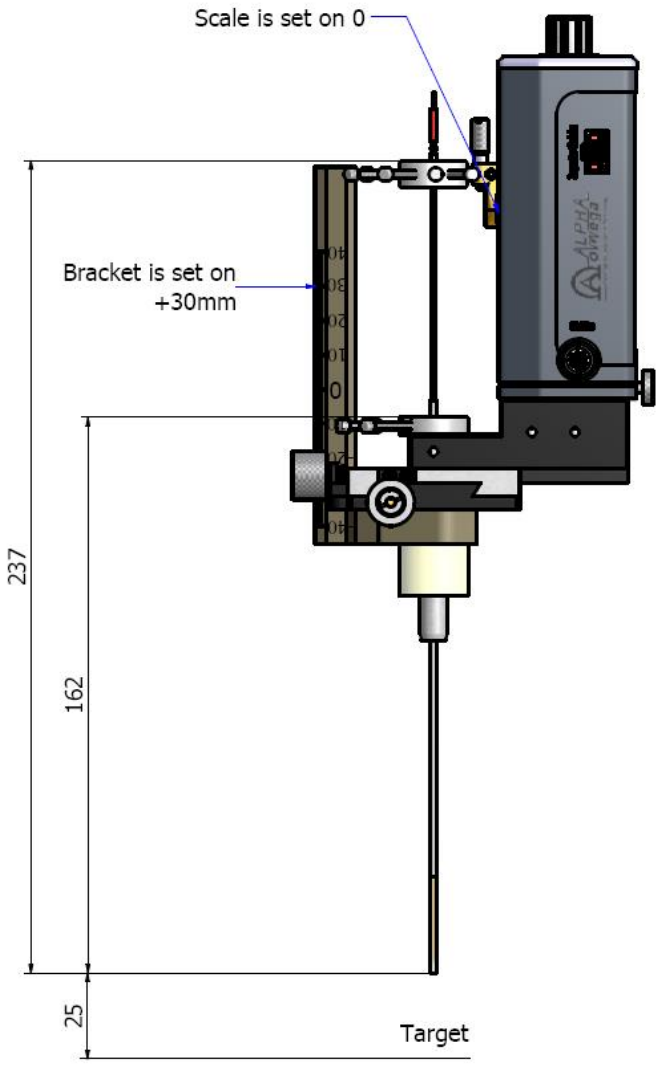


Figure 14: Using Leksell and Libenger Frames

2.2.6.3. Using Nexframe Frames

When using the Nexframe frame adaptor (***Figure 15***), set the Z-stage (***Figure 16***, Detail A).

> **Note:** When using the Nexprobe Image-guided Probe with Medtronic IGS system, add 75 mm.
>
> **Note:** The target is at 20mm depth on the drive.

Set the drive Headstage to a starting depth of 5mm (***Figure 16***, Detail B), distance to target is 15mm (target at 20mm depth).

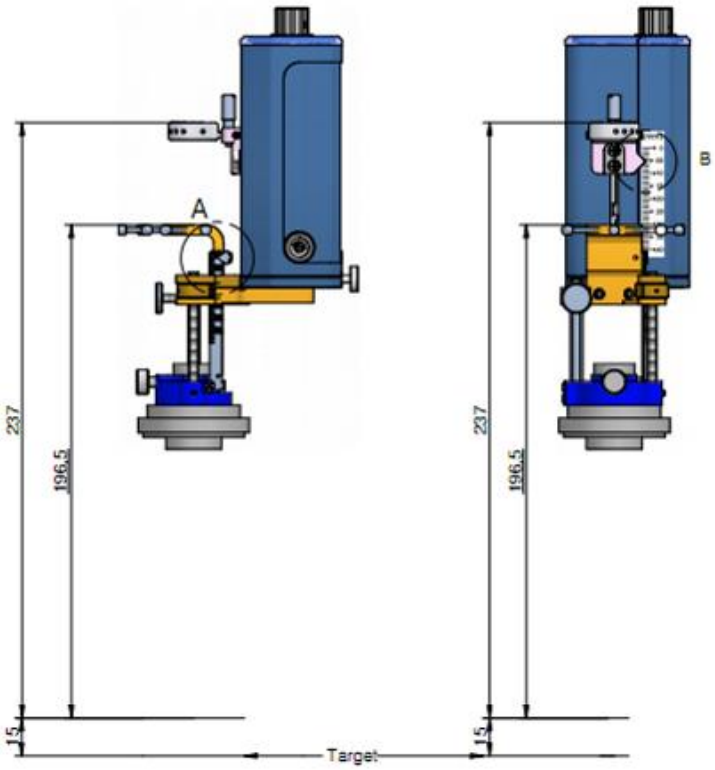


Figure 15: Using Nexframe Frames

Figure 16: Z Stage (Detail A) and Distance to Target (Detail B)

2.2.6.4. Using Starfix Frames

When using the Starfix frame adaptor (***Figure 17)***, set the T-scale (***Figure 18***, Detail A).

> **Note:** Verify the T-scale value on the Starfix frame.
>
> **Note:** The target is at 20mm depth on the drive.

Set the drive Headstage to a starting depth of 5mm (***Figure 18***, Detail B), distance to target is 15mm (target at 20mm depth).

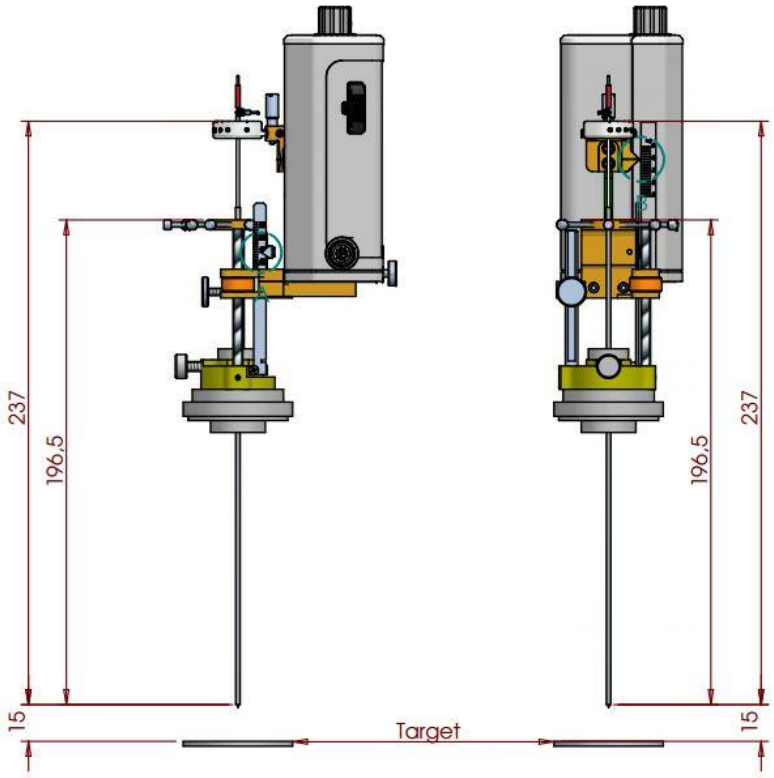


Figure 17: Using Starfix Frames

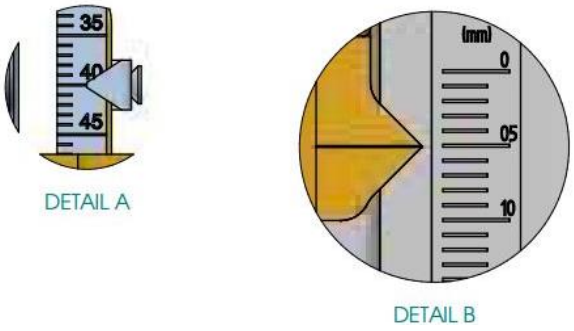


Figure 18: T-Scale (Detail A) and Distance to Target (Detail B)

2.3. MER ONLY HEADSTAGE MODULE

The MER Only Headstage module provides the framework for recording and stimulating from up to five electrodes. The Neuro Omega records the data from each of up to five micro contacts and five macro contacts as separate channels.

The MER Only Headstage module is comprised of the following components:

- ***MER Only Headstage***
- ***MER Only Electrode Input Cable***

2.3.1. MER Only Headstage

The MER Only Headstage (***Figure 19***) contains the mechanism that manipulates the electrodes, digitizes the acquired signals and provides stimulation.

Figure 19: MER Only Headstage

This mechanism is made up of the following components:

- A digitizing amplifier, which does the following:
  - Amplifies, filters, and converts the signal collected from the microelectrode from analog to digital
  - Enables the measurement of the electrode's impedance
- Data acquisition and processing boards

2.3.2. MER Only Electrode Input Cable

The electrode input cable is the interface between the MER Only Headstage and the electrodes. This cable allows for recording and stimulation from five electrodes simultaneously through the five micro tips and five macro tips. This cable is one time use only.

Black color connectors are for the micro contact and red color for the macro contact. Both the black and red connectors are labeled one through five for identification and connection. In addition, this cable has a ground clip for the recording and stimulation ground.

2.4. 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.

There are two types of Headbox modules:

- The EMG Headbox module (***Figure 20***), for differential muscle electrophysiological recording, contains the following:
  - 16 channels, with one **+** (plus) input and one **-** (minus) input touch-proof connectors for each channel
  - One ground touch-proof connector (black)
  - One global stimulation return touch-proof connector (white)

Figure 20: EMG Headbox Module

The EEG Headbox module (***Figure 21***) for referential brain recording 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)

Figure 21: EEG Headbox Module

Each Headbox module is supplied with a Velcro strap for easy attachment to the patient. 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

2.5. REMOTE CONTROL

The remote control is hand-held and comes with an LCD screen (*Figure 22*). It is connected to the Main Unit with a flexible cable and allows easy system operation.

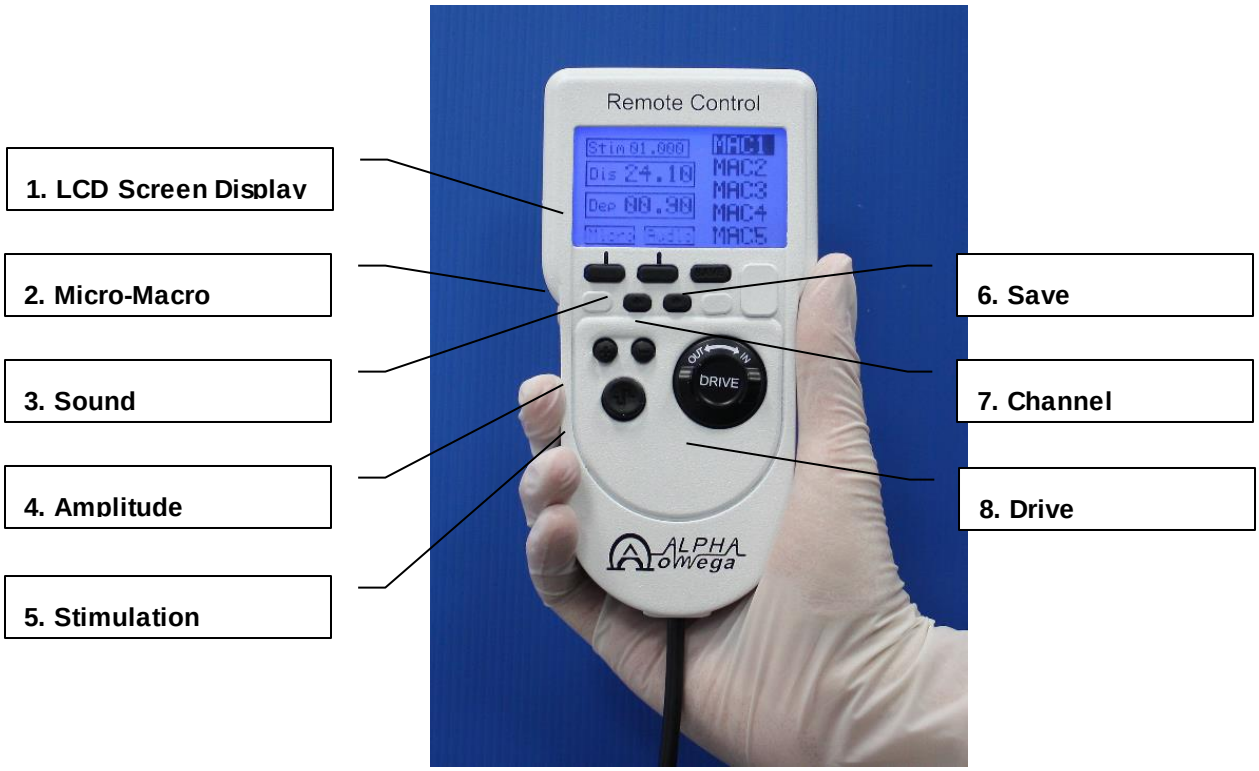


Figure 22: Remote Control

1. LCD Screen Display
2. **Micro-Macro**: Switches between the micro and macro tip, for the purposes of stimulation and sound
3. **Sound**: Activates or deactivates the sound of the selected channel
4. **Amplitude** (**+/-**): Two buttons to increase or decrease the stimulation current amplitude
5. **Stimulation**: Activates the stimulus current, applying the selected current stimulation to the selected channel
6. **Save**: Starts saving the current data set to the log file
7. **Channel**: Two buttons to toggle between different channels
8. **Drive**: Thumb wheel button to advance the electrode up and down (in/out), with speed control

CHAPTER 3. PREPARING THE NEURO OMEGA SYSTEM

This workflow describes how to prepare the Neuro Omega system for surgery, and is the prerequisite for microelectrode recording, for identifying the target

To prepare the Neuro Omega system:

1. Clean and sterilize the Neuro Omega system, as described in section ***3.1***.
2. Prepare the cannula entrance area.
3. Set the electrode starting depth, as described in section ***3.2***.
4. Assemble the Neuro Omega system, as described in section ***3.3***.
5. Assemble the Drive Headstage assembly, as described in section ***3.4***.
6. Connect all required external systems to the Main Unit, as described in section ***3.5***.

3.1. CLEANING AND STERILIZING THE NEURO OMEGA COMPONENTS

This procedure describes how to clean and sterilize the Neuro Omega components before use in surgery.

> **Caution:**
>
> - Cleaning, sterilization, and autoclaving must be performed before assembling the system for operation.
> - Do not immerse, wet, or use the washing machine for the Drive Headstage/MER Only or the Headstage Cable.
> - Only qualified personnel trained by Alpha Omega Ltd. may conduct the sterilization.
> - Items determined for Sterrad sterilization may never be autoclaved. Items determined for autoclave sterilization may alternatively be sterilized using Sterrad.

To clean and sterilize the Neuro Omega components:

1. Clean the Drive Headstage/MER Only Headstage and the Headstage cable (Table 6) by following the hospital cleaning procedure for electronic devices. Assemble the Drive Headstage assembly, as described in section ***3.4***.

Warnings:

When cleaning the Electrical Components (Drive Headstage/MER Only Headstage and Headstage Cable):

- Do not wet
- Do not immerse in bath
- Do not use washing machine
- Agents with an active ingredient of chlorine or chloride should not be used because this may lead to corrosion of stainless steel parts
- Pay special attention to lumens, crevices and hard to reach places

Recommended cleaning protocol:

1. Gently clean the components with a disinfecting agent, such as 70% alcohol solution, and a soft lint free cloth. Pay special attention to lumens, crevices and hard to reach places.
2. Dry the components using a clean soft lint free cloth.
3. Visually inspect the items to ensure there is no visible soil.

2. Clean the Frame adaptor (X/Y, Non X/Y Nexframe, Starfix), Bengun, DBS holder, DBS ruler and the electrode holder (***Table 7***) by following hospital cleaning procedures for mechanical devices (not electronic).

Warnings:[1]

When cleaning the mechanical components:

- Agents with an active ingredient of chlorine or chloride should not be used because this may lead to corrosion of stainless steel parts
- Pay special attention to lumens, crevices and hard to reach places

Recommended cleaning protocol:

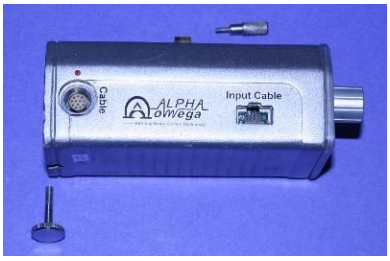
1. Using warm tap water, prepare the cleaning detergent according to manufacturer's recommendations.
2. Immerse the accessories in the detergent solution for five minutes. Actuate the devices in the solution.
3. Rinse the accessories with running reverse osmosis deionized water to remove any residuals of detergent.
4. Dry the accessories using a clean, soft, non-shedding cloth

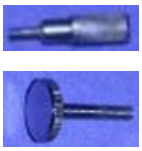
1

5. Visually inspect the items to ensure there is no visible soil.

3. Referring to the Sterilization Checklist, ***Table 9***, in the STERRAD NX, sterilize the Headstage, its cable, and its screws, as follows:
   a. Remove all screws from the Headstage.
   b. Collect the items described in ***Table 6***, and then, referring to Figure 23, place them in the STERRAD tray.
   c. Wrap the tray in 1-ply polypropylene wrap using sequential wrapping techniques.
4. Sterilize using the full standard STERRAD NX cycle.

Table 6: Sterilizable Parts, Methods and Special Notes

Reference in Figure 23	Item	Photo	Sterilization Method	Special Notes
1	Drive Headstage		Sterrad **Never autoclave**	Before sterilization, unscrew holding knob on the back and on scale 
	MER Only Headstage		Sterrad **Never autoclave**	
2	Headstage cable		Sterrad **Never autoclave**	

3	Headstage screws		Sterrad	

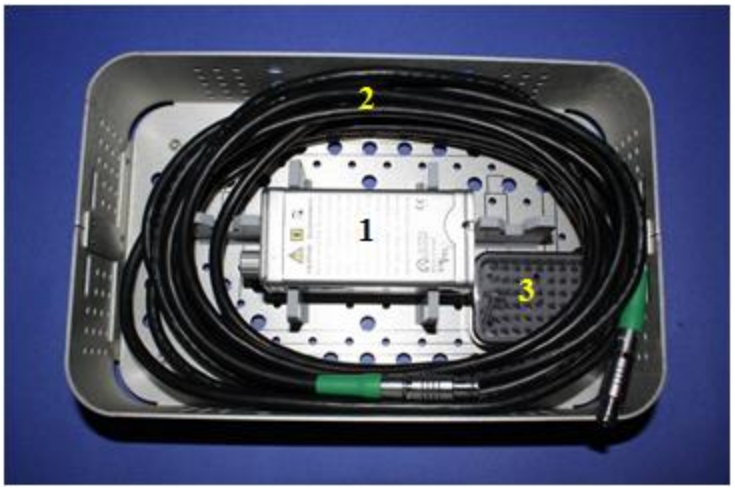
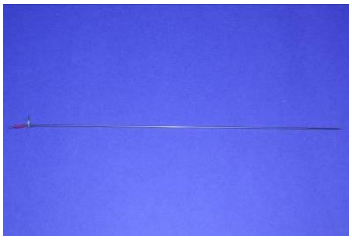
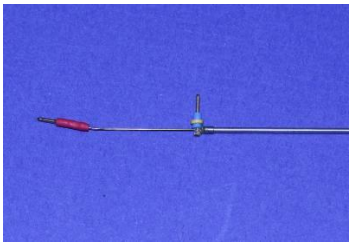
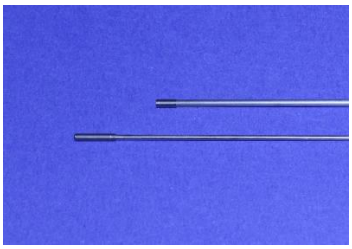


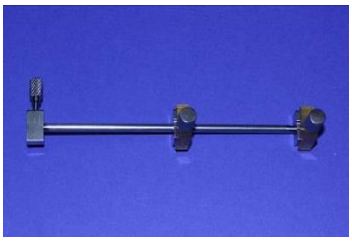
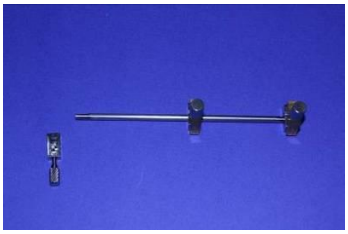
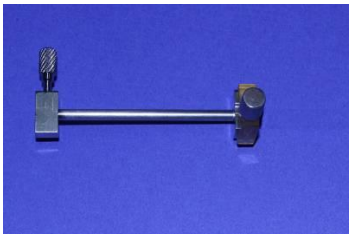
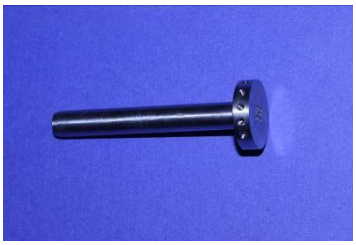
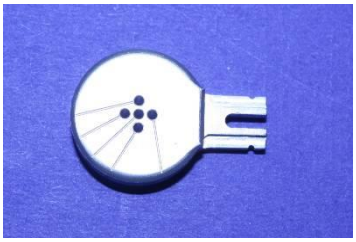
Figure 23: STERRAD Sterilization Tray

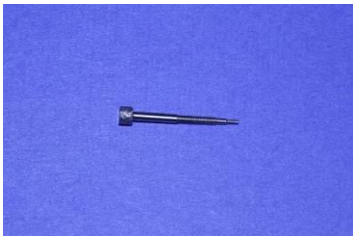
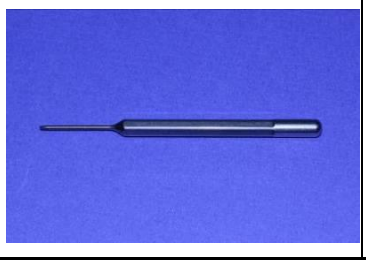
5. With the autoclave, sterilize those components marked for sterilization in the Sterilization Checklist, ***Table 9***:
   a. Remove all screws from the microelectrode holder and the Bengun.
6. Collect the items described in ***Table 7***, and then do the following:
   - Referring to Figure 24, place them in the autoclave for sterilization in accordance with in-house standard operating procedures for sterilizing surgical equipment.
   - Refer to ***Table 8*** for autoclave parameters.
7. Autoclave the items

Table 7: Sterilizable Parts, Methods and Special Notes

Reference in Figure 24	Item	Photo	Sterilization Method	Special Notes
1	X/Y frame adaptor		Autoclave	Do not take apart for sterilization.

Reference in Figure 24	Item	Photo	Sterilization Method	Special Notes
	Nexframe / Starfix frame adaptor		Autoclave	Do not take apart for sterilization
2	Electrodes **(Single Use Only)**		Autoclave	■ Available as a sterile accessory, as described in section 3.1.2. ■ Tips must always be retracted while handling. Expose tips only after securing in tray. 
3, 4	Cannulas and Stylets **(Single Use Only)**		Autoclave	■ Available as a sterile accessory, as described in section *3.1.2*. ■ For each channel, the user must sterilize one cannula and stylet. Remove stylet from guide tube.
5	Non-X/Y frame adapter		Autoclave	

Reference in Figure 24	Item	Photo	Sterilization Method	Special Notes
6	DBS Ruler		Autoclave	
7	DBS holder		Autoclave	Remove lead holder base 
	Nexframe / Starfix DBS holder		Autoclave	Remove lead holder base 
8	Bengun		Autoclave	Before sterilization, remove all screws.
9	Electrode Holder		Autoclave	Before sterilization, remove all screws.

Reference in Figure 24	Item	Photo	Sterilization Method	Special Notes
10	Microelectrode holder and Bengun screws		Autoclave	
11	Screwdriver		Autoclave	

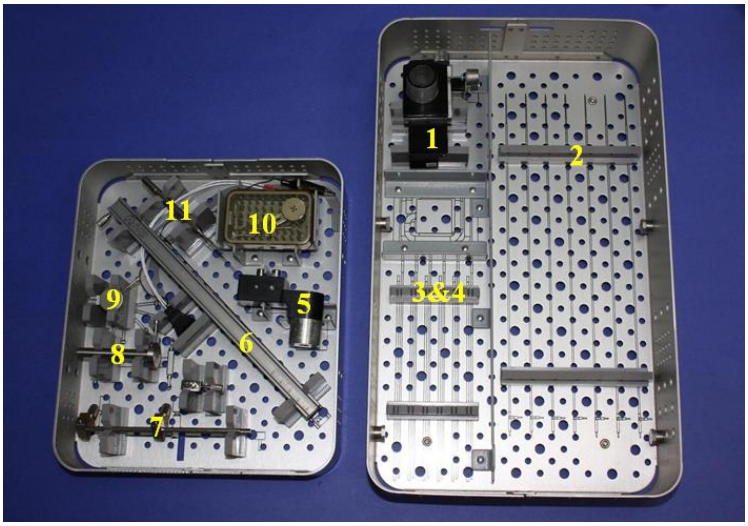


Figure 24: Autoclave Tray

Table 8: Autoclave Parameters

Sterilizer Type	Prevacuum
Preconditioning Pulses	3
Minimum Temperature	132°C
Full Cycle Time	4 minutes
Minimum Dry Time	60 minutes
Test Article Configuration	Wrapped in two layers of 1-ply polypropylene wrap

3.1.1. Sterilization Checklist

Table 9: Sterilization Checklist

√	Quantity	Description	Sterilization Method
	1	Drive Headstage or MER Only Headstage	STERRAD
	1	Headstage cable	STERRAD
	1	Headstage screws	STERRAD
	1	Microelectrode holder	Autoclave
	1	Bengun	Autoclave
	At least 2	Microelectrode holder screws and Bengun screws	Autoclave
	1	Screwdriver	Autoclave
	1	Frame adaptor	Autoclave
	1	DBS holder	Autoclave
	1	DBS ruler	Autoclave
	1	Headstage cable	Autoclave
	At least 2	Electrode cables	Sterile
	At least 2	Microelectrodes	Sterile
	1 for each channel	Cannulas and Stylets	Sterile

3.1.2. Sterile Items

In addition to the non-sterile single use items, Alpha Omega offers sterile alternatives. With these accessories, there is no need for additional sterilization. The accessories can be transferred into the sterile field through the sterilization pouch.

> **Warning:** Do not use the contents if there is any evidence of damage to the package or package seal that could compromise sterility

Contents of unopened, undamaged package are sterile and non-pyrogenic.

There are three sterile accessories options:

- Sterile Electrodes

- Sterile Cannulas and Stylets

- Sterile Electrode Cable

3.2. SETTING THE ELECTRODE STARTING POINT

Note: This section does not apply for the MER Only Headstage

The electrode starting depth is set based on the calculated distance above the target. The electrode tip must be flush with the end of the cannula, placing the electrode tip at the same distance from the target as the cannula tip.

There are two methods for setting the electrode depth:

- Method 1, described in section ***3.2.1***, is simpler and does not factor tolerances.
- Method 2, described in section ***3.2.2***, is more precise, but endangers the electrode tip.

3.2.1. Setting Electrode Starting Depth Method 1

This procedure describes method 1 for setting the starting depth of the electrodes, which is simpler.

To set the starting depth of the electrodes:

- Refer to ***Table 5: Cannula Models***, and based on the cannula you are using, adjust the turn wheel to the correct starting depth.

3.2.2. Setting Electrode Starting Depth Method 2

This procedure describes method 2 for setting the starting depth of the electrodes, which is more precise, but endangers the electrode tip. The procedure should be performed entirely in the sterile field prior to beginning the assembly.

> **Warning:** When handling the electrode, be very careful not to damage the tip. At all times during the handling of the electrode, make sure that the micro tip is retracted into the macro sheath.

1. Insert the cannula without stylet in the center hole of the Bengun.

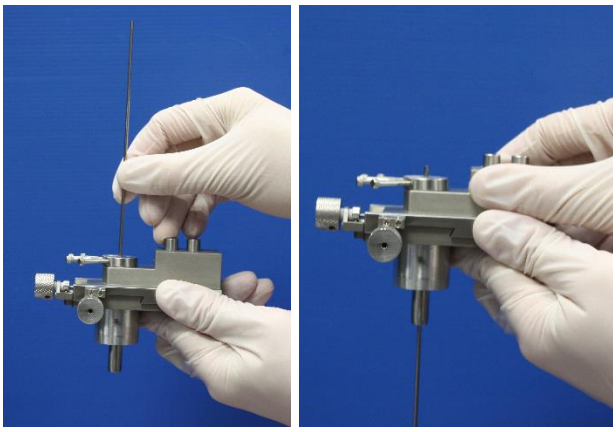


Figure 25: Cannula Inserted into Bengun Center Hole

2. Tighten the Bengun screw.

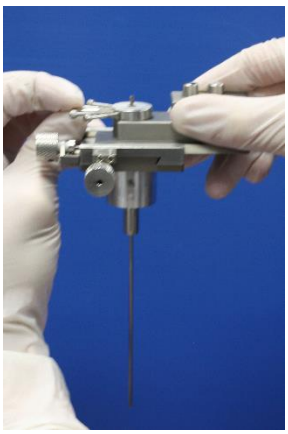


Figure 26: Holding Screw

3. Attach desired electrode holder (x or +) to the Drive Headstage, and secure screw

Figure 27: Attaching Electrode Holder

4. Attach the Drive Headstage to the frame base adaptor and tighten the screw on the back side of the Drive Headstage.

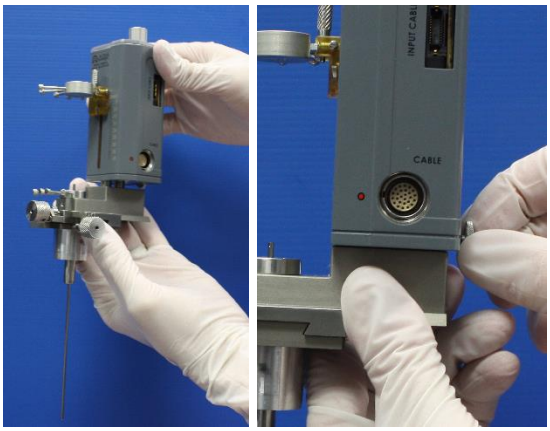


Figure 28: Attaching Driving Unit

5. Remove an electrode from the sterilization tray or sterile packet. Pull the electrode tip back into its protective sheath (***Figure 29***).

> **Warning:** Be careful not to damage the fragile tip.

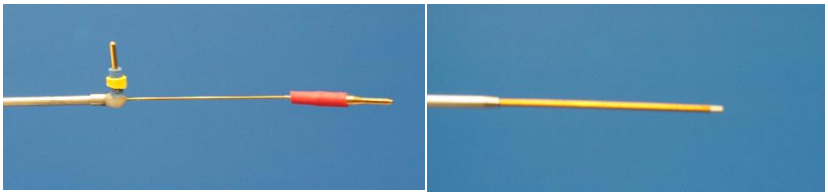


Figure 29: Retracted Electrode Tip

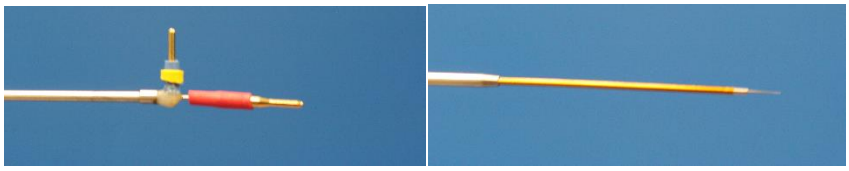


Figure 30: Exposed Electrode Tip

6. Once the electrode is in the cannula, push the electrode into the electrode holder all the way until it reaches the metal collar, and tighten the microelectrode holder screw.

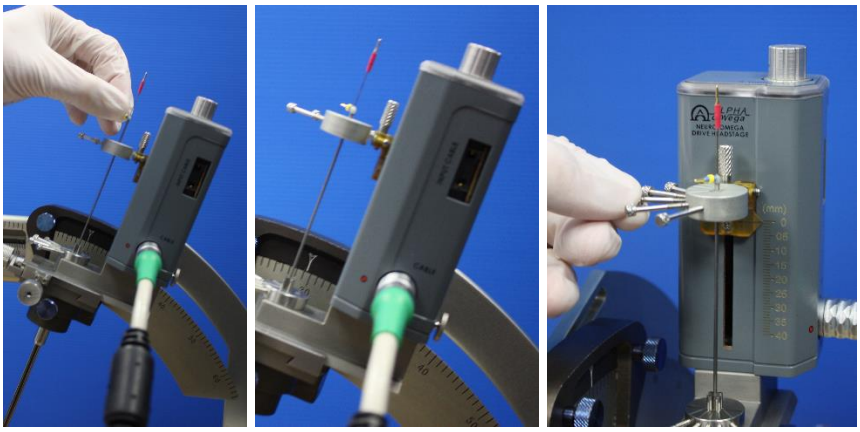


Figure 31: Electrode in Place

7. Push the electrode micro tip to expose it, and then turn the manual wheel until the electrode and its tip are extended outside the cannula.

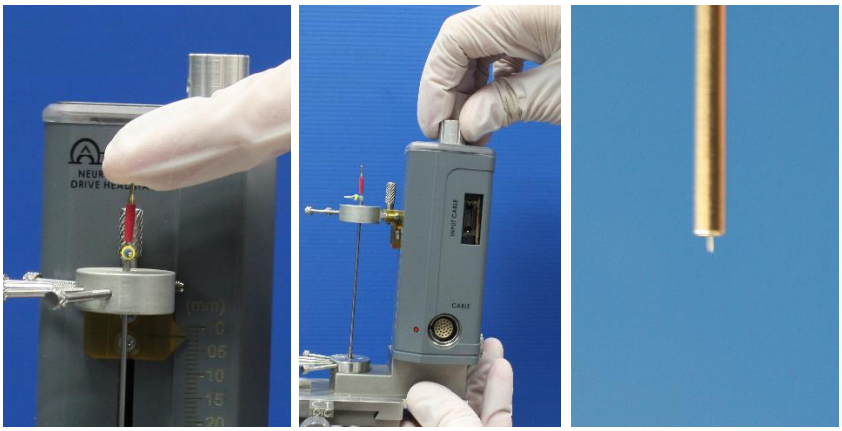


Figure 32: Electrode and Tip outside Cannula

8. Slowly turn the thumb wheel in the opposite direction to retract the electrode into the cannula, until the tip of the electrode is flush with the tip of the cannula. Doing this against a white background will help to make the tip stand out.

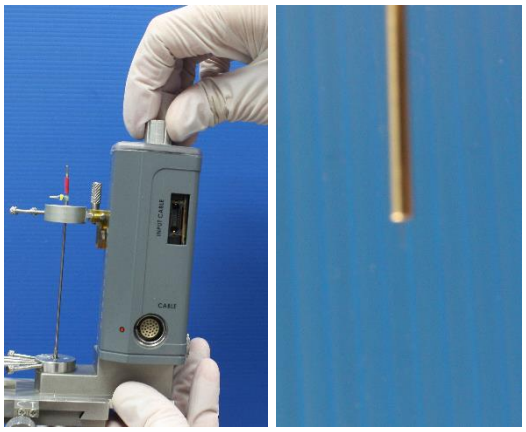


Figure 33: Electrode Tip Flush with Cannula Tip

9. Read and record the depth from the scale on the Drive Headstage. This is the **Starting Depth Value**.

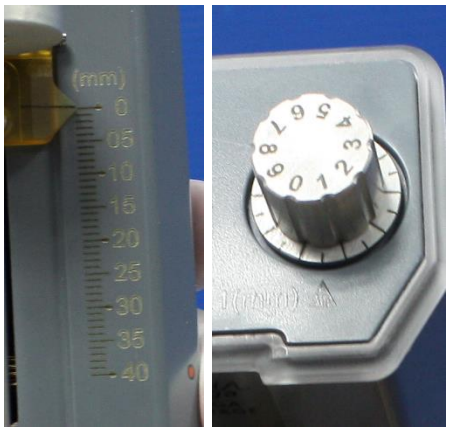


Figure 34: Reading Drive Scale

10. Disassemble Drive Headstage as follows:
    a. Retract the electrode tip by pulling pin connector up.
    b. Loosen the electrode screw.
    c. Remove the electrode.

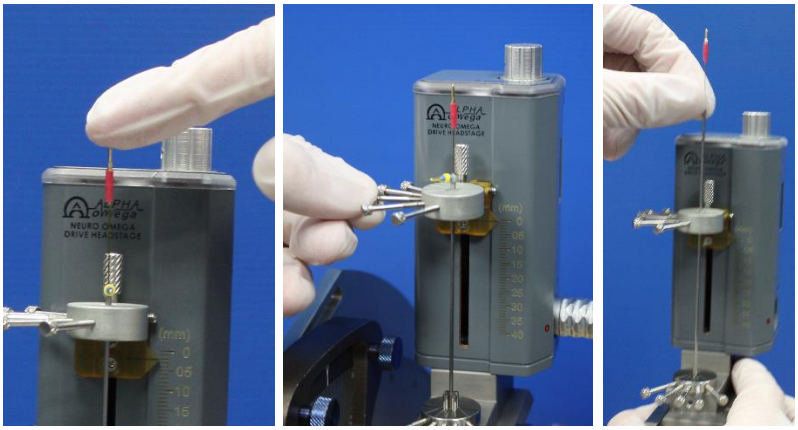


Figure 35: Removing electrode

    d. Unscrew the Drive Headstage back screw and remove Drive Headstage from frame adapter.

Figure 36: Removing Drive Headstage

3.3. ASSEMBLING THE HEADSTAGE

> **Note:** This section does not apply for the MER Only Headstage

This procedure describes how to assemble the Neuro Omega Drive Headstage on the frame.

Prerequisites:

- Set the electrode starting point, as described in section **3.2**

- Frame attached to the skull of the patient, and the area of entry prepared

To assemble the Headstage:

1. Attach the Bengun to the frame adaptor (***Figure 37***), in the configuration matching that of the electrode holder, either **X** or **+**.

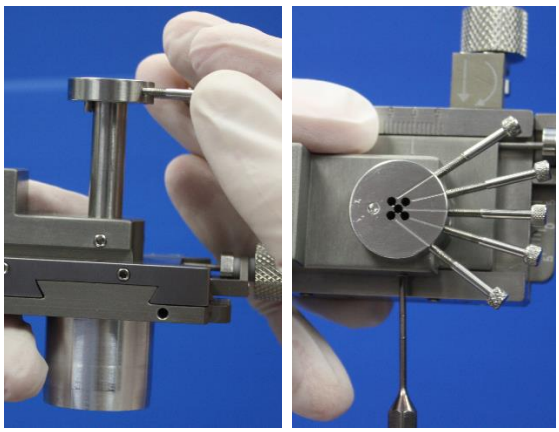


Figure 37: Attaching the Bengun to the Frame Adaptor (X position)

2. Attach and secure the frame adaptor to the frame (***Figure 38***).

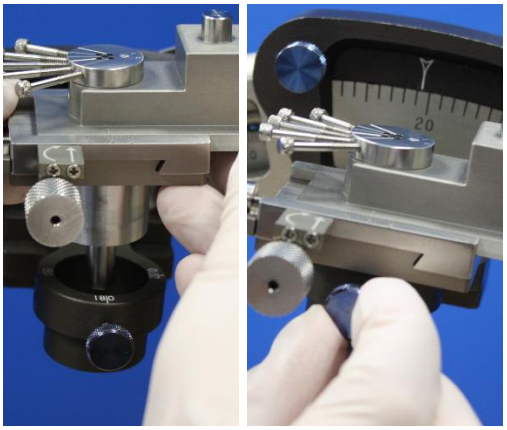


Figure 38: Attaching Frame Adaptor to the Frame

3. Holding the cannula from the stylet collar, insert the cannula through the Bengun hole (***Figure 39***) and into patient's tissue.

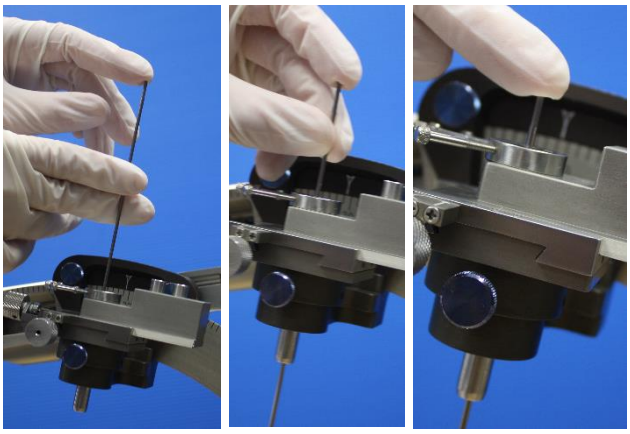


Figure 39: Inserting the Cannula through the Bengun Hole

4. Tighten the Bengun screw (***Figure 40***), and then remove the stylet from the cannula.

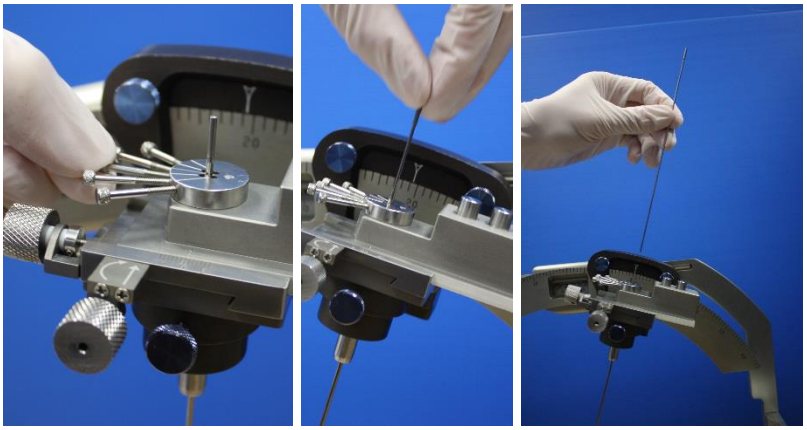


Figure 40: Tightening the Holding Screw and removing stylet

5. Repeat steps 2 and 3 for each electrode you are using.
6. Loosen the screw on the Headstage scale pointer, attach the electrode holder to the drive, and then tighten the screw.

Figure 41: Attaching the Electrode Holder to the Drive

7. Connect the Drive Headstage green cable to the Drive Headstage.

> **Note**: When inserting the cable:
>
> - Verify that the red dots on the drive and on the Main Unit are aligned with those on the cable (*Figure 42*).
> - Do not twist the cable when inserting.
> - Hold from the metal connector, not the cable.
> - Soft click will be felt when the cable is connected (the red dot on the cable disappears).

Figure 42: Aligning the Red Dots on the Drive and the Cable

8. Attach the Drive Headstage to the frame adaptor and secure screw.

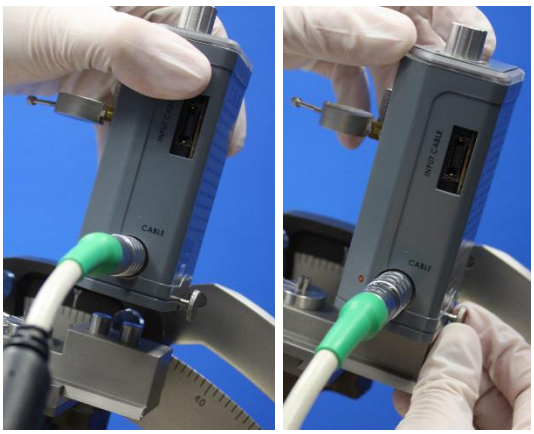


Figure 43: Inserting Electrode into Electrode Holder

9. Verify that the tip of the electrode is retracted, and then insert the electrode through the hole of the electrode holder and then into the cannula, until the collar where it catches on the drive.

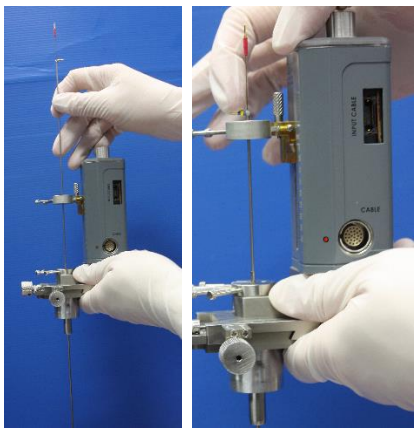


Figure 44: Inserting Electrode into Electrode Holder

10. Tighten the electrode holding screw

Figure 45: Tightening the Electrode Holding Screw

11. Repeat steps ***9*** and ***10*** for each electrode you are using.

Figure 46: All used electrodes inside

12. To connect the input cable, do the following:
    a. Connect the input cable to the Drive Headstage.

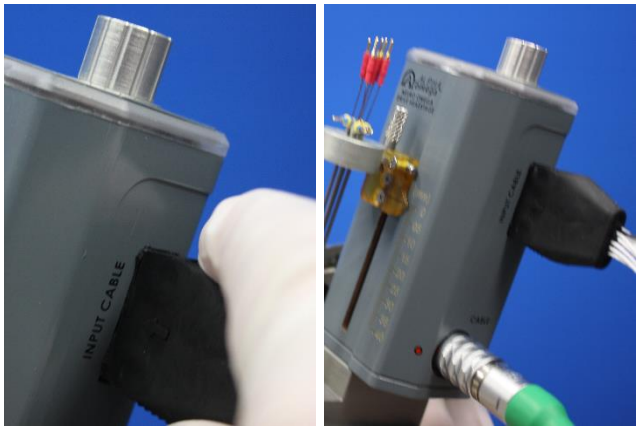


Figure 47: Connect Electrode Input Cable

b. Connect ground black wire alligator to any bengun screw

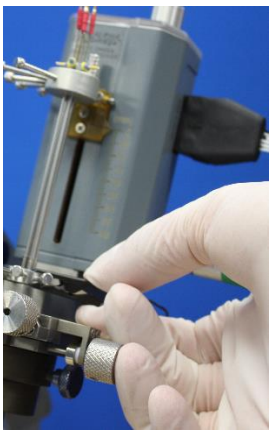


Figure 48: Connect Electrode Input Cable

c. Connect the red wires to the red micro tip connectors.

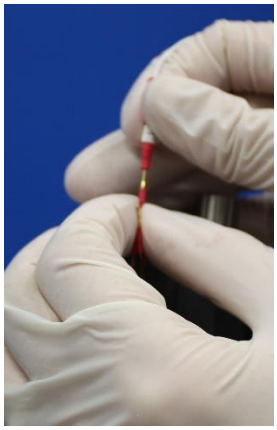


Figure 49: Connect Electrode Input Cable

d. Expose electrode tip.

Figure 50: Connect Electrode Input Cable

e. Connect the yellow wire to the yellow macro tip connector.

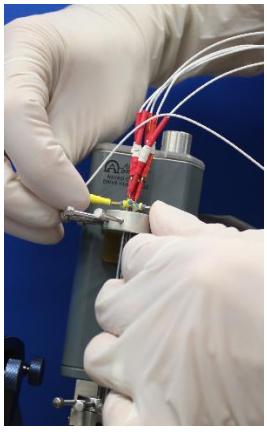


Figure 51: Connect Electrode Input Cable

f. Repeat steps c, d and e for each electrode you are using.

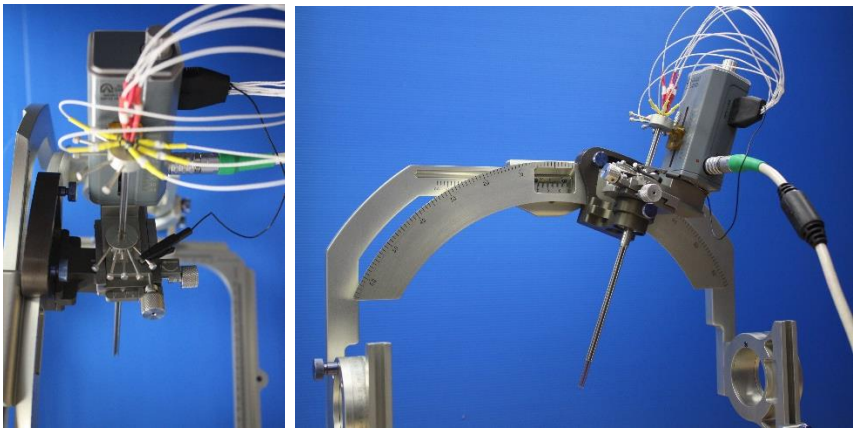


Figure 52: Final Assembly

13. Start the microelectrode recording session.

3.4. HEADBOX MODULES ASSEMBLY

There are two types of Headbox modules:

- The EMG module comprised of 16 pairs of touch-proof connectors. See section ***3.4.1*** for assembling the EMG module.
- EEG module comprises 16 touch-proof connectors. See section ***3.4.2*** for assembling the EEG module.

3.4.1. Assembling the EMG Module

Warnings:

- Information on the output waveforms, pulse durations, pulse repetition frequencies, maximum amplitude of output current is shown under section ***4.19*** of this manual.
- Avoid trans-thoracic stimulation.
- In order to use a video monitor as a part of the visual stimulator, it should be connected to the Neuro Omega trolley isolated power source.
- Operation in close proximity (for example 1 m) to a shortwave or microwave therapy equipment may produce instability in the electrical stimulator output.
- Avoid intentional or unintentional contact between connected but unapplied parts and other conductive parts including those connected to protective earth.

This procedure describes how to assemble the EMG module, for use in implanting the DBS or advanced research.

To assemble the EMG module:

- Connect the EMG 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 are aligned with those on the cable (*Figure 53*).

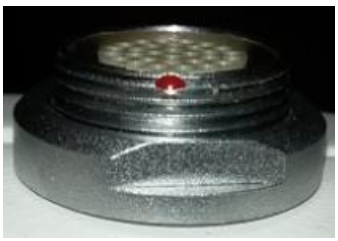


Figure 53: Red Dot on the Headbox

- Connect the electrode pairs to the EMG module, for each electrode both the + (plus) input and - (minus) input connectors.
- Connect the ground connector.
- Connect the stimulation global return connector, if in use.

3.4.2. Assembling the EEG 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 module, for use in implanting the DBS or advanced research.

To assemble the EEG module:

- Connect the EEG 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 are aligned with those on the cable (see *Figure 53*).

- Connect the electrodes to the EEG module.
- Connect the ground connector.

3.5. CONNECTING EXTERNAL SYSTEMS

This procedure describes how to connect any external systems to the Alpha Omega, such as:

- Matlab or C++ system
- External analog or digital input or output systems

You can power the systems through the trolley's isolation transformer, or through an independent isolation transformer.

> **Warning:**
>
> - External systems connected to the Neuro Omega must be independently isolated, or powered through the trolley, as this has its own isolation transformer.
> - External systems connected to the Neuro Omega by Ethernet port must include Ethernet Isolator in line.

To connect a Matlab or C++ system do the following:

- Power the system through the trolley's isolation transformer (see ***Figure 6***) as follows:
  - On the base of the Main Unit, remove the cover to the isolation transformer.
  - Plug the external computer in to the transformer.
  - Return the cover, threading the power cord parallel to the Alpha Omega system's power cord.
- Connect the Ethernet, through an Ethernet Isolator, at the bottom of the main unit (see ***Figure 4***).

To connect an external system, perform one of the following:

- Power the system through the trolley's isolation transformer (see ***Figure 6***) as follows:
  - On the base of the Main Unit, remove the cover to the isolation transformer.
  - Plug the external computer in to the transformer.
  - Return the cover, threading the power cord parallel to the Alpha Omega system's power cord.
  - Power the system through an independent isolation transformer.

On the Input/Output panel, connect the system to the required connection.

Repeat the above steps for each system you want to connect.

CHAPTER 4. OPERATION OF THE NEURO OMEGA SYSTEM

4.1. USING THE NEURO OMEGA SYSTEM FOR IMPLANTING THE DBS

1. Prepare the Neuro Omega system for use, as described in section ***CHAPTER 3***.
2. Power on the Neuro Omega, as described in section ***4.2***.
3. 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 ***4.4***.
   - If the patient's info was supplied on an earlier occasion, then select the patient, as described in section ***4.5***.
4. Define events, as described in section ***4.7***.
5. Verify diagnostic indicators, as described in section ***4.8***.
6. Do one of the following:
   - For first time use, configure drive and save settings, as described in section ***4.9.***
   - After first time use, verify the starting depth of the electrode, as described in section ***4.10***.
7. Create a new trajectory, as described in section ***4.11***.
8. Check impedance, as described in section ***4.13***.
9. Determine placement by manipulating the Drive Headstage, as described in section ***4.14***, and at each recording site, doing the following:
   - Monitor neural activity, as described in section ***4.15***.
   - Assess OPRA, as described in section ***4.16***
   - Mark significant events, as described in section ***4.164.17***.
   - Print the trajectory as needed, as described in section ***4.17.3***.
   - Save data manually to the log file as needed, as described in section ***4.19***.

10. Stimulate motor and sensory neurons, as described in section ***4.20***.
11. Define, and then during stimulation monitor, the potential evoked by stimulation, as described in section ***4.21***.
12. Implant the DBS Electrode, as described in section ***4.21****Error! Reference source not found.*.
13. Starting the Neuro Omega Player, as described in section **4.23**.

4.2. 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 5).
2. If the **Patient Info** window (Figure 54) does not appear automatically, double-click the Neuro Omega shortcut.

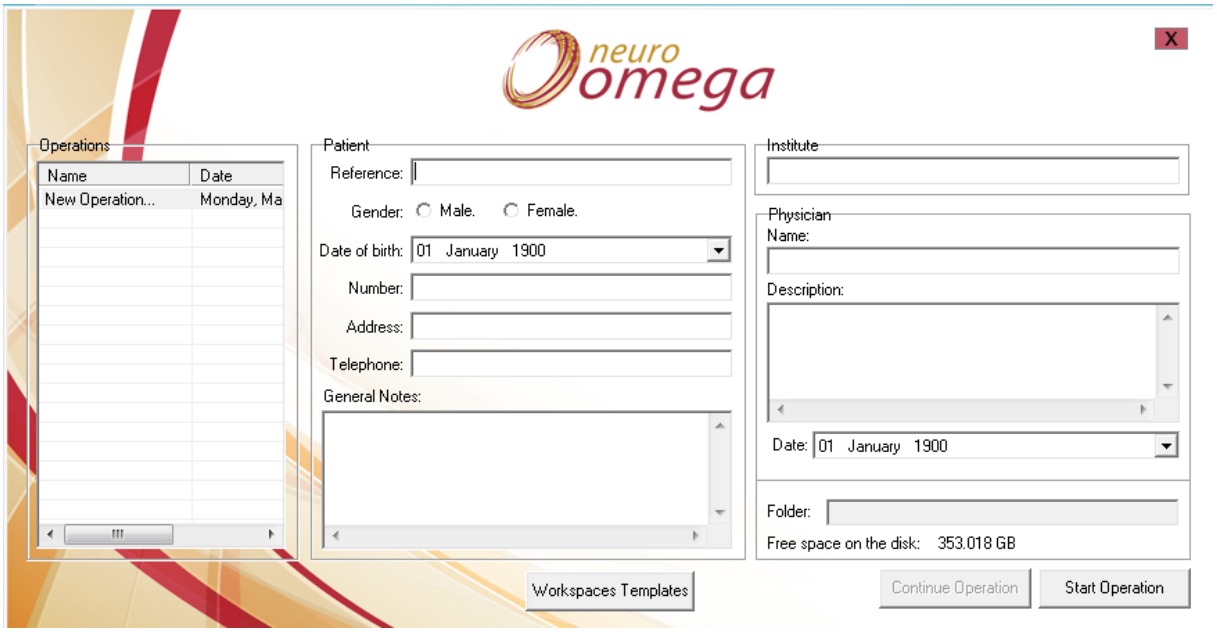


Figure 54: Patient Info Window

4.3. 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 on **Workspaces Templates** button in the Patient Info Window.

   The Choose Workspace Template Window is displayed (see Figure 55).

2. In order to create new Workspace see section 4.3.1
3. In order to edit existing Workspace see section4.3.2
4. In order to delete existing Workspace see section 4.3.3
5. For windows default see section 4.3.4

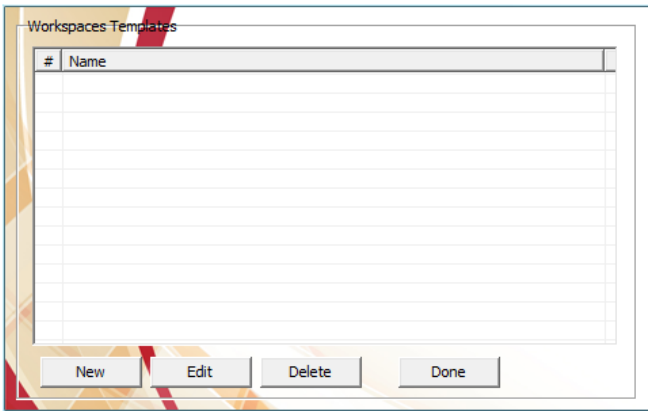


Figure 55 : Choose Workspace Templates Window

4.3.1. Create New Workspace

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

1. Press on **New** button in the Choose Workspace Templates Window (Figure 55).

   System Modules Window (Figure 56**)** will appear.

   This window contains all the system modules ports according to the system configuration. Only available modules will appear.

2. Choose in each port the module you want to connect. If the port won't be used 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.

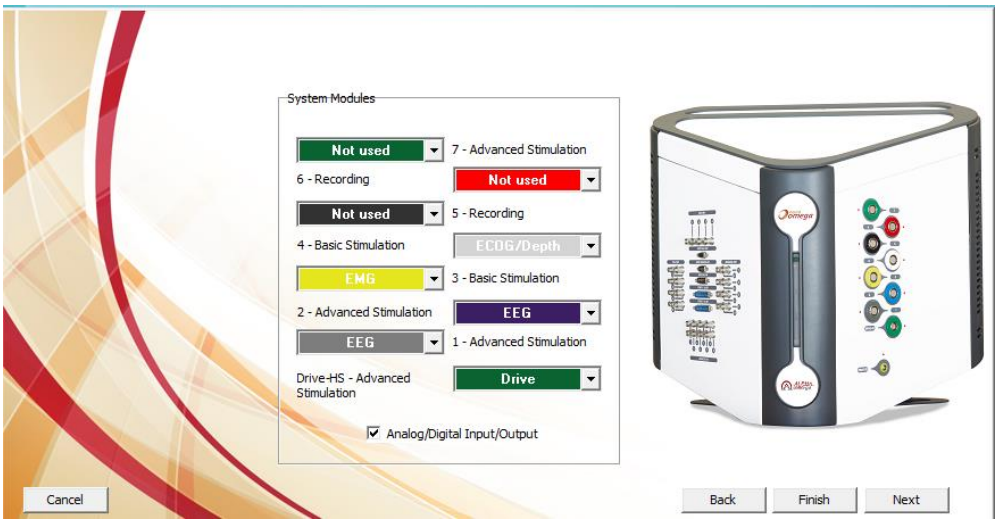


Figure 56: System Modules Window

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

4.3.1.1. EEG Module:

This procedure describes how to map EEG contacts according to the map type (Figure 57).

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 following:

   - 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.

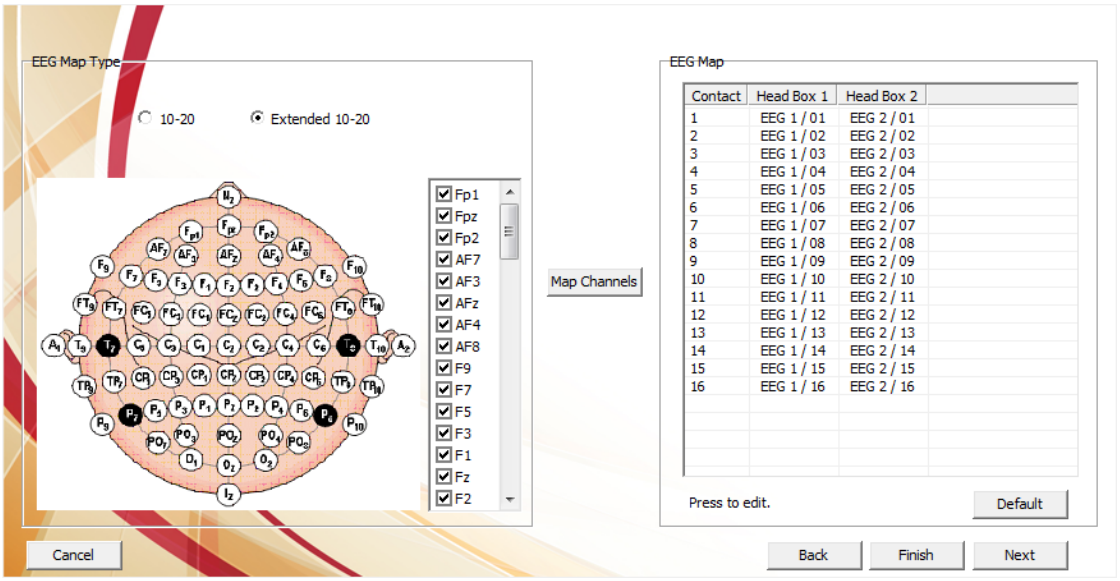


Figure 57: Extended 10-20 EEG map

4.3.1.2. EMG Module

This procedure describes how to map EMG contacts. **(**Figure 58**)**

1. Map the electrode contacts as required.

   Each module contains 16 EMG contacts, you can map each available EMG contact as following:

   - 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”.

> **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.

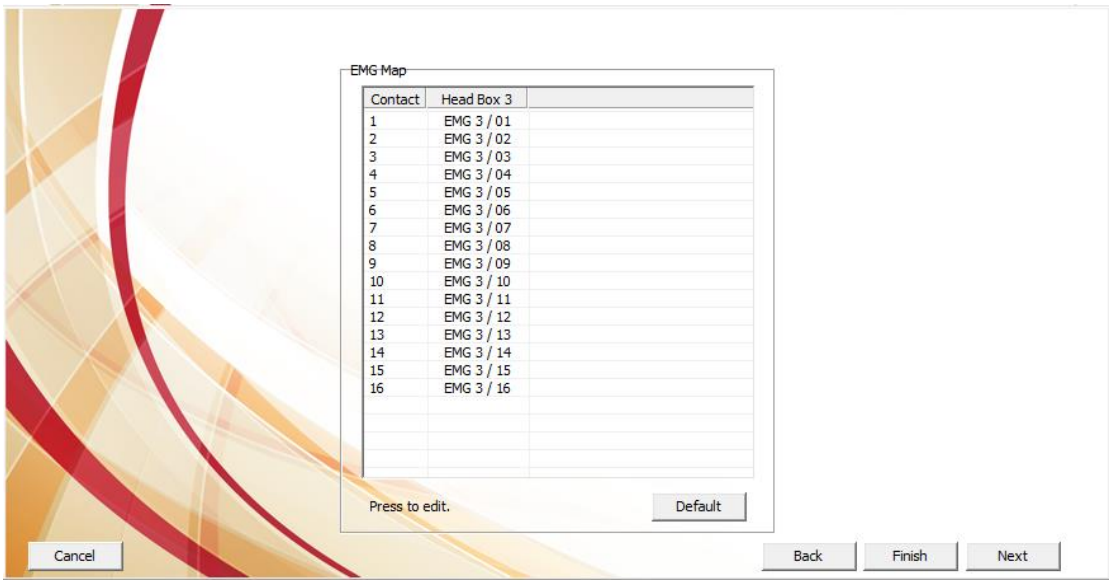


Figure 58: EMG contact mapping

4.3.1.3. ADIO Panel

This procedure describes how to select Analog/Digital ports according to the surgery.

1. Select Analog/Digital ports according to the use. (Figure 59)
   - Digital Input 1-4
   - Digital Output 1-8
   - Additional Digital Input
   - Additional Digital Output
   - Analog Input 1-8
   - Analog Output 1-8
   - Port 1 - 16 bit
   - Port 2 -16 bit

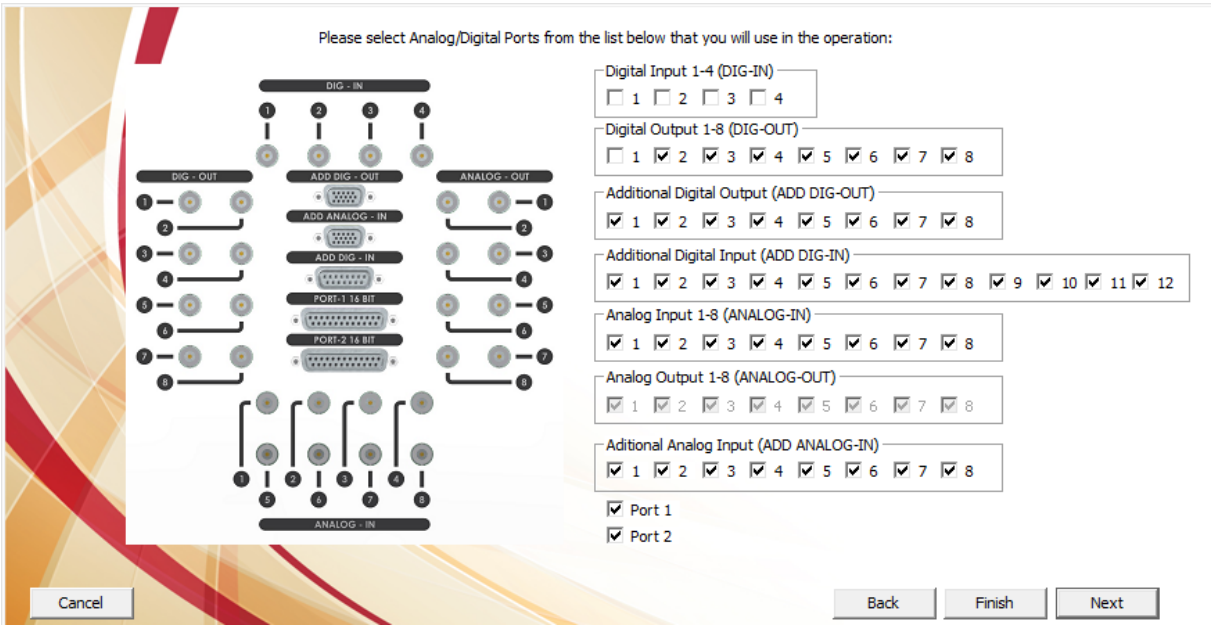


Figure 59: Analog/Digital Ports

2. Press Next to continue. A Save Workspace Window (Figure 60) will appear.
3. Write the workspace name in the New Workspace Template File Name.
4. Press **Save**.
5. **Choose Workspace** Window will appear with all the current workspaces.
6. Choose the Workspace you created and press **Done**.

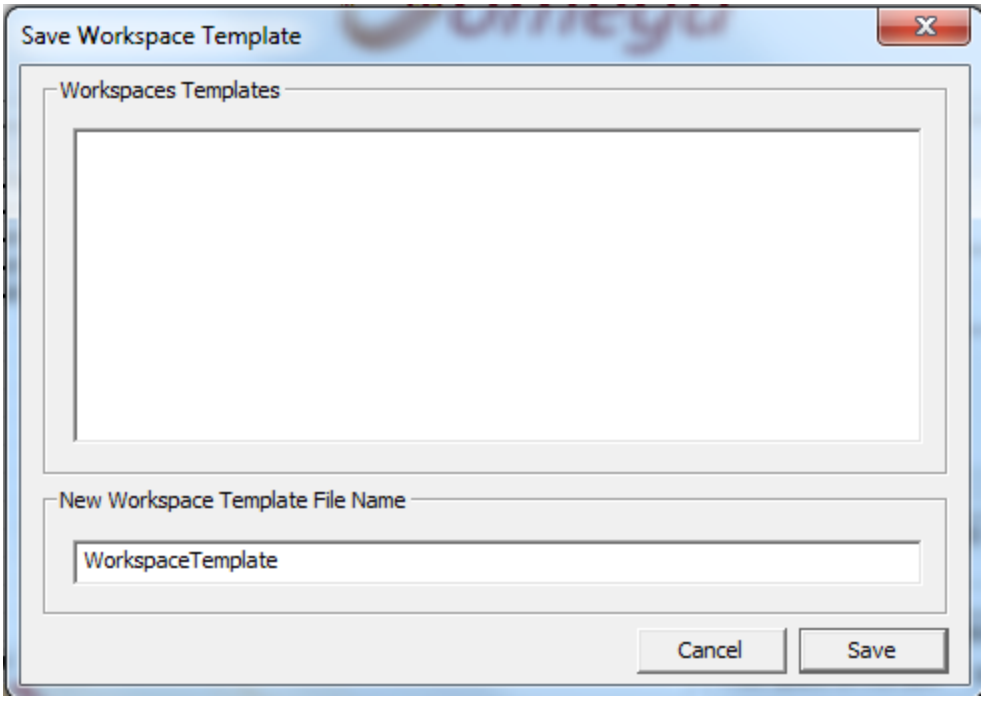


Figure 60: Save Workspace Template

4.3.2. 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 55).
2. Press on **Edit** button.
3. **System Modules Window (**Figure 56**)** will appear with all the current Workspace settings.
4. Edit the workspace settings according to section ***(4.3.1).***

   For EEG Module Editing see section (4.3.1.1).

   For EMG Module Editing see section (4.3.1.24.3.1.2).

   For ADIO Editing see section (4.3.1.3).
5. Press the **Finish** button in case the editing is done.
6. **Save Workspace Window (**Figure 60**)** will appear. You can change the workspace name or write over the current one.
7. Press **Save** button**.**

4.3.3. Delete Workspace.

This procedure describes how to delete existent Workspace.

1. Choose the Workspace you want to delete from Choose Workspace Template (Figure 55)
2. Press the **Delete** button.
3. The chosen workspace will be deleted.

4.3.4. Windows Default

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

Module	Windows
Drive	- Continuous group per all the drive SPK channels. - Continuous group per all the drive Macro LFP channels. - Segmented group per all the drive segmented channels.

Module	Windows
	- Evoked Potential - Inter Spike Interval Selected - Peristimulus time Histogram Selected - Raster Selected
EEG	- Continuous group per all used EEG contacts.
EMG	- Continuous group per all used EMG contacts.
ADIO	- Digital adapter group per all Digital Input channels. - Digital adapter group per all the Digital Output channels bits. - Digital adapter group per all Additional Digital Input channels. - Digital adapter group per all Additional Digital Output channel bits. - Continuous adapter group per all Analog Input channels. - Continuous adapter group per all Additional Analog Input channels. - Digital adapter group per Port 1. - Digital adapter group per Port 2.

4.4. SUPPLYING PATIENT INFO

This procedure describes how to supply patient info for the patient on whom the operation 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 54), in 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 61) will appear.
5. Choose workspace and press **Start**.

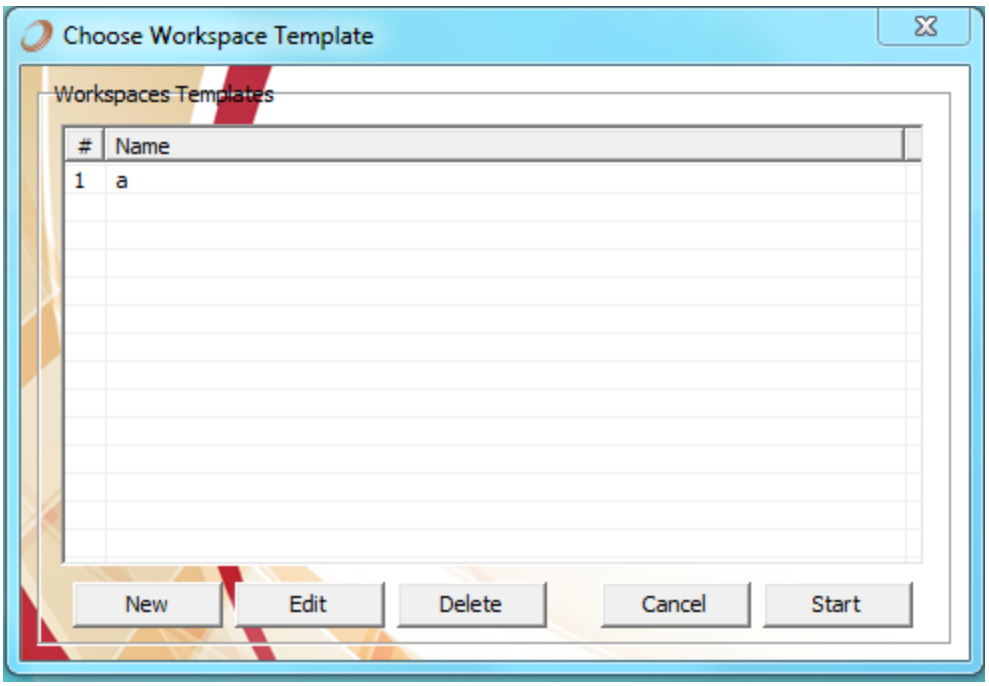


Figure 61: Choose Workspace Template Window

The main window appears.

4.5. 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 54), 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.

4.6. NEURO OMEGA INTERFACE NAVIGATION

The Neuro Omega interface is made up of the following components:

- **Toolbar**: See section ***4.6.1*** for more information.
- **Workspace**: See section ***4.6.2*** for more information.
- **Trajectory Graph**: See section ***4.6.2.1*** for more information.
- **System Diagnostics**: See section ***4.6.4*** for opening system diagnostics.

4.6.1. Toolbar

The toolbar is comprised of two rows of buttons and controls.

The top row contains the following buttons:

- **Clear All** : Restarts all readings in the open Workspace windows
- **Pause** : Pauses all readings in the open Workspace windows
- **Restore Layout** : Returns all windows to their default positions – closing windows not opened by default, and opening windows open by default
- **Window List** : Opens the Windows dialog box for activating and closing Workspace windows (see section ***4.6.2.1***)
- **Events Properties** : Opens the Events Control Panel for defining events (see section ***4.7***), marking events (see section ***4.17.1***), and adding remarks (see section ***4.17.2***)
- **Analog Output** : Opens the Analog Output dialog box for routing a channel to an external device (see section ***5.4***)
- **Sound Level Bar** : Controls the computer main volume level
- **Sound Suppression Bar** Sound Suppression: : Controls the level of sound suppression of the channel that is heard by filtering out any signal below the bar threshold

The left side of the bottom row of the toolbar (***Figure 62***) contains buttons and controls for driving the electrode.

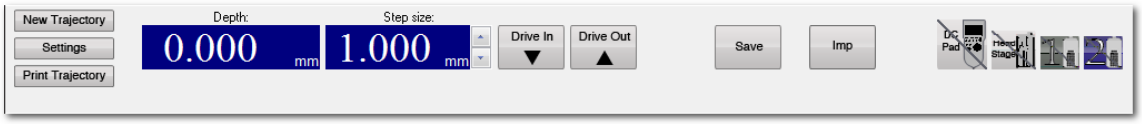


Figure 62: Toolbar, Bottom Row, Left Side

The buttons and controls on the left side of the bottom row of the toolbar (*Figure 62*) are as follows:

- **New Trajectory**: Opens the **Set Position** dialog box for creating a new trajectory (see section ***4.10***)
- **Settings**: Opens the Settings dialog box (see section ***4.9***)
- **Print Trajectory**: Opens the Print Trajectory dialog box (see section ***4.17.3***)
- **Depth**: Displays the current depth of the trajectory (see section ***4.14***)
- **Step Size**: Allows you to change the step size when driving the electrode in and out (see section ***4.14***)
- **Drive In/Out**: Allows you to drive the electrode in and out according to the step size (see section ***4.14***)
- **Save**: Allows you to manually start saving the current data set at the site to the log file (see section ***4.19***)
- **Imp**: Checks the impedance and opens the **Impedance** dialog box (see section ***4.13***)
- **Diagnostic Indicators**: Displays the diagnostic indicators for the remote control, the Headstage, and each of the Headboxes (see section ***4.7***)

The right side of the bottom row of the toolbar (***Figure 63***) contains buttons and controls for stimulation.

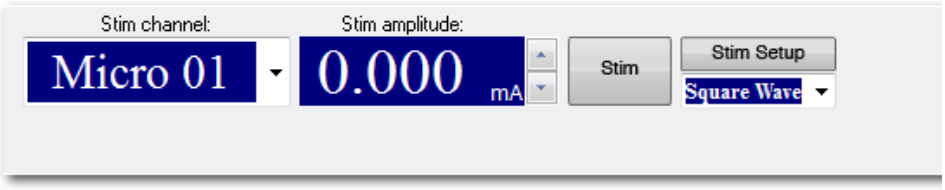


Figure 63: Toolbar, Bottom Row, Right Side

The buttons and controls on the right side of the bottom row of the toolbar (*Figure 63*) are as follows:

- **Stim Channel**: Allows you to change the channel receiving stimulation (see section ***4.20.2***)
- **Stim Amplitude**: Allows you to change the amplitude of the stimulation (see section ***4.20.2)***
- **Stim**: Applies stimulation (see section ***4.20.2***)

- **Stim Setup**: Opens the Stimulation Setup dialog box for applying stimulation (see section ***4.20.1***)

4.6.2. Workspace

The Workspace (***Figure 64***), which is to the right of the Trajectory graph (see section ***4.6.2.1***), contains all of the Workspace windows involved in monitoring and stimulating brain activity. A graph displays activity from one channel, and each Workspace window contains one or more graphs.

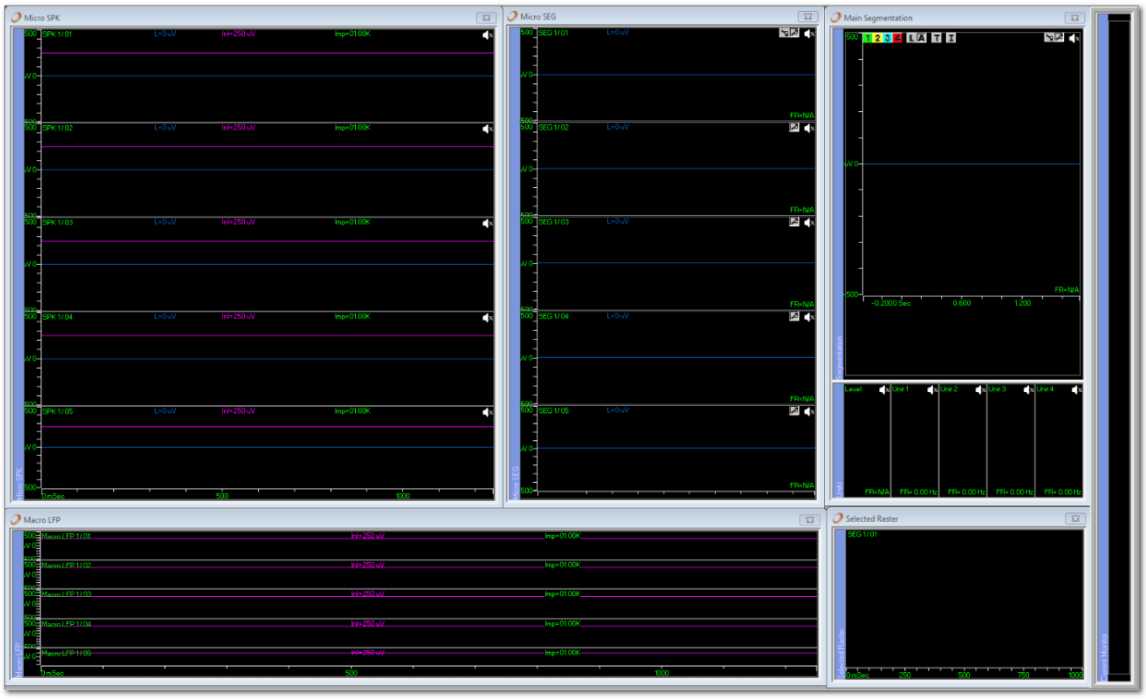


Figure 64: Workspace

The following procedures describe actions you can perform on Workspace windows in the course of using the Alpha Omega system for implanting the DBS electrode and advanced research:

- To close and open a Workspace window, see section ***4.6.2.1.***
- To pop a Workspace window out of the Workspace and onto the computer's desktop, or back into the Workspace, see section ***4.6.2.2***.
- To restore the Workspace layout to the default, see section ***4.6.2.3***.
- To clear all of the open Workspace windows from displaying their channels and have them restart, see section ***4.6.2.4***.
- To pause all open Workspace windows from displaying their channels, see section ***4.6.2.5***.

4.6.2.1. Closing and Opening a Workspace Window

This procedure describes how to close a Workspace window open in the Workspace, and open a Workspace window that you closed or that closed by default.

To open and close a Workspace window:

1. Close a Workspace window in any of the following ways:
   a. Click the  at the top right corner of the window.
   b. Click the  at the top left corner of the window, and then select **Close**.
2. Close more than one Workspace window at a time as follows:
   a. From the toolbar, click  **Window List**.
   The **Window** dialog box opens (***Figure 65***).

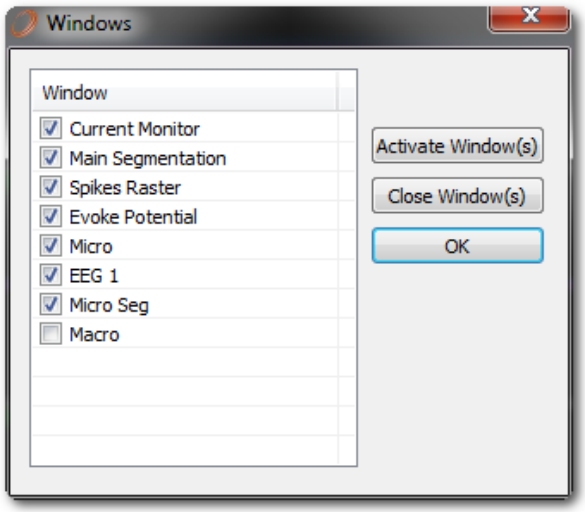


Figure 65: Window Dialog Box

3. Clear the checkbox of the window you want to close.
   The window closes.
4. Open Workspace windows as follows:
   a. From the toolbar, click  **Window List**.
   The **Window** dialog box opens (see ***Figure 65***).
   b. Select the checkboxes of the windows you want to open.
   The windows appear in the Workspace.

4.6.2.2. Popping a Workspace Window In and Out

This procedure describes how to pop a Workspace window in and out of the main Alpha Omega window, which is helpful when dealing with a large number of Workspace windows.

To pop a Workspace window in and out of the main Alpha Omega window:

1. In the Workspace, in the upper-left hand corner of the Workspace window, click  , and then click **Pop Out**.

   The Workspace window appears outside of the main Alpha Omega window.

2. Outside the main Alpha Omega window, in the upper-left hand corner of the Workspace window, click  , and then click **Pop In**.

   The Workspace window returns to the Workspace.

4.6.2.3. Restoring the Workspace Layout

This procedure describes how to restore the layout of the all windows in the Workspace to their default positions, closing windows not open by default and opening windows open by default.

To restore the Workspace layout:

1. On the toolbar, click  .

   The Workspace layout returns to the default.

4.6.2.4. Clearing All Workspace Windows

This procedure describes how to clear all of the open Workspace windows from displaying their channels and have them redrawn from the current moment.

To clear all open Workspace windows and have them restart:

1. On the toolbar, click  .

   The open Workspace windows clear and are redrawn from the current moment.

4.6.2.5. Pausing Workspace Windows

This procedure describes how to pause all open Workspace windows from displaying their channels.

To pause all open Workspace windows:

1. On the toolbar, click  .

   The open Workspace windows pause. While paused, the pause button changes to  .

To resume the Workspace window operation, click  .

The Workspace windows return to their activity, and the pause button returns to  .

4.6.3. Trajectory Graph

The **Trajectory** graph, which is to the left of the Workspace (see section ***4.6.2***), primarily describes the distance of the micro tip to the target. See ***Figure 66*** for a description of the Trajectory graph.

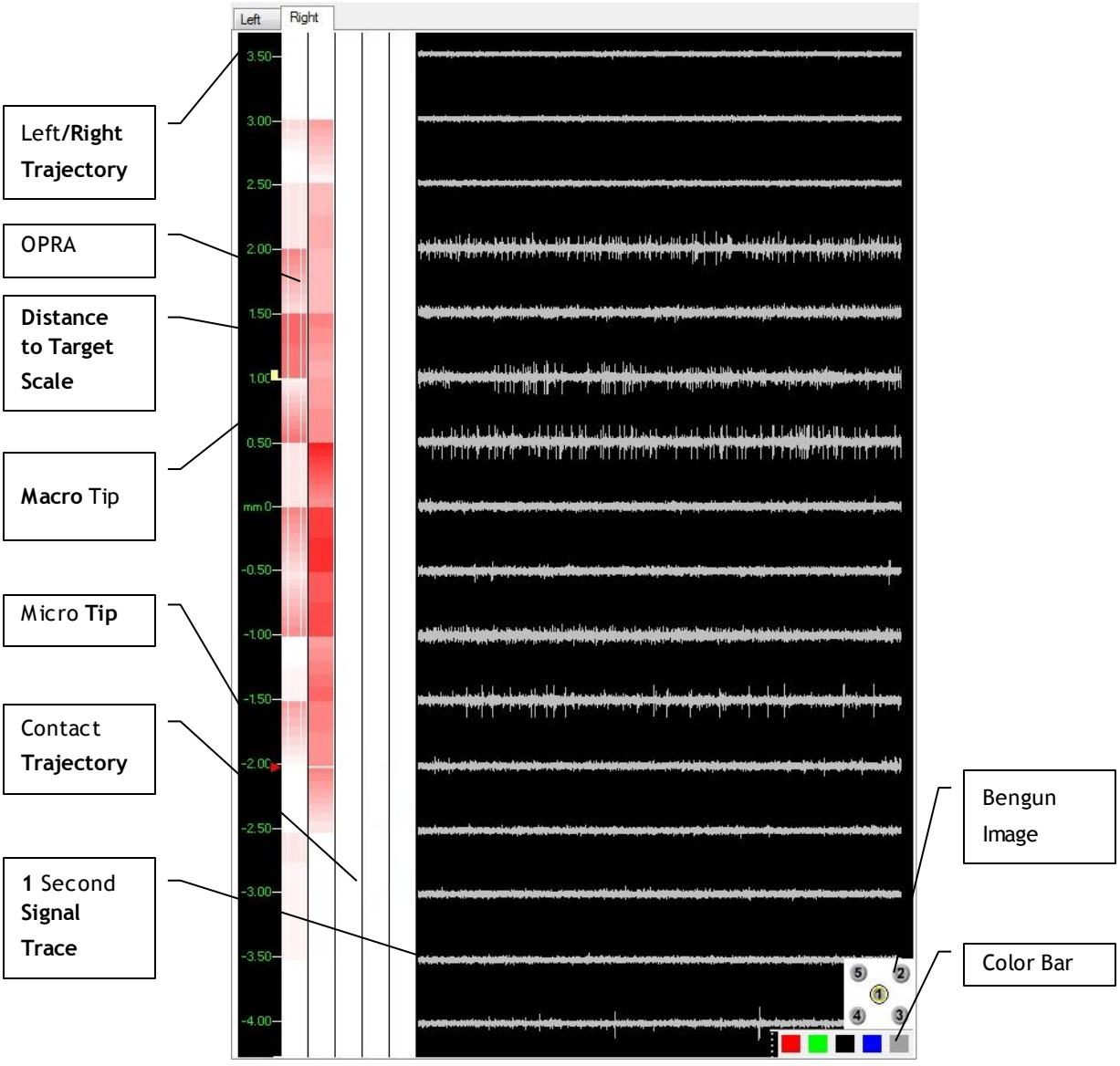


Figure 66: Trajectory Graph

The markers to the left of the graph, on the right side of the scale, are as follows:

- The white marker  precisely indicates the current location of the electrode's macro tip.
- The red carrat  precisely indicates the current location of the electrode's micro tip.

4.6.4. Viewing System Diagnostics

This procedure describes how to view system diagnostics, in the **System State** dialog box.

> **Note:** Viewing system diagnostics should be done in conjunction with an Alpha Omega trained user. This should be used as a troubleshooting step.

To view System Diagnostic:

1. Press **CTRL+SHIFT+A**.

   The **System State** dialog box appears (*Figure 67*).

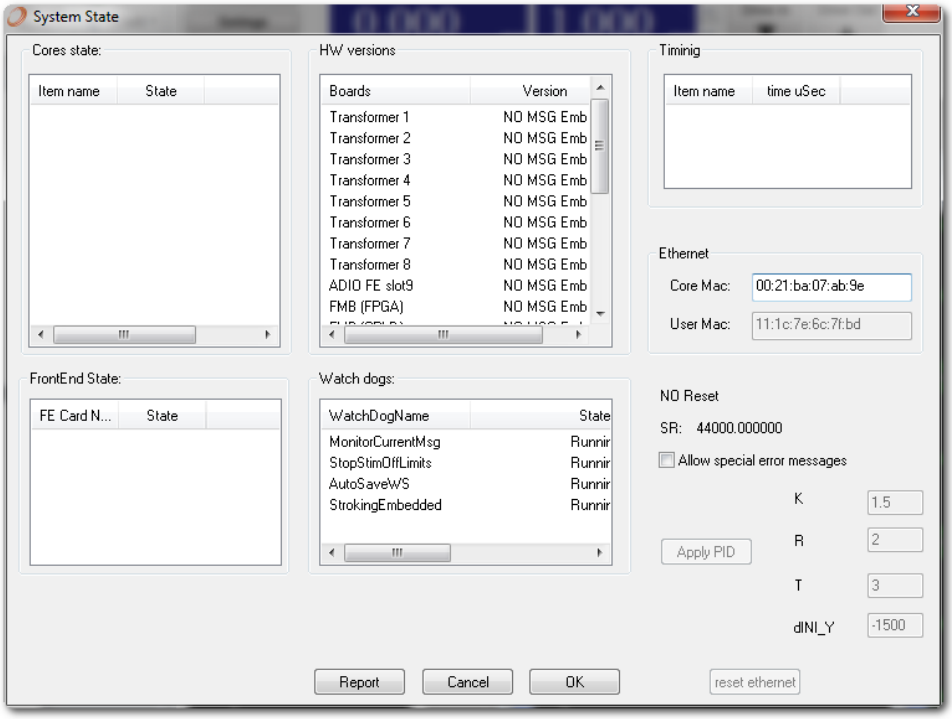


Figure 67: System State Dialog Box

2. To exit, click one of the following:
   - **X** at the top right corner of the window.
   - **Cancel**

- **OK**

4.7. EVENT DEFINITION

You can define events prior to the operation that you expect to occur during the operation, so they can be marked during the operation. These events are logged with the data acquired from the electrodes and general-purpose analog and digital inputs.

The following procedures are involved:

- ***Defining Events***
- ***Editing** Events*
- ***Deleting an Event***
- ***Events Definition Table***

4.7.1. Defining Events

This procedure describes how to define new events that you expect to occur during the operation.

To define events:

1. From the toolbar, click **Events Properties**.

   The **Events Control Panel** appears (***Figure 68***), which contains a number of predefined events for convenience.

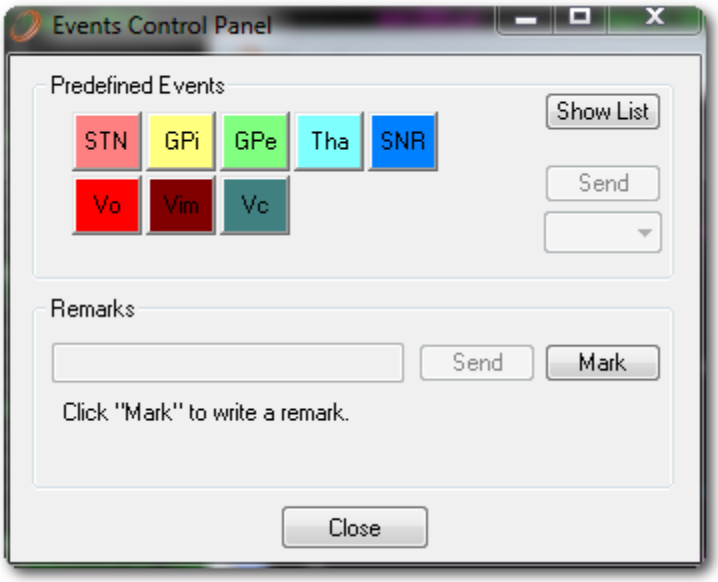


Figure 68: Events Control Panel

2. Click Show List.

   The **Events Definition** dialog box appears (***Figure 69***), with a table containing one defined event per row. See for a description of the Events Definition table.

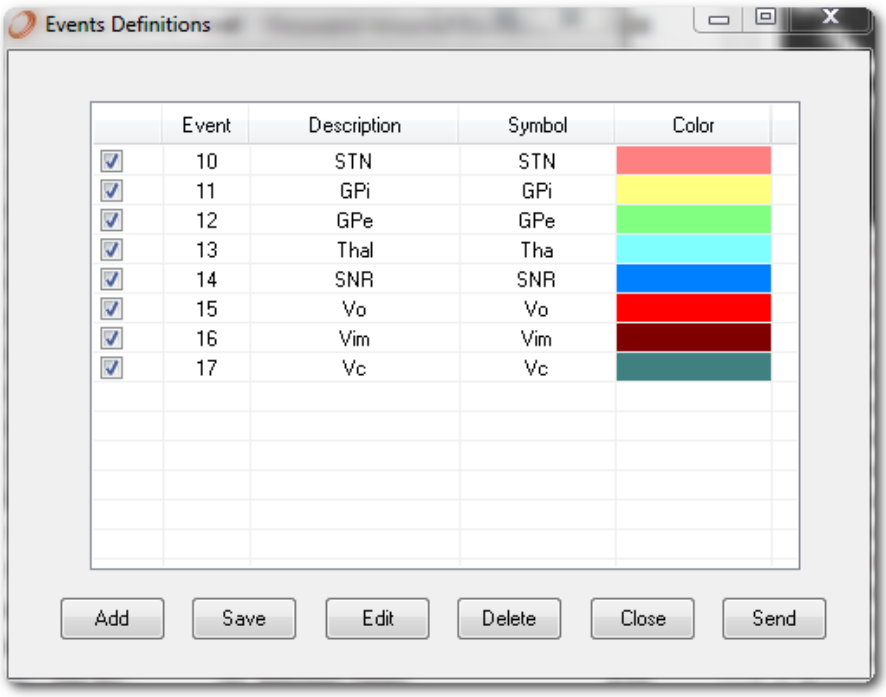


Figure 69: Events Definition Dialog

3. Click **Add**.
4. The **Create Event** dialog box opens to allow you to add an event (***Figure 70***).

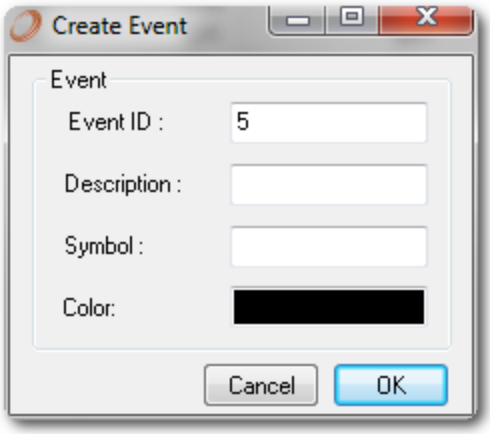


Figure 70: Create Event Dialog Box

5. Do the following:
   a. In the **Event ID** field, enter the event ID. By default, the first available event ID appears, though this can be replaced.

> **Note:** The event ID is what is saved to the log file.

   b. In the **Description** field, enter a short description of the event.
   c. In the **Symbol** field, enter the symbol as it should appear in the **Events Control Panel**.
   d. In the color field, click on the color to open the color palette, and then select the color as it should appear in the **Events Control Panel**.
6. Click **OK**.

   The **Create Event** dialog box closes.
7. Repeat steps ***3-6*** for each new event you want to define.
8. In the **Events Definition** dialog box, do the following:
   a. Select the checkboxes of events that you want to appear as individual buttons in the **Events Control Panel**.
   b. Clear the checkboxes of events that you want to appear as options in the drop-down menu of the **Events Control Panel**.
9. Click **Save** to save your changes and close the **Events Definition** dialog box.

4.7.2. Editing Events

This procedure describes how to edit events that you expect to occur during the operation.

To edit events:

1. From the toolbar, click **Events Properties**.

   The **Events Control Panel** appears (see ***Figure 68***), which contains a number of predefined events for convenience.
2. Click Show List.

   The **Events Definition** dialog box appears (see ***Figure 69***), with a table containing one defined event per row. See for a description of the Events Definition table.
3. Select the event you want to edit, and then click **Edit**.

   The **Create Event** dialog box opens to allow you to edit the event (see ***Figure 70***).

4. Do the following:
   a. In the **Event ID** field, edit the event number.
   b. In the **Description** field, edit the event description.
   c. In the **Symbol** field, edit the symbol as it should appear in the **Events Control Panel**.
   d. In the color field, click on the color to open the color palette, and then edit the color as it should appear in the **Events Control Panel**.
5. Click **OK**.

   The **Create Event** dialog box closes.
6. Repeat steps *3-5* for each event you want to edit.
7. In the Events **Definition** dialog box, do the following:
   a. Select the checkboxes of events that you want to appear as individual buttons in the **Events Control Panel**.
   b. Clear the checkboxes of events that you want to appear as options in the drop-down menu in the **Events Control Panel**.
8. Click **Save** to save your changes and close the **Events Definition** dialog box.

4.7.2.1. Deleting an Event

This procedure describes how to delete an event from the **Events Control Panel**.

To delete an event:

1. From the toolbar, click **E** **Events Properties**.

   The **Events Control Panel** appears (see *Figure 68*), which contains a number of predefined events for convenience.
2. Click Show List.

   The **Events Definition** dialog box appears (see *Figure 69*), with a table containing one defined event per row. See 4.7.3 for a description of the Events Definition table.
3. Select the event you want to delete, and then click **Delete**.

   The event is deleted.

4.7.3. Events Definition Table

A description of each column is detailed below:

- **First column (no title)**: A checkbox appears here after an event is defined. When this box is checked, the event on that line appears in the Events Control Panel dialog as a button; otherwise, it will appear in the drop down list.

- **Event**: The event code is shown in this column. Event codes are automatically assigned but can be changed by the user; valid values are any number from 5 to 65536; values 0 through 4 are reserved for system use.
- **Description**: Description of the event.
- **Symbol**: A 3-digit alpha-numeric symbol to identify the event. This will appear on the event's button, or represent the event in the drop-down list of the Events Control Panel.
- **Color**: This color will be saved in the data file, and can be used later in offline review. If a button is created representing the event in the Events Control Panel dialog, its background will be of that color.

4.8. 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 Remote Control is not functioning or not connected
   - 

: Indicating that the Drive Headstage or MER Only Headstage module is not functioning or not connected.
   -  : 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 modules in use.

4.9. CONFIGURING DRIVE AND SAVE SETTINGS

This procedure describes how to configure drive and save settings, which is required for first time use, and may be returned to subsequently as needed.

To configure drive and save settings:

1. On the main screen, on the toolbar, click **Settings**.

   The **Settings** dialog box appears (***Figure 71***).

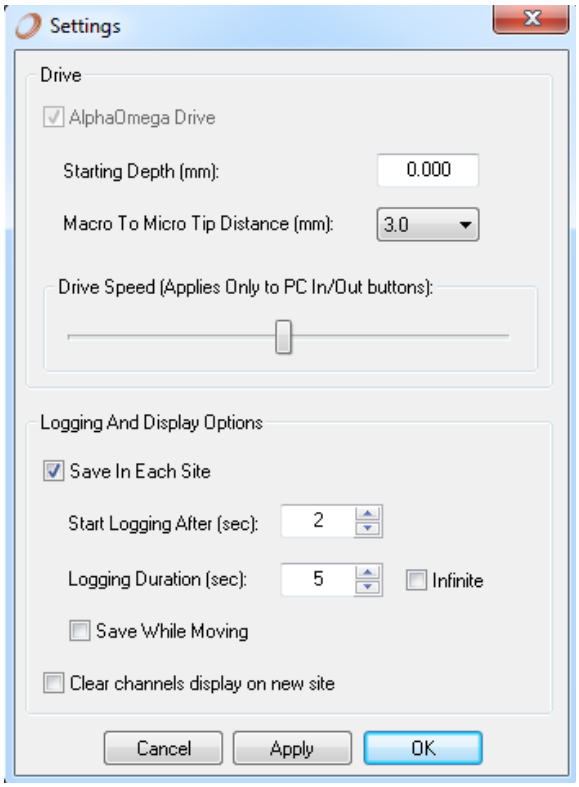


Figure 71: Settings Dialog Box

2. In the **Starting Depth** field, refer to Table 5, *page 28*, and based on the cannula you are using, enter the correct starting depth.
3. In the **Macro to Micro Tip Distance** dropdown list, refer toTable 4, *page 27*, and based on the electrode you are using, select the correct distance.
4. In the **Drive Speed** area, move the slider to the right to increase the drive speed, or to the left to decrease the drive speed.
5. In the Logging And Display Options, do one of the following:
   a. Select **Save in Each Site** if you want Headstage and Headbox data saved to the log file each time the electrode stops advancing, and then proceed to step ***6***.
   b. Clear **Save in Each Site** if you want to manually click **Save** to start saving Headstage and Headbox data manually, and then proceed to step 7.

Note: For more information about saving, see **section 4.19**.

6. If you selected **Save in Each Site**, do the following:
   a. From the **Start Logging After** dropdown list, select the length of time (in seconds) for Neuro Omega to wait after electrode stops advancing, to start saving data to the log file.
   b. From the **Logging Duration** dropdown list, select the length of time for Neuro Omega to save data to the log file. The Infinite checkbox can be selected if nonstop saving is required.
   c. Select the **Save while Moving** checkbox if you want Neuro Omega to continue saving data to the log file after it has started, or after you have clicked **Save** – even if you have since advanced the electrode.
   d. Select the **Clear channels display on new site** checkbox if you want all the windows to be cleared from data at every new site.

> **Notes:**
> - The drive moves until a step is reached, regardless of drive speed.
> - The thumb wheel on the remote control (see section ***4.14***, step ***3***) overrides the drive speed defined in the **Settings** dialog box.
> - When using the MER Only Headstage the thumbwheel cannot be used.

7. Click **OK**.

   The **Settings** dialog box closes, and the settings are saved.

4.10. VERIFYING STARTING DEPTH

This procedure describes how to verify the starting depth. This is a prerequisite for creating a new trajectory.

4.10.1. Drive Headstage Module

To verify starting depth:

1. On the main screen, on the toolbar, click **Settings**.

   The **Settings** dialog box appears (see ***Figure 71***).
2. In the **Starting Depth** field, refer to Table 5***, page 28***, and based on the cannula you are using, verify the correct starting depth.

4.10.2. MER Only Headstage Module

To verify starting depth:

1. On the main screen, on the toolbar, click **Settings**.

   The **Settings** dialog box appears (see ***Figure 71, page 85***).

2. In the **Starting Depth** field, enter the drive starting depth value.
   - To use a distance to target calculation, enter the value as a negative number (for example, starting 20mm above target should enter -20 into the starting depth).
   - To use the values on the drive, enter the actual depth, as it appears on the drive.

4.11. CREATING A NEW TRAJECTORY

This procedure describes how to create a new trajectory with up to five electrodes, each electrode as its own track.

> **Note:** When continuing an operation, all existing trajectories are resumed.

To create a new trajectory:

1. Verify the following:
   a. The electrode tip is advanced in the cannula to the starting position, as described in section ***3.3***.
   b. The Headbox modules are assembled, as described in section ***3.4***.
2. On the main screen, on the toolbar, click **New Trajectory**, and then, in the confirmation box, click **Yes**.
3. Do one of the following:
   a. If the **Set Position** dialog box appears (***Figure 72***), do the following:

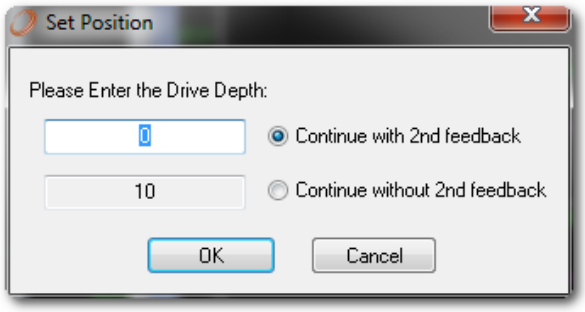


Figure 72: Set Position Dialog Box

   i. Manually set the drive position, as described in section ***4.12***.

   A popup appears asking if you want to move the drive to the starting depth.

ii. Continue with step **4**.

b. If the **Set Position** dialog box does not appear, proceed to step **4**.

4. In the popup, click **Yes**.

> **Note**: For safety reasons, when moving to the starting depth, the drive can only move forward towards the target manually. Therefore, if the drive must advance to reach the starting position, and in step **4** you clicked **Yes**, the drive stays in place. A popup appears, notifying you that you cannot reset forward.
>
> If the drive must advance to reach the starting position, then you must advance it manually.

The **New Trajectory** dialog box appears (***Figure 73***).

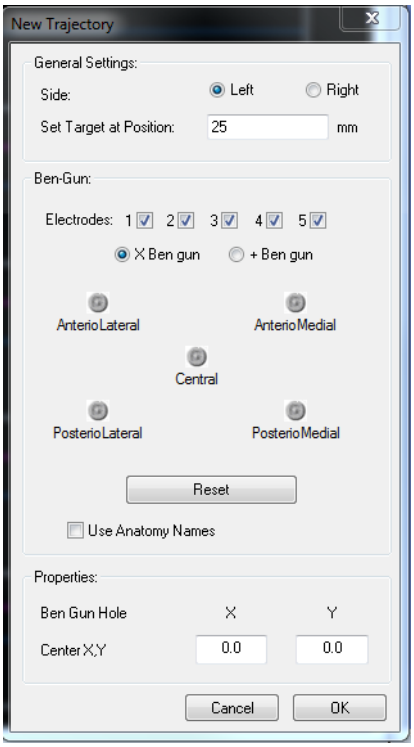


Figure 73: New Trajectory Dialog Box

5. In the **General Settings** area, select the operation side.
6. In the **Set Target at Position** field:
   a. For the Drive Headstage – type the distance, in millimeters, from the electrode tip to the target, as shown in Table 5, ***page 28***.
   b. For the MER Only Headstage – this value cannot be set, see Section ***4.10.2*** on how to set the starting depth and trajectory.
   c. When using the Nexframe or Starfix frames – the target position is at 20mm. See Sections ***2.2.6.3*** and ***2.2.6.4***.
7. Select the checkboxes for the electrodes you want to use, and then select the Bengun configuration. Select the electrode tracks in the order that you want them to appear in the Workspace.
8. Select the Use Anatomy Names checkbox to display the Anatomy names in the Workspace.

   The trajectories are numbered in the order that you click them.
9. If you have manually moved the XY frame adapter, then in the **Properties** area, in the **X** and **Y** fields, type the offset values accordingly.
10. Click **OK**.

    The following happens:

    - The trajectory configuration is finalized.
    - The program creates the trajectory and activates OPRA.
    - The Workspace displays the trajectory in the **Trajectory** graph, which primarily describes the distance of the micro tip to the target. See section 4.6.3 for a description of the **Trajectory** graph.

4.12. SETTING DRIVE POSITION

This procedure describes how to manually set the drive position. This is important if the value on the Drive Headstage does not match the position according to the software, or if there is a problem with the Drive Headstage. This could happen if the drive was attached at a position other than that from which it was previously detached.

To manually set the drive position:

1. In the **Set Position** dialog box (see ***Figure 72***), select **Continue with 2nd Feedback**.
2. In the upper field, enter the value you read on the drive.
3. Click **OK**.

   Neuro Omega compares the value you entered with the 2nd feedback, which is the value from the motor. One of the following happens:

- If the value you entered agrees with the value from the motor, the **Set Position** dialog box closes.
- If the value from the motor disagrees with the value from the drive, the **Set Position** dialog box closes but then reopens. Proceed to step *4*.

4. Select **Continue without 2nd Feedback** (*Figure 74*), and then, in the upper field, enter the value you read on the drive.

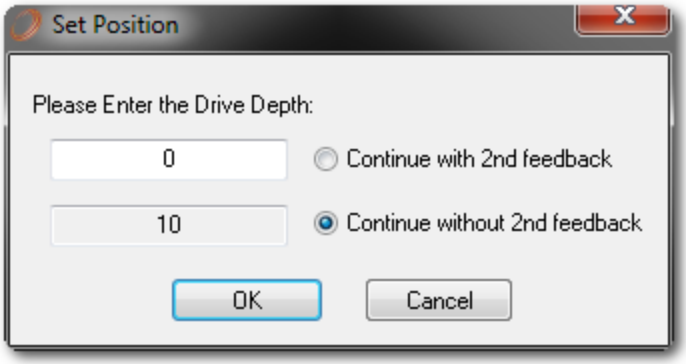


Figure 74: Set Position – Continuing without 2nd Feedback

5. Click **OK**.

   The **Set Position** dialog box closes, and Neuro Omega continues with the value from the drive; not the value from the motor or from the software.

> **Note:** If, as in step *4*, you must continue without the feedback from the motor, contact Alpha Omega support.

4.13. CHECKING IMPEDANCE

This procedure describes how to check the impedance of the electrodes and the modules. This 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.

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

4.14. MANIPULATING THE DRIVE HEADSTAGE

> **Note:** This section does not apply for the MER Only Headstage

This procedure describes how to lower the electrode towards the target, using the drive. This procedure is performed in conjunction with section ***4.15***.

To lower the electrode toward the target:

1. In the **Trajectory** area, do the following:
   a. Verify you are viewing the correct hemisphere.
   b. In the graph, click within the vertical electrode track strips until the electrode track you plan to manipulate appears circled in the Bengun representation at the bottom right.
2. In the **Step Size** field, enter a positive value, maximum 1 millimeter.
3. Do the following:
   - In the toolbar of the Workspace, click **Drive In** to drive the electrode down one step towards the target (clicking **Drive Out** drives the electrode up one step away from the target).
   - From the remote control, turn the thumb wheel to the right to drive the electrode down towards the target (turning it to the left drives the electrode up away from the target).

> **Note:** The further you rotate the thumb wheel, the quicker the distance of the step is covered. Using the thumbwheel replaces the slider in the **Drive Speed** area of the Settings dialog box (see section ***4.9***, step ***4***).

Each drive movement appears in the **Trajectory** area.

Adjust the scale of the **Trajectory** graph as required by doing the following:

a. Right-click and drag to move the scale up and down.
b. Left-click and drag to zoom in and out within the scale.

To make identifying areas easier, use the **Colors** bar, as follows:

a. Select a color.

b. Highlight an area in the electrode track strip.

4.15. MONITORING ACTIVITY

The following procedure describes how to perform online monitoring of the electrophysiological activity derived from the Drive Headstage and the modules. This monitoring is used for target localization. Monitoring activity is generally performed in conjunction with manipulating the Headstage, described in ***4.14***, at each recording site.

To monitor electrophysiological activity:

- See section ***4.15.1*** for monitoring any of the following channels:
  - **EEG**: Electroencephalography signals
  - **EMG**: Electromyography 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 ***4.15.1.6*** for monitoring spikes from the micro tip in the spikes raster.
- See section ***4.15.1.6*** for monitoring segmentation spike sorting from the micro tip.
- See section ***4.15.2*** for monitoring Digital input and Port signals from and external digital input system

4.15.1. Monitoring Channels

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

To monitor a channel:

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

   The window appears (***Figure 75***), with each channel in the window appearing in its own graph.

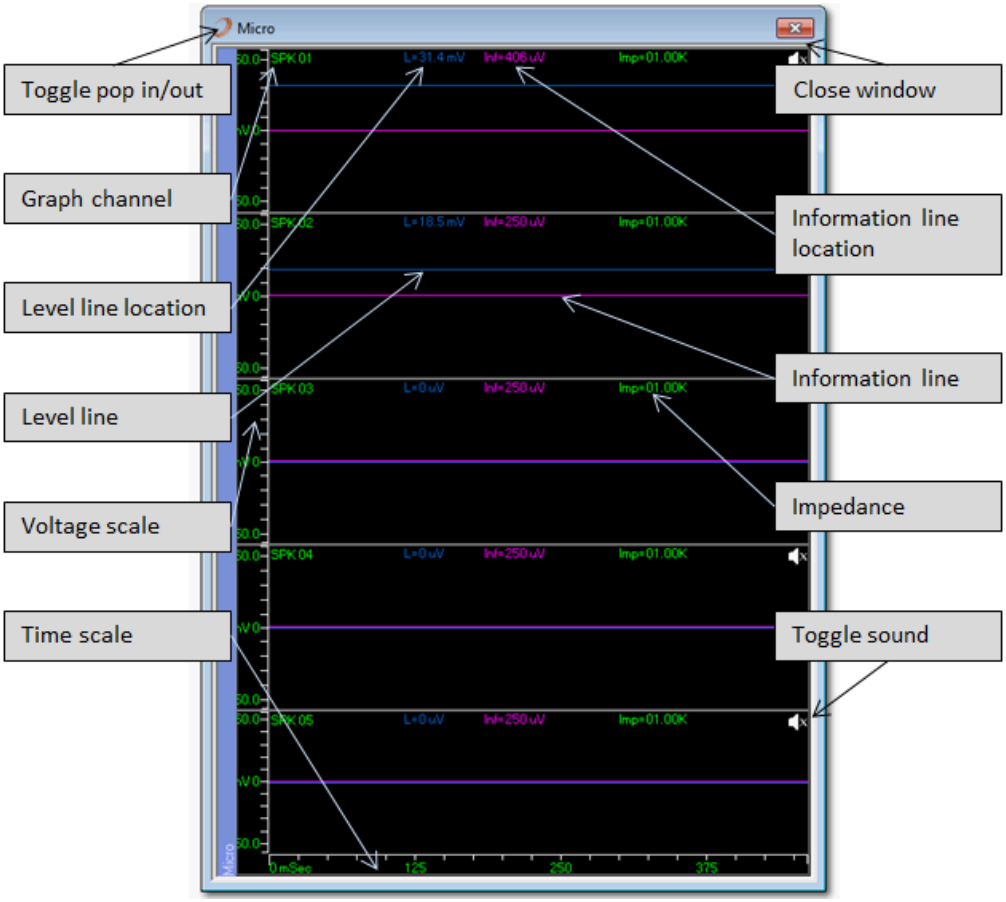


Figure 75: Channel Workspace Window

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 ***4.13***.
   - Adjust the channel voltage or time scales, as described in section ***4.15.1.1***.
   - Listen to a channel sound, as described in section ***4.15.1.2***.
   - Ground a channel, as described in section ***4.15.1.3***.
   - Change the channel name, as described in section 4.15.1.4.
   - Make use of the information line by clicking the line and dragging it up or down, as described in section ***4.15.1.4***.
   - Apply a recording reference to the contact, as described in section ***4.15.1.6***.
   - 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 ***4.15.3.2***, and monitoring spikes in the spikes raster window, as described in section ***4.15.4***.

4.15.1.1. 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 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 zoom in, drag rightward on the scale.
   - To zoom out, drag leftward on the scale.
   - 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 Time Scale area, enter the duration that the graphs should cover, in milliseconds, and then click OK.

   The scales change accordingly.

4.15.1.2. Toggling a Channel's Sound

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

To toggle a channel sound on and off:

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

Press the **Sound** button to turn the sound on or off.

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

4.15.1.3. Grounding a Channel

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

To ground a channel:

1. In the graph of the applicable channel, 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**.

4.15.1.4. Changing a Channel Name

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

To change a channel name:

1. In the graph of the applicable channel, right click, and then select **Set Name**.
2. Type the new name of the channel in the **Channel New Name** box, and click **OK**.

Figure 76: Set Channel Name

4.15.1.5. Using the Information Line

This procedure describes how to use the information line (see ***Figure 75***) in channel graphs (informational only). It enables the user to measure the amplitude of the signal. It is a displayed figure only and has no effect on segmentation.

To use the information line:

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

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

4.15.1.6. 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 of reducing the amount of noise. This is known as flexible referencing.

Consider the following while using the flexible referencing function:

- In general, use an electrode that is lacking in 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, EMG, 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 77***).

Figure 77: Macro LFP 01 Referencing Macro LFP 02

4.15.2. 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 78***), with each input bit in the window appearing in its own graph.

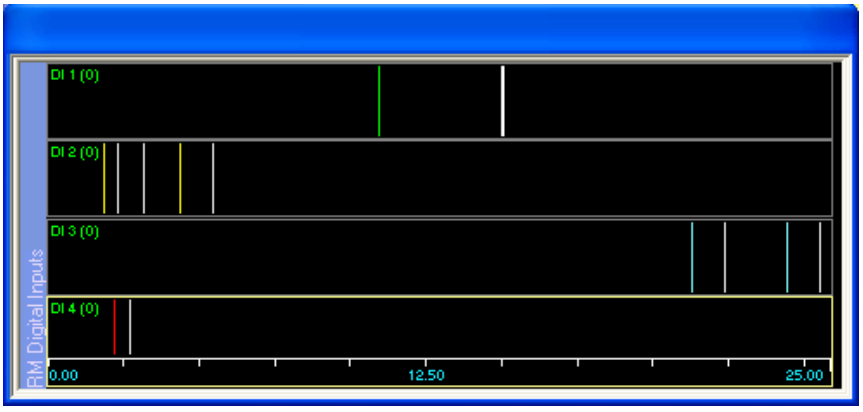


Figure 78: Single-Bit Digital Input Display

For each input bit:

- A colored tic mark indicates the change to active high (1).
- A white tic mark 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 ***4.15.1.1***.

4.15.3. Monitoring Micro Segmentation Spike Sorting

This procedure describes how to monitor micro segmentation spike detections. This is done, 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, as described in section ***4.15.3.1***.

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 ***4.15.3.2***.
2. For each template, define the template variation, as described in section ***4.15.3.3***.
3. For each template, add Include Windows, as described in section ***4.15.3.4***.
4. Monitor the spike segments per template, as described in section ***4.15.3.5***.

4.15.3.1. Main Segmentation Window Navigation

The main segmentation window (*Figure 79*) 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

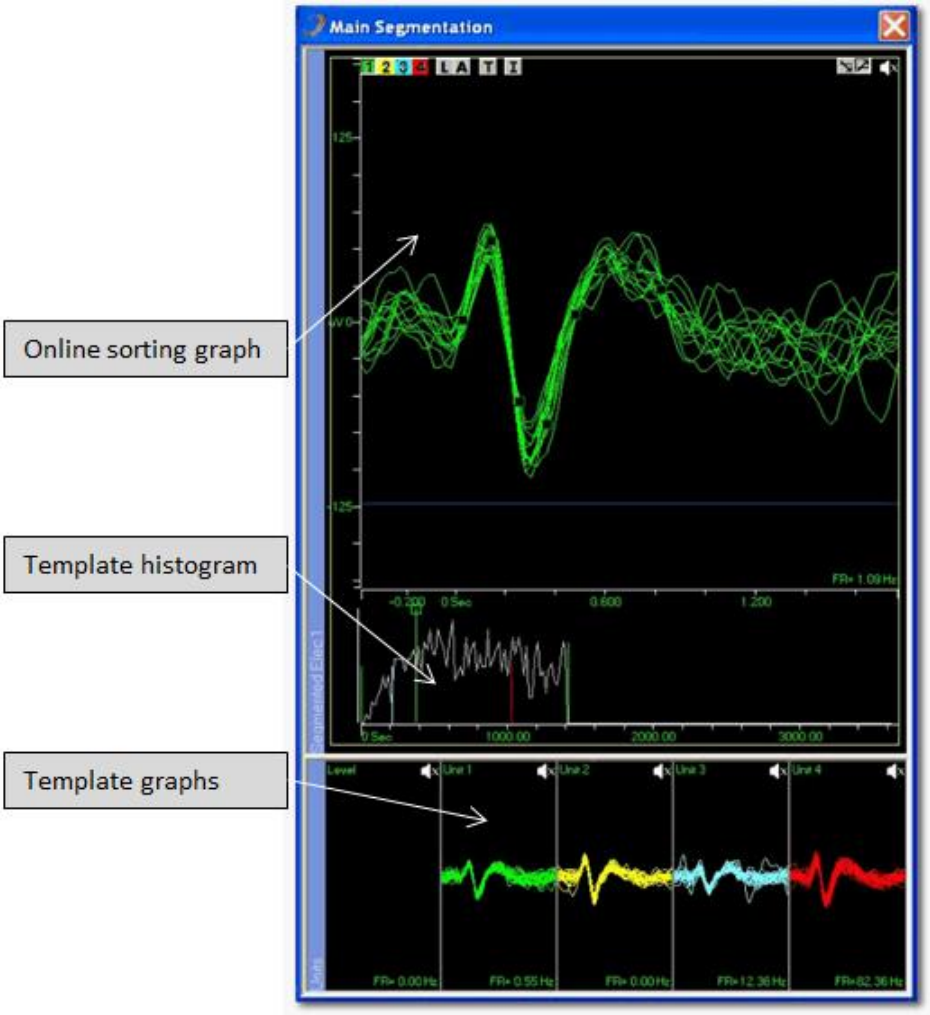


Figure 79: Main Segmentation Dialog Box

The online sorting graph toolbar (*Figure 80*) contains the following tools:

Figure 80: 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.

- (**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.
- (**Level**): When selected, only unsorted spikes are displayed. No template points, window discriminator, or histogram are shown.
- (**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.
- **(Define Templates)**: Freezes the spike segments, and commences template definition mode.
- (**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 at the bottom right corner of the online sorting graph. When is selected, the firing rate of the unsorted spikes is displayed. When is selected, the combined firing rate of all spikes is displayed.

4.15.3.2. Defining Spike Sorting Templates

This procedure describes how to define spike sorting templates. This 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 75*), 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 81***).

Figure 81: Color Coded Window Cursors

   - Saving options appear at the bottom of the graph (***Figure 82***).

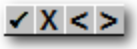


Figure 82: Template Definition Saving Options

   The following options are available:

   - 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.
   - After all templates have been defined, click ✓ to save.
   - If necessary, click X to cancel.

   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: Verify that the position of the window cursor includes the desired spikes. The actual position of the window cursor along the XY axis does not matter.

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, perform manual adjustments as described under Figure 81.

   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.

9. Continue with ***4.15.3.3*** to define the template threshold for each template.

4.15.3.3. Defining the Template Variation

This procedure describes how to define the template variation for a spike sorting template defined in section ***4.15.3.2.*** It is the second step in ***Monitoring Micro Segmentation Spike Sorting.***

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

The template threshold is defined using the template histogram (***Figure 83***), which displays a distribution of spike variability.

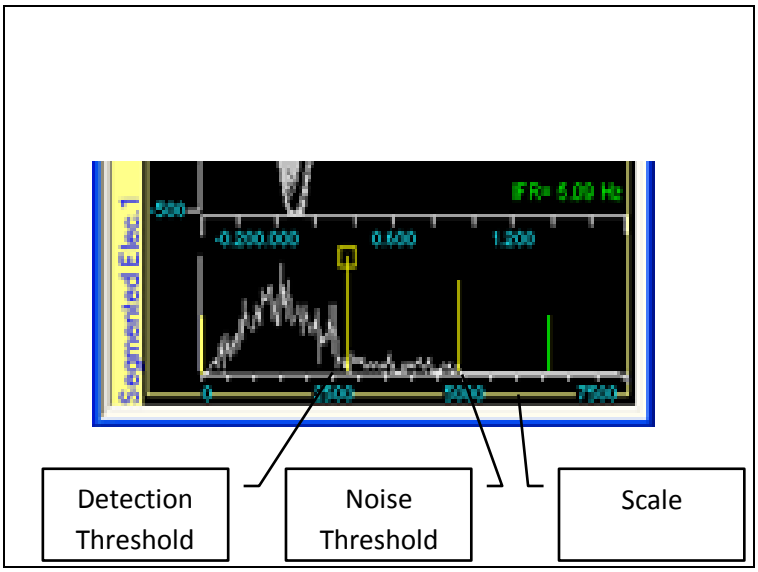


Figure 83: Template Histogram

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 80, page 99***).

   Only that template spikes appear in the graph; below it, the graph the template histogram appears (see ***Figure 83***).

2. Do the following:
   a. Drag the X axis to include more or less spike distances. Including more spike distances allows you to set the threshold more accurately.
   b. 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.
   c. 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.

4.15.3.4. 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 80***).
2. Only the present template spikes appear in the graph. Below it, the template histogram appears (see ***Figure 83***).
3. From the toolbar of the online sorting graph, click  .

   An Include Window, which looks like another window cursor, appears on the level line.
4. 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: Verify that the position of the window cursor includes the desired spikes. The actual position of the window cursor along the XY axis does not matter.

5. To add another Include Window, do the following:

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

      Another Include Window appears on the level line.

   b. Repeat step 4 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 **I**.

4.15.3.5. 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:

- 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.
- 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 84*).

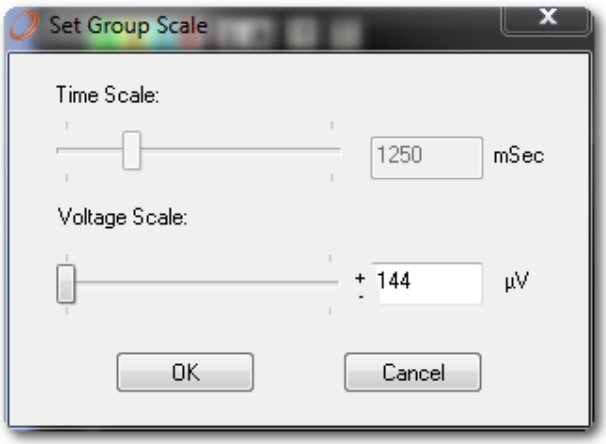


Figure 84: Set Group Scale Dialog Box

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

     The voltage scale is adjusted.

4.15.4. 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 ***4.15.3.2***, 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 ***4.15.3.2***.
     ii. Define the template threshold, as described in section ***4.15.3.3***.
     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 75***), 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 85***).

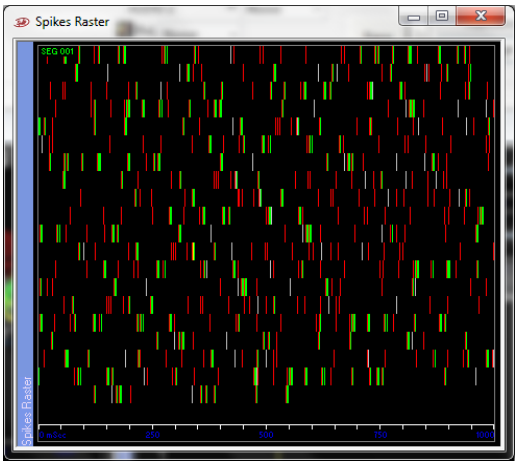


Figure 85: Spikes Raster Window

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

6. Right-click in the graph area, and then verify that **Level Line** is selected.
7. Right-click again in the graph area, and then select **Options**.

   The **Raster Options** dialog box appears (*Figure 86*).

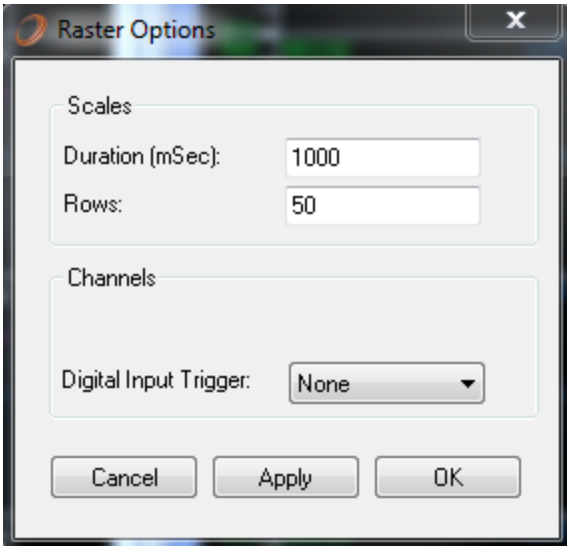


Figure 86: Raster Options Dialog Box

8. 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.
- 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**.

Note: See section *3.5* for connecting an external digital input system.

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

4.15.5. 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; i.e. 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 ***4.15.3.2***, 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 ***4.15.3.2***.
     ii. Define the template threshold, as described in section ***4.15.3.3***.
     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 75, page 93***), 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 85***).

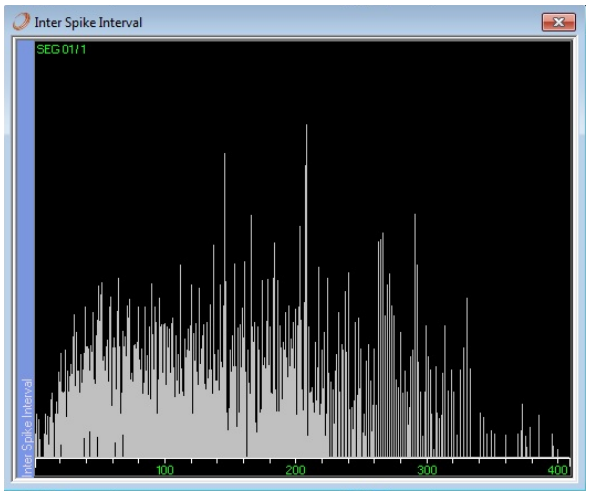


Figure 87: ISI Window

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

4.15.6. 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 represents time; X axis represents frequency range of the EEG channel (according to the channel 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 88).

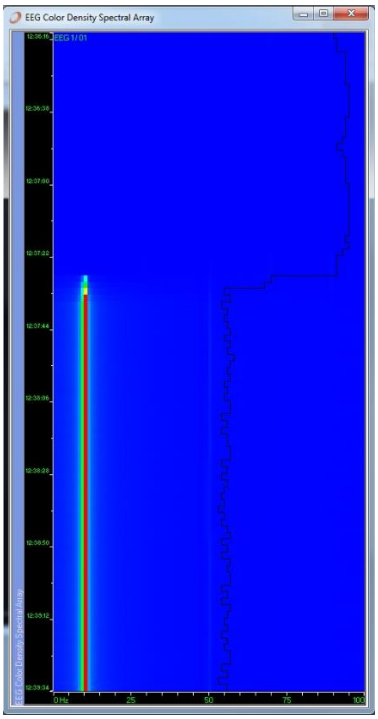


Figure 88: Color Density Spectral Array Window

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 89).

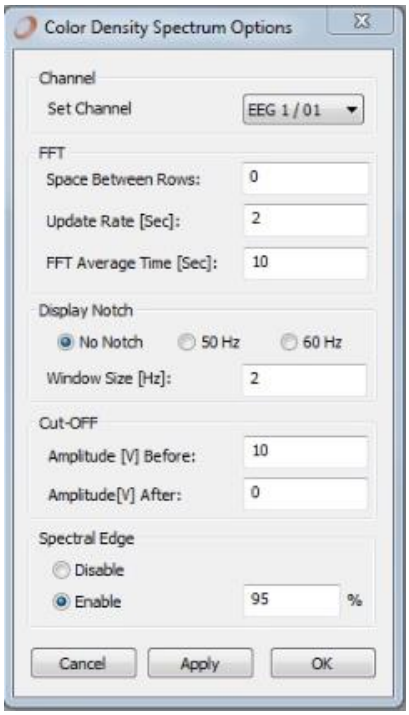


Figure 89: Color Density Spectral Array Dialog Box

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 50 Hz or 60 Hz to remove the unselected notch 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:

- When the chosen function entails clearing data or changing channel (for example, choosing a different channel, or changing the Cut-OFF settings), the outcome is not reversible – all previous calculations will be lost.

4.16. OPRA

OPRA (Online Pattern Recognition Algorithm) is a tool that provides visual feedback on neural activity throughout the trajectory. It appears in an electrode track of the **Trajectory** graph from the moment you create the new trajectory, and appears in a printed trajectory. Changes in neural activity and signal energy are estimated by two functions: the energy of the recorded signal and the spike firing rates. As these increase, the OPRA bar changes from white (no activity) to red (increased activity).

The OPRA process is as follows:

1. OPRA takes a two-second snapshot at each new depth while you drive the trajectory (data must be logged for this to occur – see section ***4.9***)
2. Based on the snapshot, OPRA calculates the increase in neural activity.
3. OPRA provides visual feedback in the electrode track of the trajectory in the **Trajectory** graph.

OPRA is calculated at each site with the root mean square of the spike signal at that site. The first five sites are used a reference for the track. Each electrode is calculated individually. Using OPRA can "help the surgical team assess in real-time the location of the STN in the trajectory." Particularly, "the entry into and exit from the STN can be predicted."*

4.16.1. Assessing OPRA Feedback

This procedure describes how to assess OPRA feedback in the Trajectory graph.

To assess OPRA:

1. At each recording site, in the Trajectory graph, select the electrode track for which to assess OPRA feedback.

   OPRA feedback appears for the electrode track (***Figure 90***).

* This process is described at length in *Real-Time Refinement of Subthalamic Nucleus Targeting Using Bayesian Decision-Making on the Root Mean Square Measure*, by Moran, Bar-Gad, Bergman, and Israel.

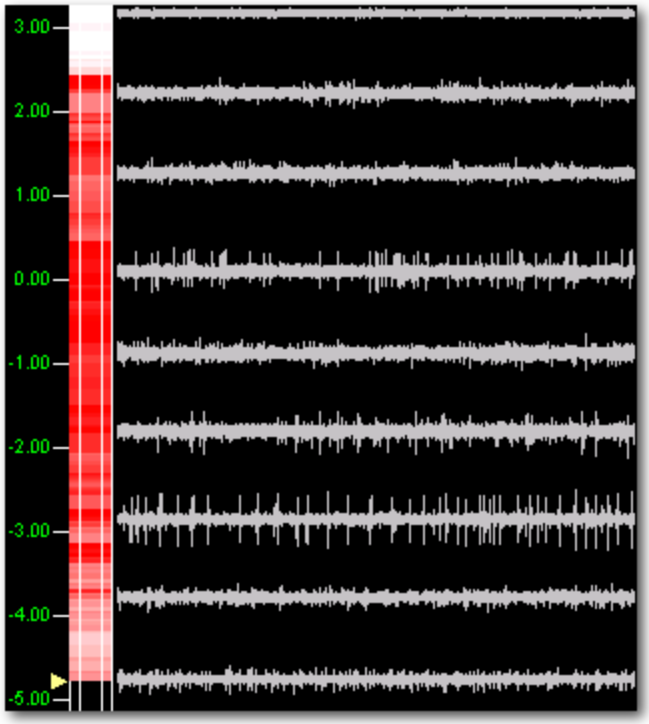


Figure 90: OPRA Feedback Appearing in the Trajectory Graph

2. Assess the OPRA feedback, as follows:
   - If the OPRA representation is white, this indicates low neural activity.
   - If the OPRA representation is red, this indicates high neural activity.

4.16.2. OPRA Best Practices

For best use, do the following:

- Create the new trajectory only after everything else (electrodes, cables, assembly) has been prepared, as setting up can interfere with the OPRA calculation.
- Create the new trajectory after completing the impedance check as described in section ***4.13.***
- Move the threshold for spike sorting outside the noise, so that the firing rate is not calculated from the noise, as OPRA takes the firing rate into account.
- Ensure that **Save in Each Site** is selected, as described in section ***4.9.***

4.17. USER EVENTS

The following procedures describe methods for inserting placeholders in the log file, at each recording site, for subsequent review:

- Marking Events from the **Events Control Panel**, as described in section ***4.17.1***
- Marking Events while in the Events Definition table, as described in section ***4.17.2***
- Adding remarks, as described in section ***4.17.3***

Before the operation, define the events you expect to encounter during the experiment, as described in section ***4.7***. During the operation, have the Events Control Panel open to mark these events.

All event values are stored in user-defined digital port number 21, while remarks are stored in Stream Format. The default log file location is under the patient reference in the surgeries data folder on C:\.

Note: New events are not saved across patients.

4.17.1. Marking Events from the Events Control Panel

This procedure describes how to mark events on the **Events Control Panel**. The events appear in the log files for review.

This is the simpler way of marking events. The other way is from the **Events Definition** table, as described in section ***4.17.2***.

To mark events:

1. From the toolbar, click **Events Properties**.

   The **Events Control Panel** appears (see ***Figure 68***). The panel contains a number of predefined events for convenience.

2. To mark an event, in the **Predefined Events** area, do one of the following:
   - Select an event button.
   - From the dropdown list, select an event.
3. Click **Send**.

   The event is marked in the log file.

4.17.2. Marking Events from the Events Definition Table

This procedure describes how to mark events while already in the **Events Definition** table. This is helpful if you have edited events (see section ***4.7.2***) during monitoring. The events appear in the log files for review.

The simpler way to mark events is from the Events Control Panel, as described in section ***4.17.1***.

1. From the **Events Definition** dialog box (see ***Figure 69, page 81***), select the event you want to send for logging, and then click Send.

   The event is marked in the log file.

4.17.3. Adding Remarks

This procedure describes how to add remarks, which are text comments. The remarks are stored in the log file in a stream format.

To add remarks:

1. From the toolbar, click **E** **Events Properties**.

   The **Events Control Panel** appears (see ***Figure 68***); the panel contains a number of predefined events for convenience.

2. Click **Mark**.

   The following happens (***Figure 91***):

   - The text field is enabled.
   - The **Mark** button changes to **Cancel**.
   - After entering text in the **Remarks** field, the **Send** button activates.

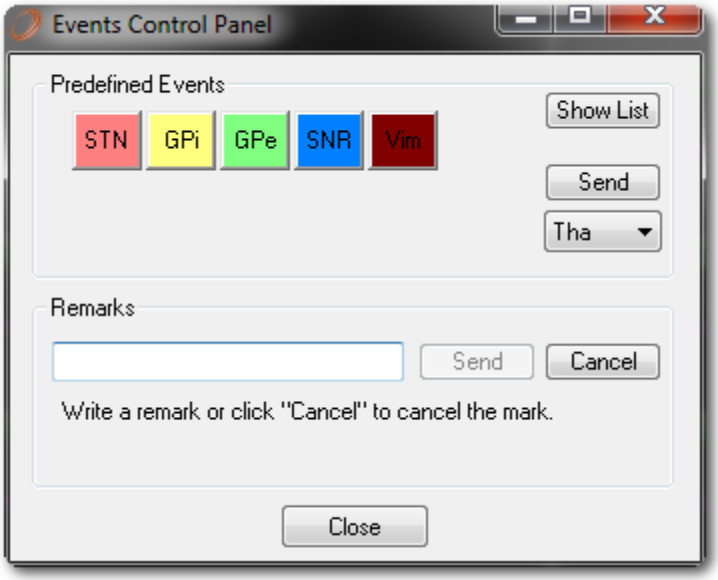


Figure 91: Events Control Panel, Remarks Enabled

If you want to cancel the remark, click **Cancel**.

3. Enter your remark, and then click **Send**.

   In the log file, the timestamp of the message is from when the user clicked **Mark**.

4.18. TRAJECTORY PRINTING

The following procedures describe printing the trajectory, which is useful for review:

- ***Printing the Selected Track***
- ***Printing an Active***

The printout can be saved and attached to the patient file, or viewed later to compare all the depths together. OPRA (see section ***4.16***) is also shown in the dots on the depth locations.

4.18.1. Printing the Selected Track

This procedure describes how to print the selected recording site in the Trajectory graph for review.

To print the trajectory:

1. Double-click anywhere on the trajectory graph (***Figure 66***).

   The **Print Trajectory** dialog box appears (***Figure 92***), containing a version of the **Trajectory** graph, as follows:

   - Each row of the graph describes the activity of one recording site.
   - The recording sites are divided into pages of ten to a page.

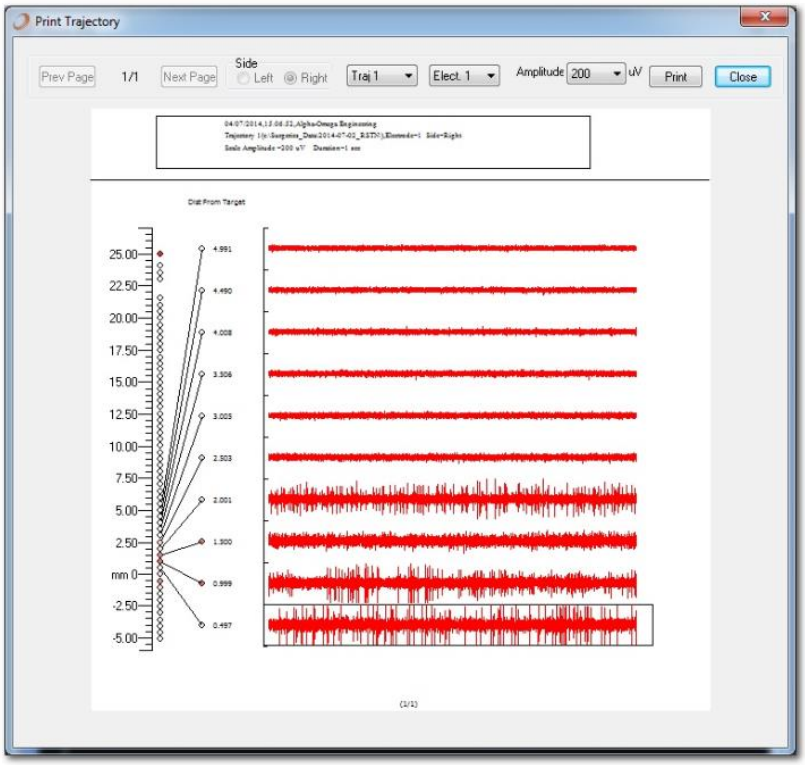


Figure 92: Print Trajectory for a Selected Track

2. Prepare the print job by selecting, from the **Amplitude** dropdown list, the amplitude, in millivolts, of the traces that you want to appear in the print job.
3. Click **Print**.

   The trajectory is printed.

4.18.2. Printing an Active Track

This procedure describes how to print any of the active tracks for review.

To print the trajectory:

1. From the toolbar, click **Print Trajectory**.

   The **Print Trajectory** dialog box appears (***Figure 93***), containing a version of the **Trajectory** graph, as follows:

   - Each row of the graph describes the activity of one recording site.
   - The recording sites are divided into pages of ten to a page.

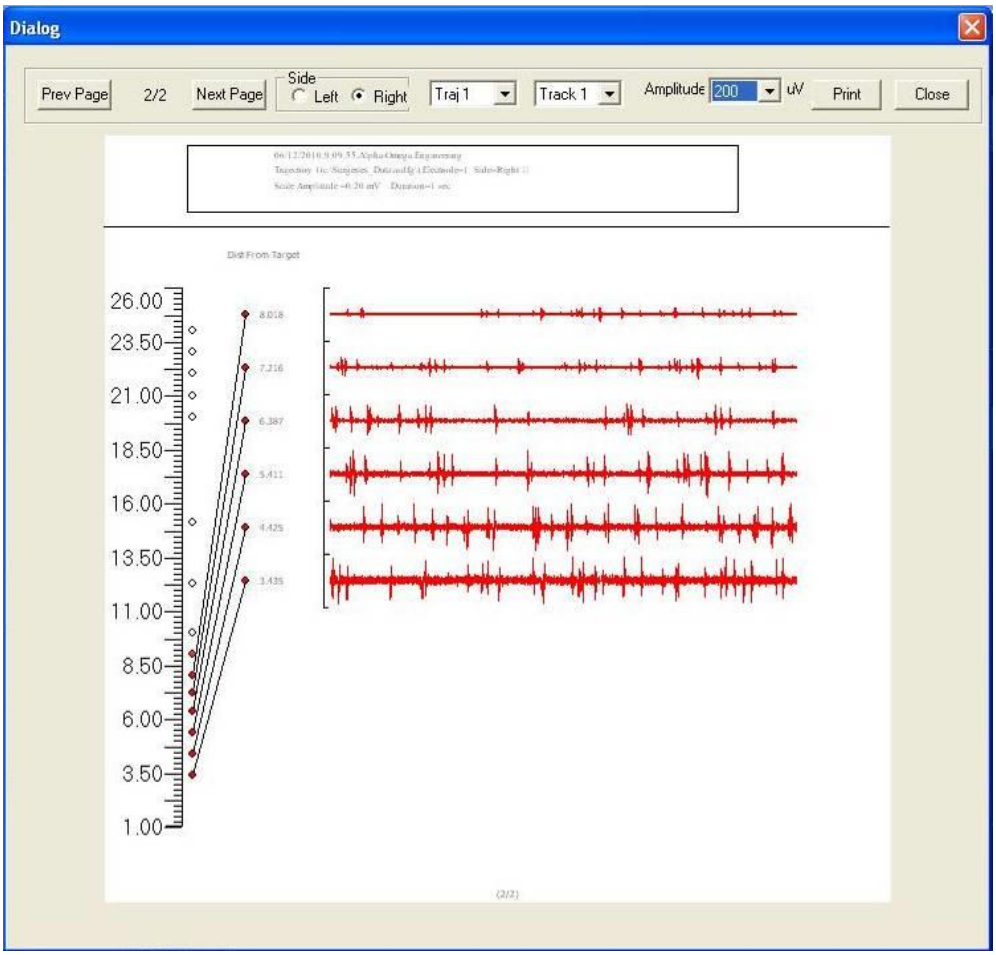


Figure 93: Print Trajectory Dialog Box

2. Prepare the print job by doing any of the following:
   - Click **Prev Page** or **Next Page** to open the page of recording sites you want to print.
   - In the **Side** area, select the hemisphere of the trajectory you want to print.
   - From the **Trajectory** dropdown list, select the trajectory (left or right) you want to print.
   - From the **Track** dropdown list, select the track of the trajectory that you want to print.
   - From the **Amplitude** dropdown list, select the amplitude of the traces that you want to appear in the print job, in millivolts.
3. Click **Print**.
   - The trajectory is printed.

4.19. 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. Settings for saving automatically are located in the **Settings** dialog box, as described in section ***4.9***.

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

To save manually:

Do any of the following:

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

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)
  - Displays OPRA (see section ***4.16***)
- Save the continuous data to the log file

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

4.20. STIMULATION

Perform stimulation after successfully determining placement (see section ***4.1***, step ***9***). 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 ***4.20.1***.
2. Apply the stimulation, as described in section ***4.20.2***.
3. Monitor the stimulation with the current monitor, which displays the real injected current value, as described in section ***4.20.3***

4.20.1. 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 up stimulation:

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 94***).

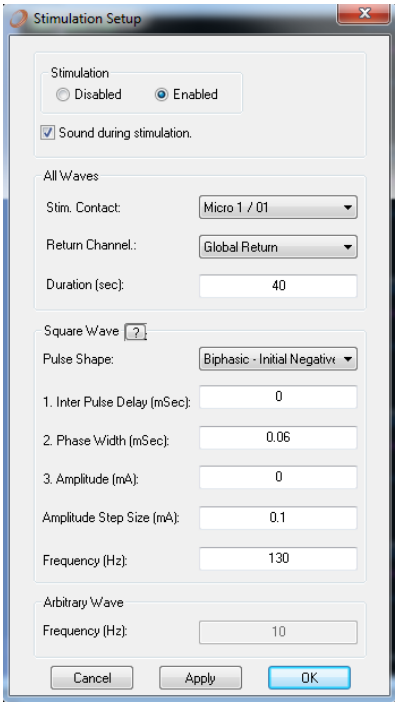


Figure 94: Stimulation Setup Dialog Box

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 louder to hear this.

- In the **All Waves** area define the following:
  - **Stim. Contact:** is the required stimulation contact. From the Dropdown box, select any contact available for stimulation.
  - In the **Return Channel** dropdown list, select the channel through which to return the stimulation (see section 4.20.2, step 1) by doing one of the following:
    - If you plan to apply the stimulation from a micro channel, select another micro channel or a macro channel.
    - If you plan to apply the stimulation from a macro channel, select another macro channel.
    - If you plan to apply the stimulation from an EMG channel, select another EMG channel.
    - Select **Global Return** for the current to return through the global stimulation return. In the Drive Headstage, this is shorted to ground. In the Headbox modules, there is an individual connector (see section 3.4).

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

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

Note: When applying stimulation, 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:

- If you selected the **Biphasic** waveform from the **Pulse Shape** dropdown list, each phase has this 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 between pulses in milliseconds.
- In the **Phase Width** field, type the duration of the phase in milliseconds.
- In the **Amplitude** field, type the pulse phase amplitude of the stimulation in milliamps.
- 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 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 ***4.21***.

4.20.2. 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:
     i. From the toolbar, from the **Stim Channel** dropdown list (see ***Figure 63***), select a channel.
     ii. From the remote control (see ***Figure 22, page 36***), press the **Micro-Macro** button to select either micro or macro, and then press the arrow buttons to select the channel.
   - To adjust the current amplitude of the stimulation if necessary (in milliamps):

i. From the toolbar, in the **Stim Amplitude** field, click the **Up** and **Down** buttons.

ii. From the remote control, press the **+** and **-** buttons.

2. To apply the stimulation, do the following:

   a. From the toolbar, click and hold down **Stim**.

   b. From 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 ***4.20.1***) is less.

3. Monitor the stimulation using the **Current Monitor** window, which displays the real injected current value, as described in section ***4.20.3***

4.20.3. Monitoring Stimulation in the Current Monitor Window

This 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 95***), 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 95: Current Monitor Window

Note: For safety reasons, if the measured value is above the requested value by more than 30%, the system stops the current and the Current Monitor displays purple.

4.21. DEFINING AND MONITORING THE EVOKED POTENTIAL

This procedure describes how to define the potentials evoked upon stimulation are viewed in the evoked potentials window, and then monitor the 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. 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 Evoke Potential window.

   The **Evoke Potential** window appears (***Figure 96***).

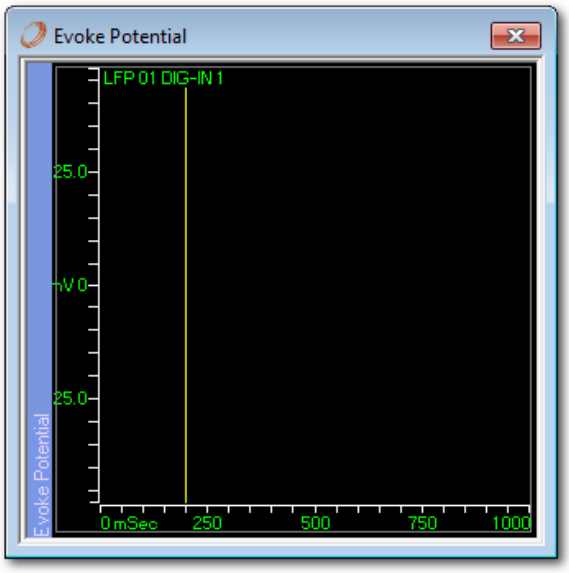


Figure 96: Evoke Potential Window

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

   The **Options** dialog box appears (***Figure 97***).

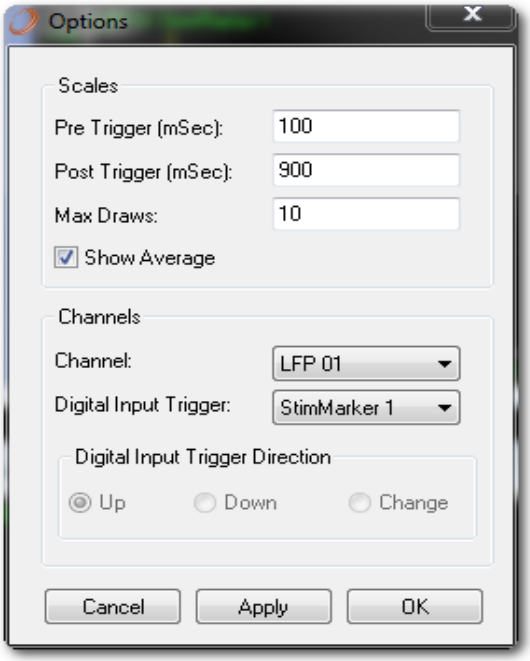


Figure 97: Evoked Potentials Options Dialog Box

2. Do the following:

   a. 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.

   b. 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.

   c. 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.

   d. In the **Channels** area, from the **Channel** dropdown list, select an **LFP** or **SPK** channel.

   e. From the **Digital Input Trigger** dropdown list, select a trigger for the tool to start creating the time-locked averages:

      i. Select a digital input trigger.

      The **Digital Input Trigger Direction** area becomes active (***Figure*** 98).

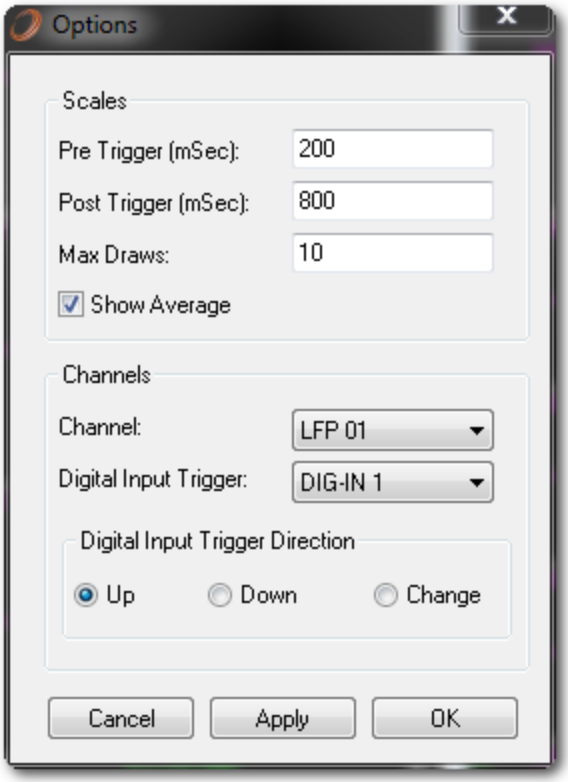


Figure 98: Evoked Potentials Options with DIG-IN Selected

ii. Select a **StimMarker** trigger.

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

3. 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 **Evoked Potentials** dialog box open.
   - Click **OK** to apply your settings and close the **Evoked Potentials** 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 expand the voltage scale, drag up on the scale.
   - To contract the voltage scale, drag down on the scale.

- 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** buttor , select the evoked potential window.

   The Evoke Potential window appears (***Figure 99***), displaying signals based on the stimulation in real time. Above the signals a colored line appears, displaying the average of all the signals.

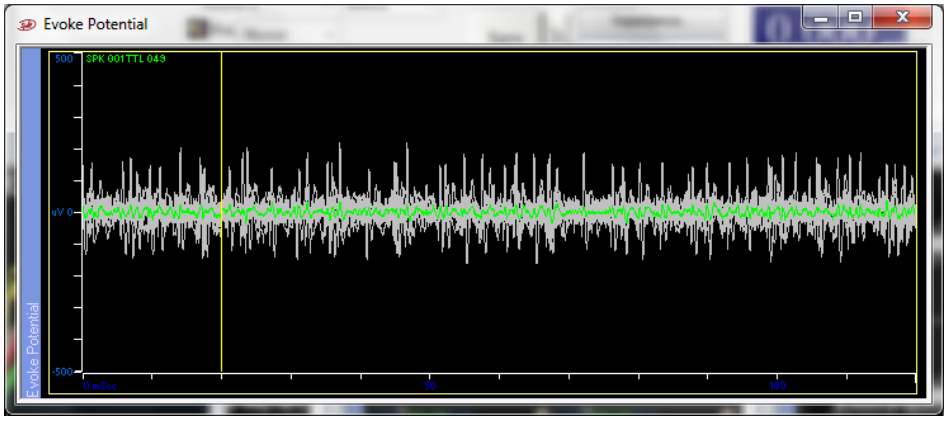


Figure 99: Active Evoked Potential Window

7. Adjust the channel voltage or time scales, as described in section ***4.15.1.1***.

4.22. 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 96, page 125*).

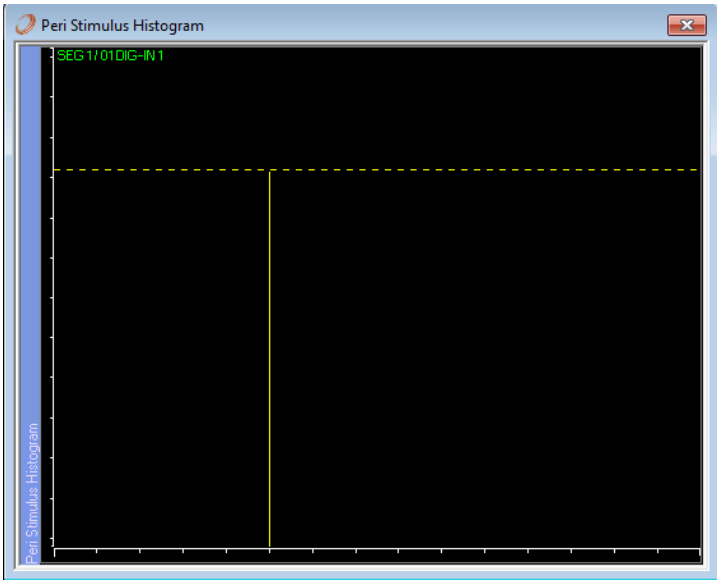


Figure 100: PSTH Window

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

   The **Options** dialog box appears (*Figure 97, page 125*).

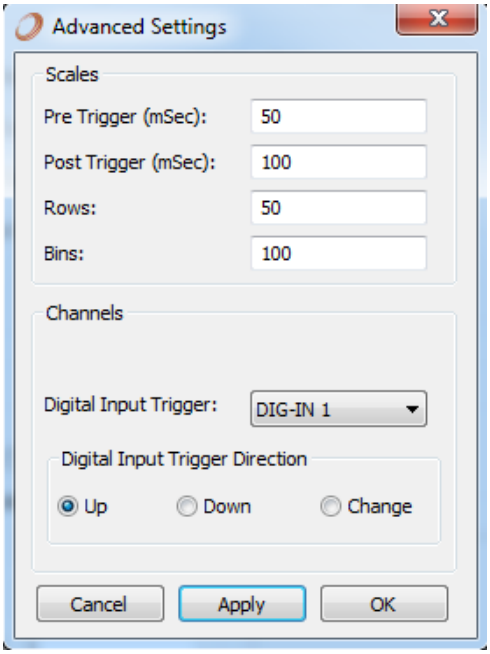


Figure 101: Evoked Potentials Options Dialog Box

3. Do the following:

   a. 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.

   b. 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.

   c. In the **Bins** field, enter the number of bins that can be drawn on every row in the **PSTH** lower part of the window. The amount of bins must be between 1 -100.

   d. From the **Digital Input Trigger** dropdown list, select a trigger for the tool to start creating the trigger-locked averages:

      i. Select a digital input trigger.

         The **Digital Input Trigger Direction** area becomes active.

      ii. Select a **StimMarker** trigger.

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

   e. 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 99***), displaying signals based on the triggering in real time.

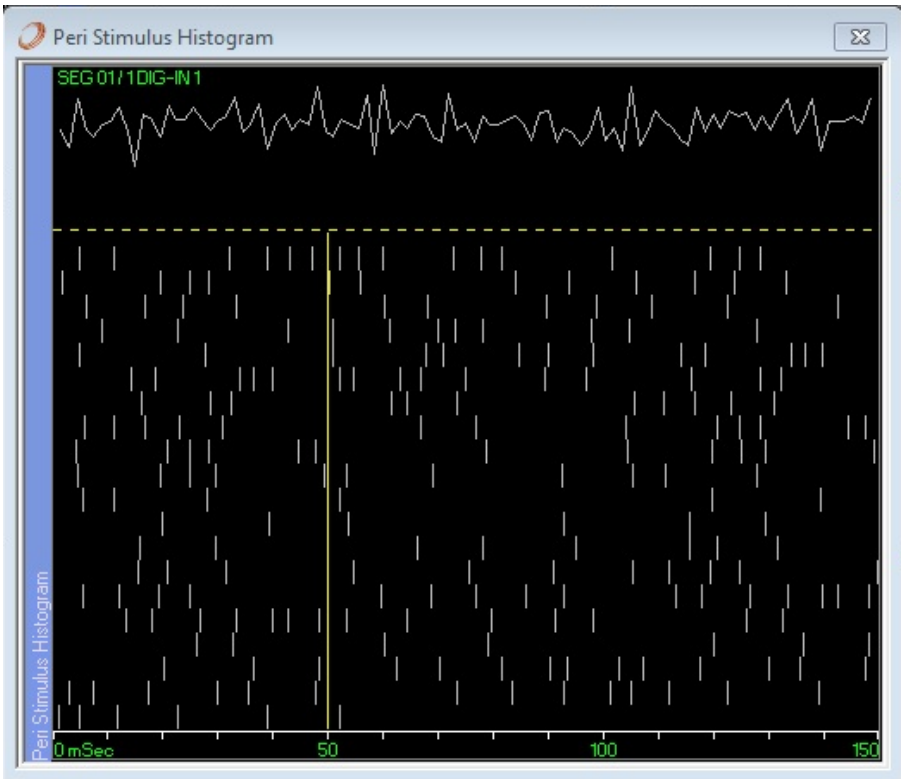


Figure 102: Active PSTH Window

7. Adjust the channel time scales, as described in section ***4.15.1.1***.

4.23. OPERATION OF THE NEURO OMEGA PLAYER MODE

Neuro Omega Player gives the option to replay and recreate the surgery.

- Replay all the surgery files or a chosen files on a computer, Offline Mode

> **Warnings:**
> Neuro Omega Player must not be used while Neuro Omega software is used.

4.23.1. Player Offline Mode

Powering the Player On.

This procedure describes how to power on the Neuro Omega Player in offline mode.

1. Power on the computer and double click the Main Player shortcut.

   The Patient window appears (Figure 103).

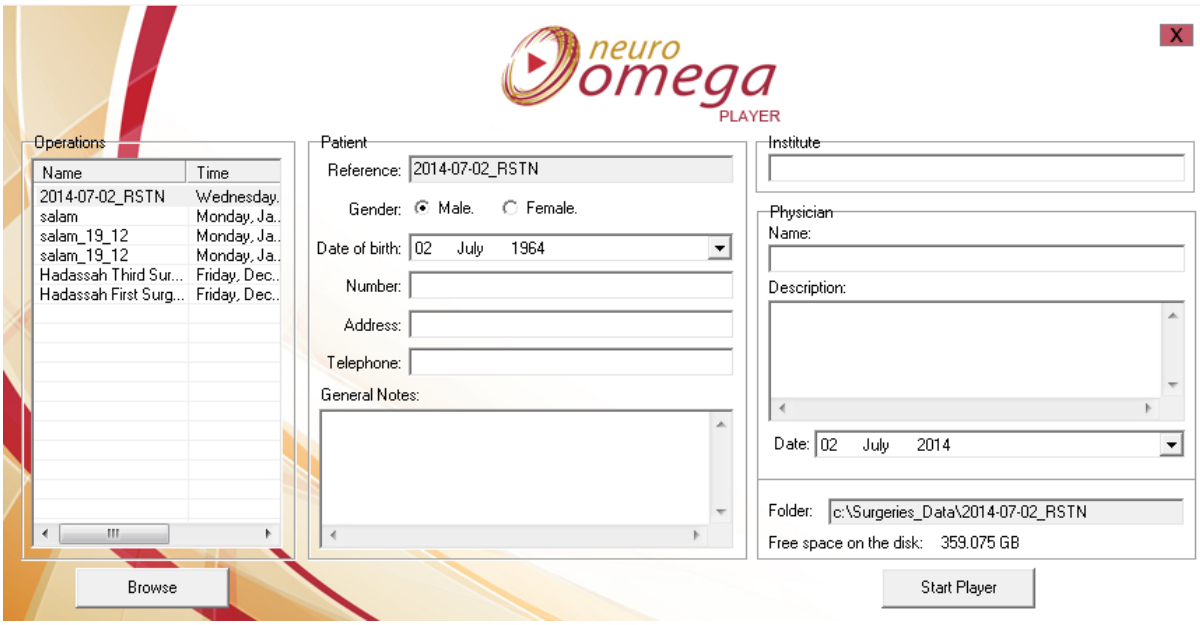


Figure 103: Patient window

Choosing operation

This procedure describes how to choose operation data in order to recreate the surgery.

To choose new surgery

1. Click on the **Browse** button and choose a surgery file from the window.

To choose an existing file

1. From the **Operations** area, click the chosen file name.

   The patient data is updated.

2. Click **Start Player**.

Neuro Omega Player Interface

The Neuro Omega Player interface is made of the following components:

- **Toolbar**: See section ***4.6.1*** for more information.
- **Workspace**: See section ***4.6.2*** for more information.
- **Trajectory Graph**: See section ***4.6.2.1*** for more information.
- **System Diagnostics**: See section ***4.6.4*** for opening system diagnostics.
- **Playlist (**Figure 104, page 134)
- **Slider Bar (**Figure 105, page 134)

Playlist

The playlist has two columns

- In case of a trajectory playlist, one column is for the distance from target and the other one for the total recording time.
- In case of a general playlist, one column is for the file name and the other one for the total recording time.

The Playlist contains the following buttons:

- **Open/hide playlist button**  : Opens or hides the playlist from the interface.
- **Browse button** 

: Opens a window to choose files to run by name.
- **Combobox** 

: Switches between playlists; only the selected playlist is shown.

Two ways to play a file

- Double clicking the file in the playlist will open it and run it.
- Double clicking the OPRA pane will start playing the closest recorded file to the clicked "Distance from target".

Slider Bar

The Slider Bar comprises the following components:

- **Time indicator** 

: Shows the total time of the current played playlist entry and the progress time of the presently played playlist entry.
- **Speed button** 

: gives the option to change the speed of the running file .
- **Repeat button**  **:** gives the option to repeat only the running file automatically or not to repeat , or to repeat the whole playlist .
- **Stop button**  **:** stops the running file.
- **Play button**  **:** plays or resumes to play the selected file .
- **Pause button**  **:** Pause the played file.
- **Previous/next button**  : enables the user to Select/Open/Play the previous/next playlist entry.

- **Indicates the playing progress**  .

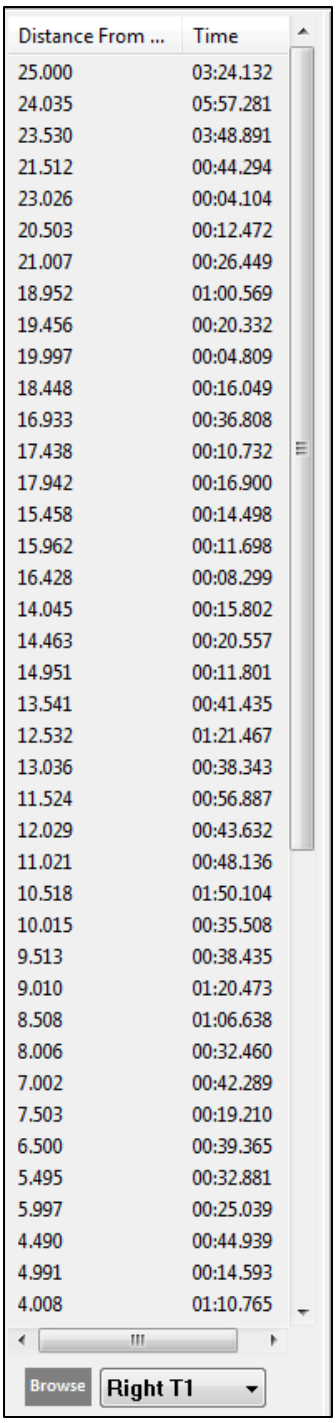


Figure 104: Playlist

Figure 105: Slider Bar

Replay Software Display

- **Distance from target** is updated according to the running file.
- **Step Size** is updated according to the running file.
- **Settings button** opens a window that includes the same data saved, related to the recording setup.
- While running a file with stimulation, the **Stim button** turns red and the Stim contact and amplitude are updated.
- If the running file includes impedance check, the **Imp button** turns red, and by pressing the button, a window with the result appears.
- **Stim Setup button** opens a window that includes the same data saved, related to the stimulation setup.

4.24. DRY RUN: DBS ELECTRODE HANDLING

> **Note:** This section does not apply for the MER Only Headstage

This procedure describes how to handle the DBS electrode.

1. Move the recording electrode to the exact depth in which you have determined to implant the DBS electrode, and then disconnect the electrode connections (***Figure 106***).

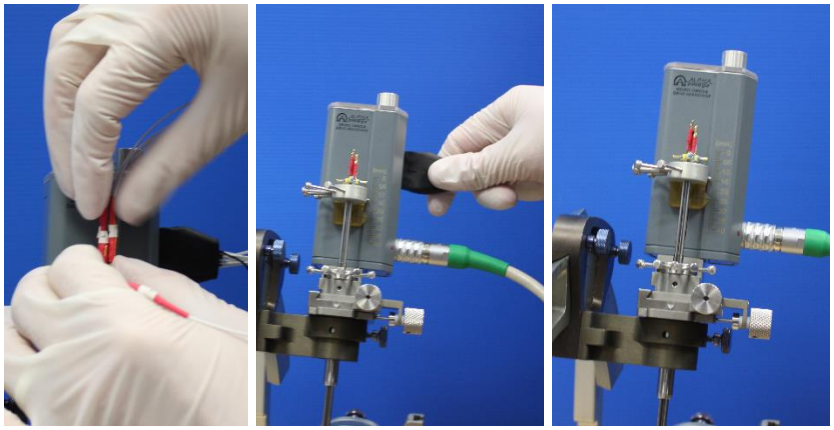


Figure 106: Disconnecting the Electrodes

2. Loosen the retaining screws on the electrode holder, and then remove all of the electrodes (Figure 107).

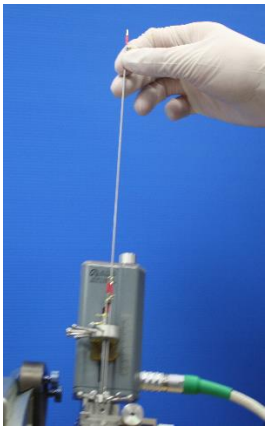


Figure 107: Removing the Electrodes

3. Remove the electrode holder (Figure 108), leaving the cannula connected to the Bengun.

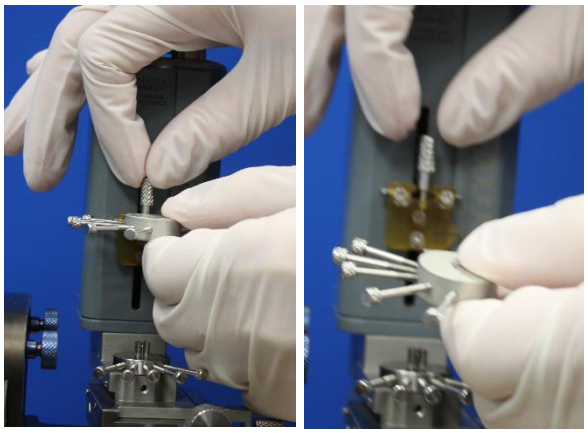


Figure 108: Removing the Electrode Holder

4. Attach and secure the DBS holder socket to the Drive Headstage. It attaches and locks in the same place and the same way as did the electrode holder (Figure 109).

Figure 109: Attaching the DBS Holder Socket

5. Connect the DBS holder to the ruler and secure screw (Figure 110).

Figure 110: Connecting the DBS Holder to the Ruler

6. Thread the DBS electrode into the clamps of the DBS holder, through the depressed area to prevent the DBS from being pinched by the clamps (Figure 111).

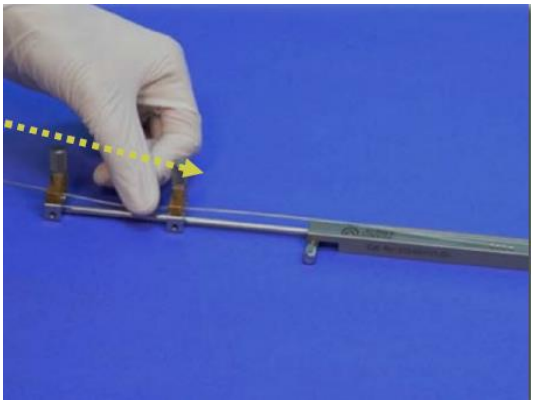


Figure 111: Threading the DBS into the DBS Holder

7. The 237 marker is where the micro-tip was (Figure 112)

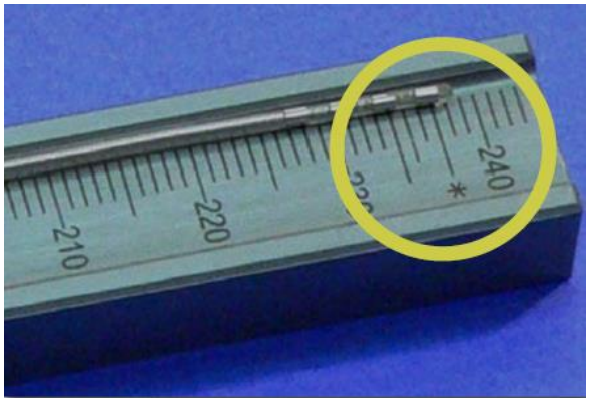


Figure 112: the 237 Marker

Note: The placement of the strips provides different options for stimulation during the patient programming phase.

8. On the DBS holder, while slightly pushing the DBS electrode downward, lock the clamps onto the DBS electrode, to hold the DBS electrode in place (Figure 113).

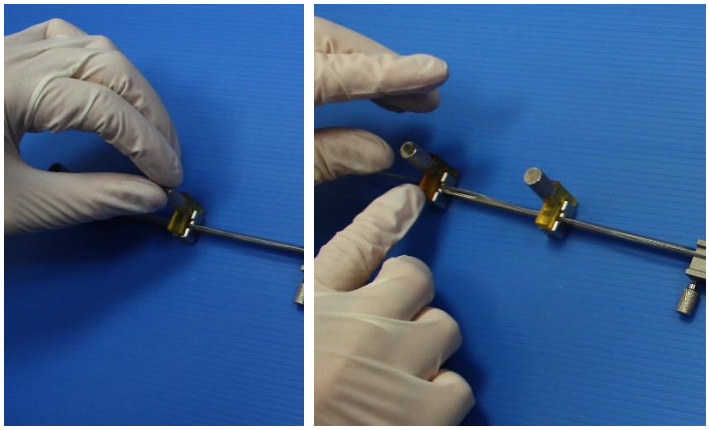


Figure 113: Locking the Clamps onto the DBS

9. Remove the DBS holder from the ruler (Figure 114).

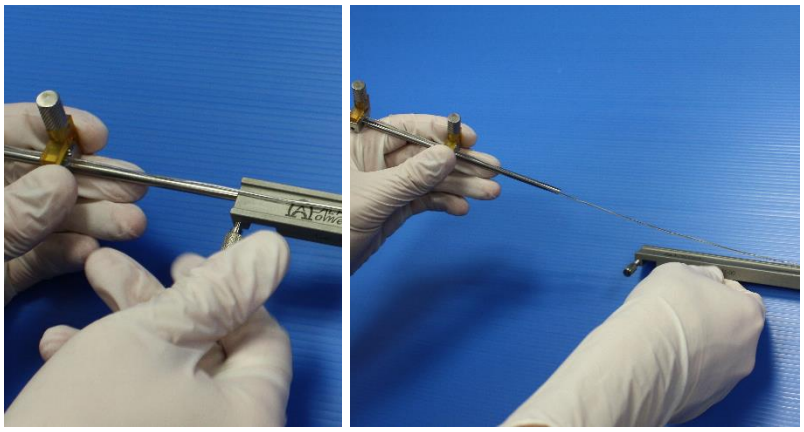


Figure 114: Removing the DBS Holder from the Ruler

The DBS electrode is now measured to the correct length.

10. Bring the DBS holder to the Drive Headstage Assembly (Figure 115).

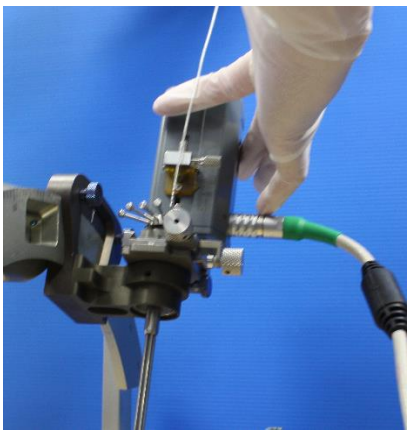


Figure 115: Threading the DBS into the Cannula

CHAPTER 5. ADVANCED CAPABILITIES

5.1. ADVANCED OVERVIEW

More advanced capabilities are as follows:

- Defining filtering and sampling properties, described in section 5.2.
- Defining options for the log files generated by the system during recording, described in section ***5.3***.
- Editing a contact channel, described in section ***5.5***.

> **Note:** Some advanced capabilities involve external systems. Connecting these systems is described in section ***3.5***.

5.2. 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 Micro, see section ***5.2.1***.
- For Macro, see section ***5.2.2***.
- For EEG, see section ***5.2.3***.
- For EMG, see section ***5.2.4***.

You can also change a channel name, as described in section ***5.2.5***.

5.2.1. Controlling Micro Filtering and Sampling Properties

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

To control micro filtering and sampling properties:

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

   The **Channels Settings (Micro)** dialog box appears (***Figure 116***), displaying relevant information on all of the channels derived from the micro contact type.

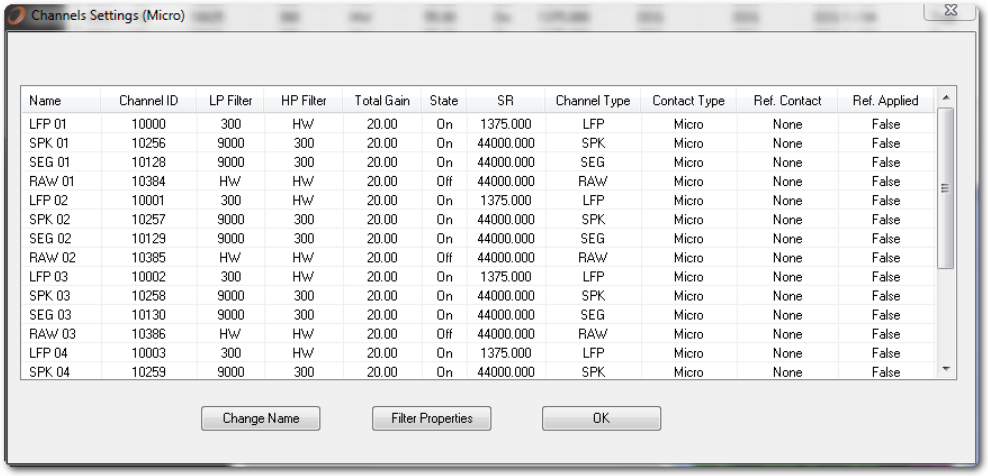


Figure 116: Channel Settings Dialog Box (Micro)

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

   The **Filter Properties (Micro)** dialog box appears (Figure 117)

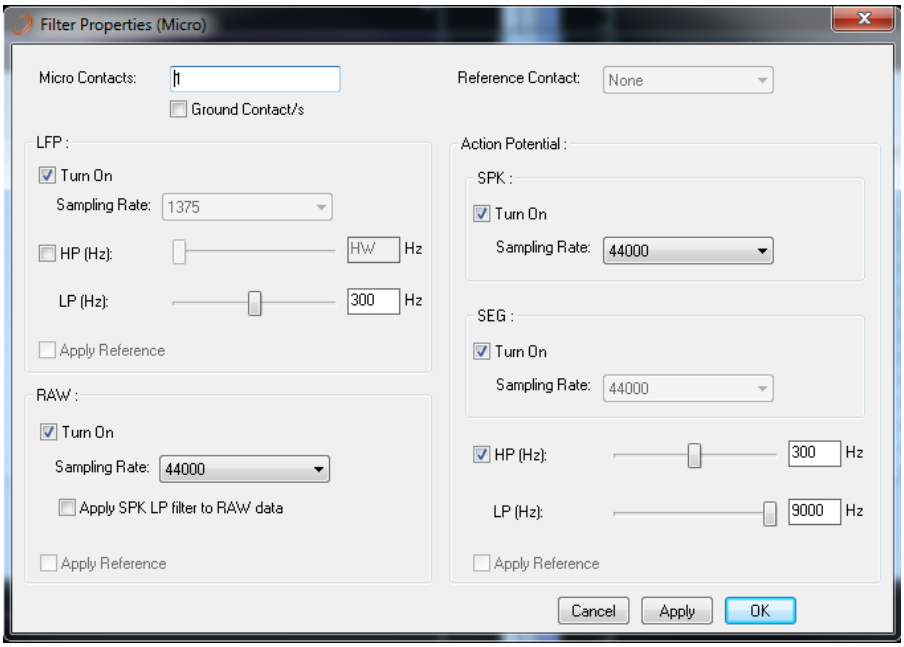


Figure 117: Filter Properties Dialog Box (Micro)

4. Do the following:

   a. In the **Micro 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.

   b. In the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***4.15.1.6*** for more information on flexible referencing.

   c. Select **Ground Contact/s** if you want the contacts entered in **Micro Contacts** grounded. See section ***4.15.1.3*** for more information on grounding a contact.

   d. In the **LFP** area, do the following:

      i. Select **Turn On** to enable the acquisition of LFP signals.

      ii. View the **Sampling Rate** field, which shows the LFP signal sampling rate.

      iii. From the **HP (Hz)** slider bar, select the high pass filter for the LFP signals. If the checkbox is not selected, it will be only HW filters.

      iv. From the **LP (Hz)** slider bar, select the low pass filter for the LFP signals.

e. In the **RAW**: This section is related to the raw continuous signals.

i. Select **Turn On** to enable the acquisition of raw signals.

ii. From the **Sampling Rate** dropdown list, select the raw signal sampling rate.

iii. Select **Apply SPK LP filter to RAW data** if you want the system to apply the SPK LP filter to the RAW data before.

f. In the **SPK** area of the **Action Potential** area, do the following:

i. Select **Turn On** to enable the acquisition of SPK signals.

ii. From the **Sampling Rate** dropdown list, select the SPK signal sampling rate.

g. In the **SEG** area of the **Action Potential** area, do the following:

i. Select **Turn On** to enable the acquisition of segmented signals.

ii. View the **Sampling Rate** field, which shows the segmented signal sampling rate, which is the full sampling rate of the system.

h. From the **HP (Hz)** slider bar, select the high pass filter for the SPK and SEG signals. If the checkbox is not selected, it will be only HW filters.

i. From the **LP (Hz)** slider bar, select the low pass filter for the SPK and SEG signals.

5. Do one of the following:

a. Click **Apply** to apply the new settings.

b. Click **OK** to apply the new settings and close the dialog box.

5.2.2. Controlling Macro Filtering and Sampling Properties

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

To control macro filtering and sampling properties:

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

   The **Channels Settings (Macro)** dialog box appears (***Figure 118***), displaying relevant information on all of the channels derived from the macro contact type.

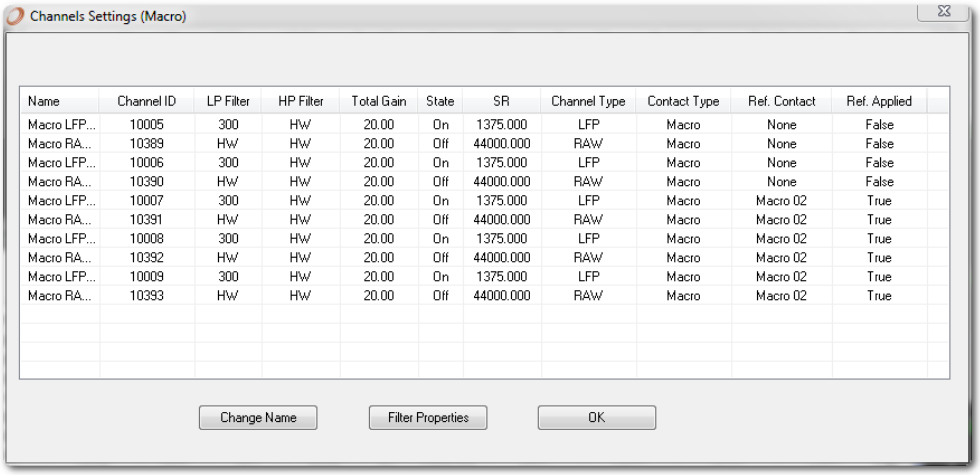


Figure 118: Channel Settings Dialog Box (Macro)

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

   The **Filter Properties (Macro)** dialog box appears (***Figure 119***).

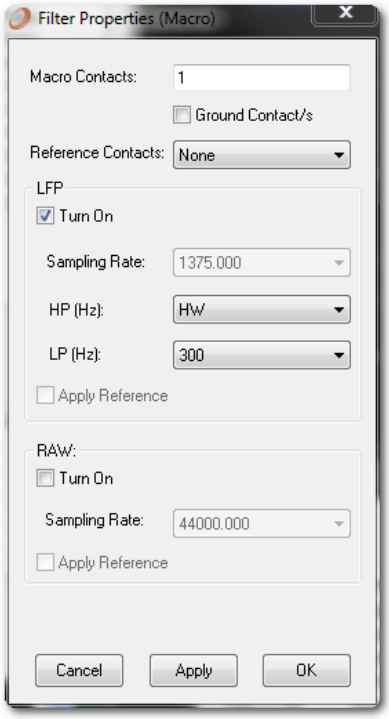


Figure 119: Filter Properties Dialog Box (Macro)

- Do the following:
  - In the **Macro 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.

- In the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***4.15.1.6*** for more information on flexible referencing.
- Select **Ground Contact/s** if you want the contacts entered in **Macro Contacts** grounded. See section ***4.15.1.3*** for more information on grounding a contact.
- In the **LFP** area, do the following:
  - Select **Turn On** to enable the acquisition of LFP signals.
  - View the **Sampling Rate** field, which shows the LFP signal sampling rate.
  - From the **HP (Hz)** dropdown list, select the high pass filter for the LFP signals.
  - From the **LP (Hz)** dropdown list, select the low pass filter for the LFP signals.
- In the **RAW**: This section is related to the raw continuous signals.
  - Select **Turn On** to enable the acquisition of raw signals.
  - From the **Sampling Rate** dropdown list, set the raw signal sampling rate.

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.

5.2.3. 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 120***), displaying relevant information on all of the channels derived from the micro contact type.

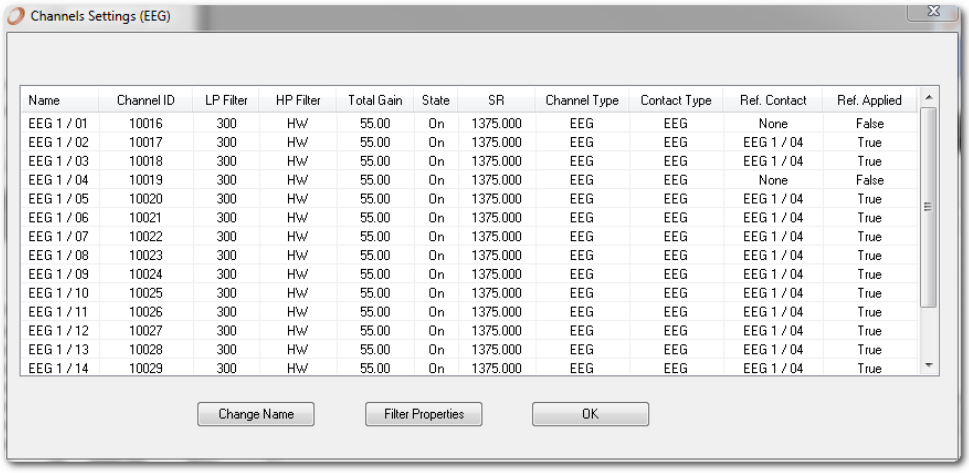


Figure 120: Channel Settings Dialog Box (EEG)

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

   The **Filter Properties (EEG)** dialog box appears (Figure 121).

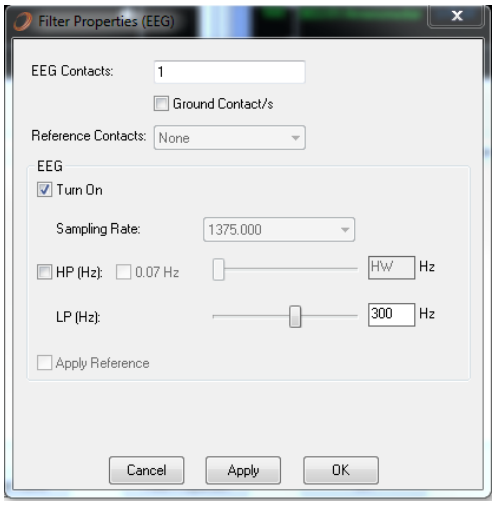


Figure 121: Filter Properties Dialog Box (EEG)

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.
   - In the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***4.15.1.6*** for more information on flexible referencing.

- Select **Ground Contact/s** if you want the contacts entered in **EEG Contacts** grounded. See section ***4.15.1.3*** 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 checkbox is not selected, 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.
   - Click **OK** to apply the new settings and close the dialog box.

5.2.4. Controlling EMG Filtering and Sampling Properties

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

To control EMG filtering and sampling properties:

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

   The **Channels Settings (EMG)** dialog box appears (***Figure 122***), displaying relevant information on all of the channels derived from the micro contact type.

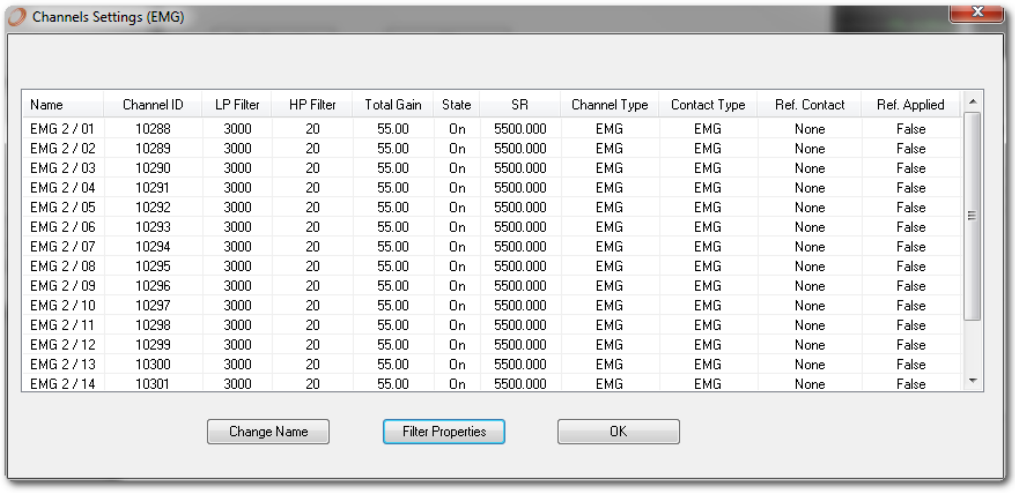


Figure 122: Channel Settings Dialog Box (EMG)

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

   The **Filter Properties (EMG)** dialog box appears (Figure 123).

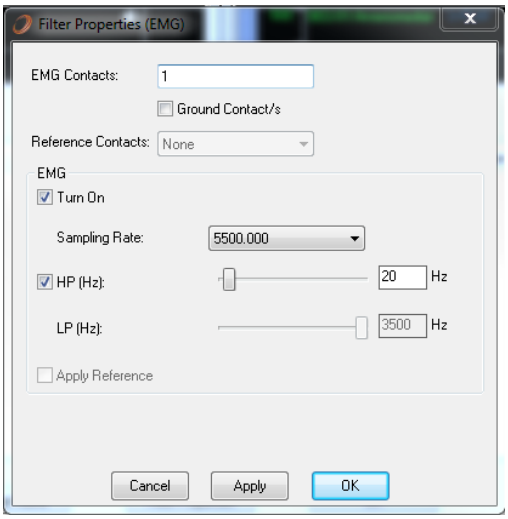


Figure 123: Filter Properties Dialog Box (EMG)

4. Do the following:

   - In the **EMG 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.
   - In the **Reference Contact** dropdown list, select the contact to be used as the reference in recording. See section ***4.15.1.6*** for more information on flexible referencing.

- Select **Ground Contact/s** if you want the contacts entered in **EMG Contacts** grounded. See section ***4.15.1.3*** for more information on grounding a contact.
- In the **EMG** area, do the following:
  - Select **Turn On** to enable the acquisition of EMG signals.
  - From the **Sampling Rate** dropdown list, set the EMG signal sampling rate.
  - From the **HP (Hz)** slider bar, select the high pass filter for the EMG signals. If the checkbox is not selected, it will be only HW filters.
  - View the **LP (Hz)** the low pass filter for the EMG signals.

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

5.2.5. Changing Channel Names

This procedure describes how to change the name of a channel, which is comprised, by default, of the channel and the 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 116, page 142*** for example).
3. Click **Change Name**.

   The **Channels Properties** dialog box appears (Figure 124).

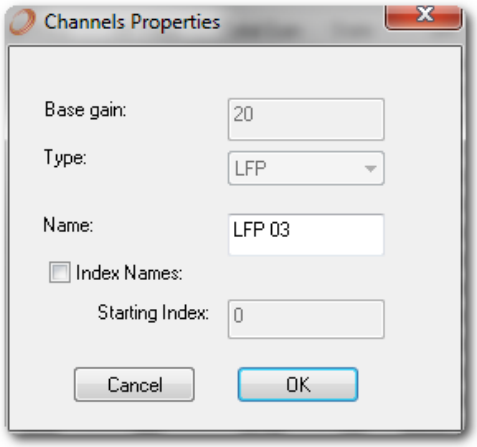


Figure 124: Channels Properties Dialog Box

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**.

   Your changes are saved.

5.3. 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, which 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.

5.3.1. 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 125***).

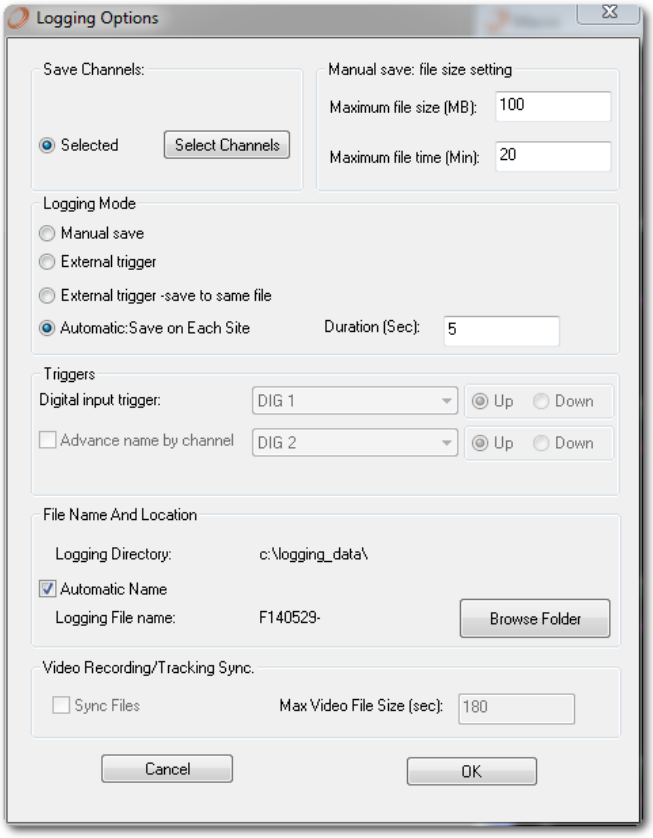


Figure 125: Logging Options Dialog Box

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

   The **Saving Channels** dialog box appears (***Figure 126***).

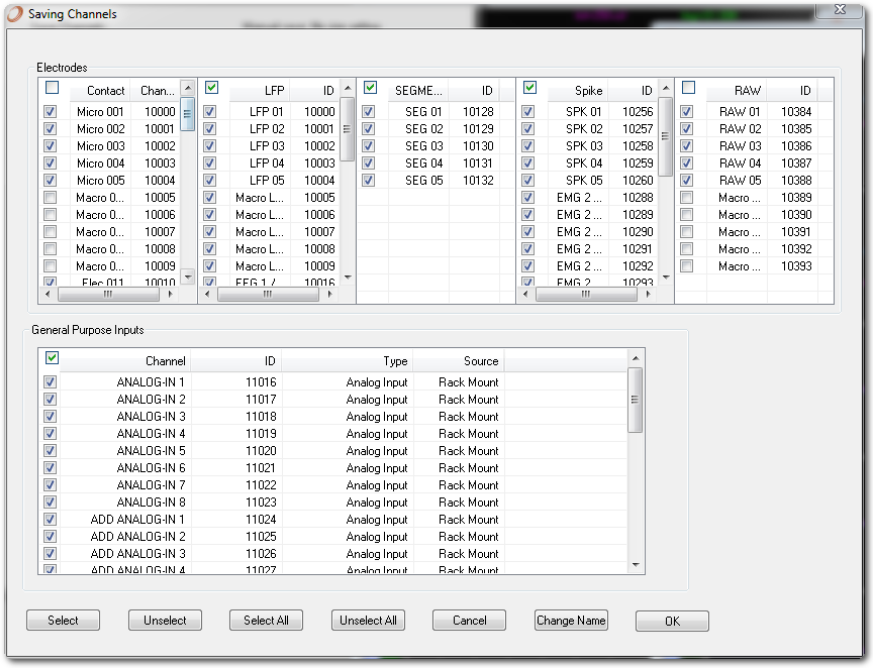


Figure 126: Saving Channels Dialog Box

5. 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 EMG 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, verify that the acquisition of raw signals is enabled. This is done when defining the micro filtering and sampling settings, as described in section ***5.2.1***.

6. 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

7. Click **OK**.

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

8. 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.

9. 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 activates (***Figure 127***).

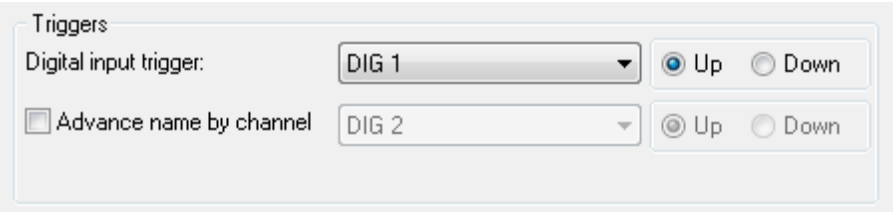


Figure 127: Triggers Area Activated

The logging by trigger behavior is illustrated in ***Figure 128***.

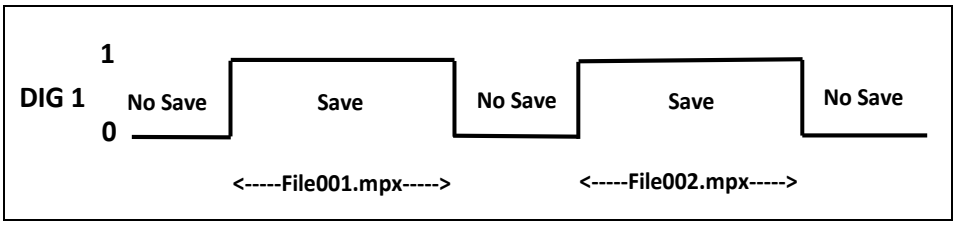


Figure 128: Logging by External Trigger Behavior

- **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 activates (***Figure 129***).

Figure 129: Triggers Area Activated – Save to Same File

The logging by trigger behavior is illustrated in ***Figure 130***.

Figure 130: Logging by External Trigger Behavior – Save to Same File

10. If you selected any of the **Triggers** options in the **Logging Mode** area, complete the **Triggers** area, as described in section ***5.3.2***.
11. 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 save the files.

      The naming convention is 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.

5.3.2. Saving Files by Digital Triggers

This procedure describes how to define the triggers for the commencement of data logging, which is a part of ***5.3.1***, and relevant when one of the trigger options is selected (step ***10***).

To control the commencement of data logging by digital triggers:

1. Connect the digital input trigger on the Input/Output panel, as described in section ***3.5***.
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.

5.4. Channel Routing of Analog Outputs

The Neuro Omega system comes standard with eight analog output BNC connectors on the ADIO panel (see ***Figure 3, page 20***). It is possible to route any of the Drive Headstage or Headbox signals to any of the analog outputs. Any electrode signal sent to the analog output is amplified to a total of 4000 times, which includes the Drive Headstage gain.

You can route channels in the following ways:

- By pre-selecting the channel, as described in section ***5.4.1***
- By clicking on the channel in the Workspace, as described in section ***5.4.2***
- By defining the channel beforehand, as described in section

5.4.1. Routing a Pre-Selected Channel

This procedure describes how to select and route an analog channel for output to an external component.

To route a pre-selected analog channel for output:

1. Connect the external component receiving the output as described in section ***3.5***.
2. Connect the external component to an output port on the Input/Output panel.
3. From the toolbar, click the **Analog Output** button .

   The **Analog Outputs** dialog box appears (***Figure 131***).

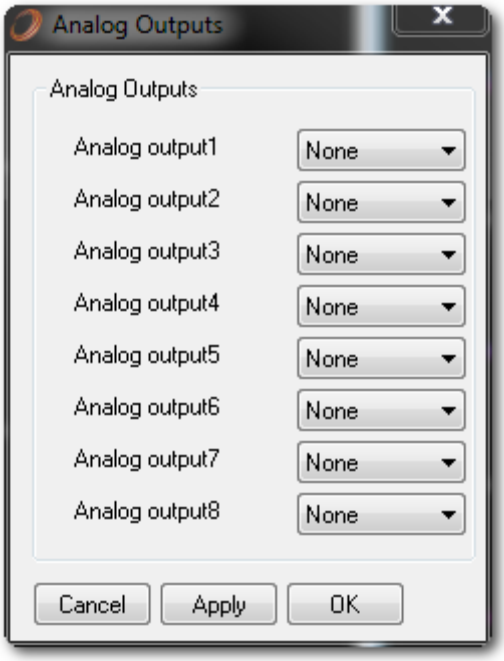


Figure 131: Analog Outputs Dialog Box

4. From the dropdown list of the output port to which you connected the external component, select the channel to route.
5. Do one of the following:
   - Click **Apply** to apply the new settings.
   - Click **OK** to apply the new settings and close the dialog box.

   Upon receiving a signal, the selected channel outputs to the external component.

5.4.2. Routing the Channel in Focus

This procedure describes how to have the system route the analog channel currently selected in the Workspace to an external component.

To have the system route the currently selected analog channel for output:

1. Connect the external component receiving the output as described in section ***3.5***.
2. Connect the external component to an output port on the Input/Output panel.
3. From the toolbar, click the **Analog Output** button  .

   The **Analog Outputs** dialog box appears (see ***Figure 131***).
4. From the dropdown list of the output port to which you connected the external component, select **Selected**.
5. Do one of the following:
   - Click **Apply** to apply the new settings.
   - Click **OK** to apply the new settings and close the dialog box.
6. In the Workspace, select a channel.

   Upon receiving a signal, the selected channel outputs to the external component.

5.5. Editing a Channel Contact

This procedure describes how to edit a contact channel.

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

- Add or edit the window containing the contacts of any of the modules, as described in section 4.3.
- Edit filtering and sampling for any of the channels, as described in section ***05.2***.
- Edit logging options for any of the channels, as described in section ***5.3***.
- Edit impedance settings, as described in section ***5.6***.

5.6. 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 132***).

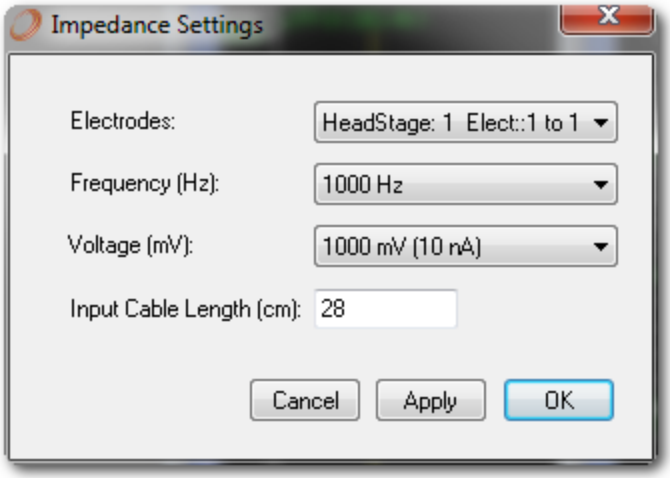


Figure 132: Impedance Settings Dialog Box

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.

CHAPTER 6. TECHNICAL SPECIFICATIONS

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

- *General*
- *Sorting*
- *Drive Headstage*
- *Headbox Modules for EEG/EMG*
- *General Purpose Analog Inputs*
- *General Purpose Analog Outputs*
- *Audio Outputs*
- *General Purpose Single Bit Digital Inputs*
- *General Purpose Digital Input 16-bit Ports*
- *General Purpose Digital Outputs*
- *Analog Digital Inputs and Outputs Pinout*

6.1. GENERAL

Parameter	Value
Operating System	Windows 7 64bit
Computer	Touch screen PC
Power	100V-240V, 50Hz-60Hz
Trolley Connectors	4 USB ports
Main Unit system connectors	■ Ethernet ports (1 GB) ■ 1 Remote port (USB) ■ 2 Audio out (3.5mm stereo)
Communication	Ethernet protocol
Peripherals	Microsoft Wireless keyboard and mouse
Number of Channels	■ Up to 10 MER channels (5 Micro and 5 Macro) Up to 112 EEG/EMG channels.

6.2. SORTING

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

6.3. DRIVE HEADSTAGE/MER ONLY HEADSTAGE

Parameter	Value
Number of Electrode Physiological Inputs	10 Electrode channels with standard AO microelectrodes: ■ 5 Micro channels ■ 5 Macro channels
First Amplifier Input Impedance	100 GΩ || 2pF
Hardware Filter	0.075Hz - 10.0KHz
Gain	20
Dynamic Input range	±62.5mV
Input Type	Differential to shared reference/ground
A/D Converter Input Range	± 1.25Volts
A/D Resolution	16 bits
Input Bit Resolution	1.9uV
Sampling Rate	Micro Channel Contact: ■ Raw: 44kHz (sample per Sec) ■ Spike: 44kHz ■ LFP: 1.375kHz (fixed) Macro Channel Contact: ■ LFP: 1.375kHz (fixed)
Noise	<20µV peak-to-peak @ 10kOhm load

Parameter	Value
Software Filters Defaults	Micro Channel Contact: SPK : ■ High Pass Range: 0 – 600Hz ■ Low Pass Range: 5000 – 9000Hz LFP: ■ High Pass Range: 0 – 45Hz ■ Low Pass Range: 200 – 400Hz Macro Channel Contact: LFP: ■ High Pass Range: 2 – 45Hz ■ Low Pass Range: 200 – 400Hz
Hardware Filter	Micro Channel Contact: ■ High Pass Range: 0.07 Hz ■ Low Pass Range: 10,000Hz Macro Channel Contact: ■ High Pass Range: 0.07 Hz Low Pass Range: 10,000Hz
Stimulation Sources	2 Options: ■ 1 source for basic stimulation ■ 10 sources, 1 per channel for advanced stimulation

Parameter	Value
Stimulation Pulse	Square Pulses: Micro Channels: ■ Phase Width : 0.01ms - 0.5ms ■ Biphasic Amplitude: 0 -> ±0.1mA (up to ±50V) ■ Step size Resolution 0.001mA Frequency - up to 300Hz *Notes:* *Amplitude tolerance within 15%.* *Pulses below 40uA, the Amplitude may be up to 40% lower than the requested value.* ■ Macro Channels: ■ Phase Width : 0.01ms - 0.5ms ■ Biphasic Amplitude: 0 -> ±7 mA (up to ±50V) ■ Step size Resolution 0.001mA Frequency - up to 300Hz *Notes:* *Amplitude tolerance within 5%.* *Pulses below 400uA, the Amplitude may be up to 15% lower than the requested value.*
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%. ■ Micro Stimulation: ■ Stimulation artifact on other Micro Recoding channels is up to 7mSec. ■ Stimulation artifact on other Macro Recoding channels is up to 15mSec. Macro Stimulation: ■ Stimulation artifact on other Micro Recoding channels is up to 15mSec. Stimulation artifact on other Macro Recoding channels is up to 50mSec.

Parameter	Value
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% Micro Stimulation: ■ Switching artifact on other Micro Recoding channels is up to 7mSec. ■ Switching artifact on other Macro Recoding channels is up to 15mSec. ■ Switching artifact on the same channel is up to 12mSec. Macro Stimulation: ■ Stimulation artifact on other Micro Recoding channels is up to 15mSec. ■ Stimulation artifact on other Macro Recoding channels is up to 50mSec. ■ Switching artifact on the same channel is up to 13Sec. *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*
Impedance Check	1000Hz (Micro and Macro contacts)
Headstage Size	110mm X 40mm X 50mm
Headstage Weight	220 Grams
Range (Drive Headstage)	40mm
Resolution (Drive Headstage)	10um

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	±5VDC, ±12VDC

Class	II
Type	BF

6.4. HEADBOX MODULES FOR EEG/EMG

Parameter	Value
Number of Electrode Physiological Inputs	16 per module
Input Connector	Touch proof DIN connector
First Amplifier Input Impedance	100 GΩ || 2pF
Hardware Filter	0.075Hz - 3.5kHz
Gain	55
Dynamic Input range	±23mV
Input Type	Differential (EMG) or Referential (EEG)
A/D Converter Input Range	± 1.25Volts
A/D Resolution	16 bits
Input Bit Resolution	0.7uV
Sampling Rate at HS	44kHz Samples per Sec
Sampling Rate	■ EMG: 44ks/Sec ■ EEG: 1.375ks/Sec (fixed) *Notes:* *Systems with more than 2 EMG/EEG Modules, the sampling rate will be 22ks/sec* ■
Software Filters	■ EMG: ■ HPF: 1-600 Hz ■ LPF: HW 3500 (fixed) ■ EEG: ■ HPF: 0.07,2-45 Hz ■ LPF: 200-400 Hz
Noise	<20µV peak-to-peak @ 1kOhm
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 : 0.01ms - 0.5ms ■ Biphasic : 0 -> ±15 mA (up to ±50V) ■ Step size Resolution 0.001mA Frequency - up to 300Hz
Impedance Check	30Hz

6.5. HEADBOX MODULES STIMULATION FOR EMG

Operating Environment	Value
Stimulation Pulse	Square Pulses: ■ Phase Width : 0.01ms - 0.5ms ■ Biphasic : 0 -> ±15 mA (up to ±50V) ■ Step size Resolution 0.001mA Frequency - up to 300Hz *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 Sources	2 Options: ■ 1 source for basic stimulation 16 sources, 1 per channel for advanced stimulation
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%. EMG Stimulation: ■ Stimulation artifact on other EMG 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% EMG Stimulation: ■ Switching artifact on other EMG 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 EMG Stimulation channel is up to 13Sec.*

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	±5VDC
Class	I
Type	BF

6.6. General Purpose Analog Inputs

Parameter	Value
Number of Inputs	16 Channels
Input Connector	8 BNC and 8 D-type Male connector
Input Range	±5V
Gain	0.25
Hardware High Pass Filter	None

Parameter	Value
Hardware Low Pass Filter	1KHz Passive (0.7@1KHz, 0.8@500Hz)
A/D Converter Input Range	± 1.25Volts
A/D Resolution	12 bits
Input Bit Resolution	2.5mV
Sampling Rate	2.75kHz

6.7. General Purpose Analog Outputs

Parameter	Value
Number of Outputs	8 Channels
Output connector	8 BNC
Purpose	Output the signal of any of the channels
Bandwidth	DC-48kHz (Drive Headstage bandwidth is 0.075-10kHz)
Gain	Total gain - 4000
D/A Converter Output Range	± 5Volts
D/A Resolution	16 bits
Sampling Rate	44kHz

6.8. Audio Outputs

Parameter	Value
Number of Outputs	2 Stereo
Output Connector	3.5mm Audio Jacks
Purpose	Output the signal of any of the high frequency channels
Bandwidth	DC-3.5kHz (Drive Headstage bandwidth is 0.075-10kHz)
Gain	Total gain 2000
D/A Converter Output Range	±2.5 Volts
D/A Resolution	16 bits
Sampling Rate	44kHz

6.9. General Purpose Single Bit Digital Inputs

Parameter	Value
Number of Inputs	16 Channels
Input Connectors	4 BNC, 12 D-type Female Port
Input Type	Standard TTL
Logic Low	0V - 1.8V
Logic High	2V - 5V
Sampling Rate	44kHz
Maximum input frequency	1kHz

6.10. General Purpose Digital Input 16-bit Ports

Parameter	Value
Number of Inputs	32 Channels
Input Connectors	2x 16 D-type Female Port
Input Type	Standard TTL
Sampling Rate	44kHz
Logic Low	0V - 1.2V
Logic High	2V - 5V
Maximum input frequency	1kHz

6.11. General Purpose Digital Outputs

Parameter	Value
Number of Outputs	16 Channels
Output Connector	8 BNC, 8 D-type Female Port
Sampling Rate	44kHz
Control	Script only

6.12. ANALOG DIGITAL INPUTS AND OUTPUTS PINOUT

The Neuro Omega has an optional Analog/Digital Input/Output package. All inputs and outputs are available on the Input/Output panel of the unit (see ***Figure 3, page 20***). Pinout details for the D-Type connectors are described in the following sections:

- ***ADD DIG-OUT Pinout***
- ***ADD ANALOG-IN Pinout***
- ***ADD DIG-IN Pinout***
- ***PORT-1 16 BIT, PORT-2 16 BIT Pinout***

The BNC connectors are numbered and logged as marked on the panel in ***Figure 133***.

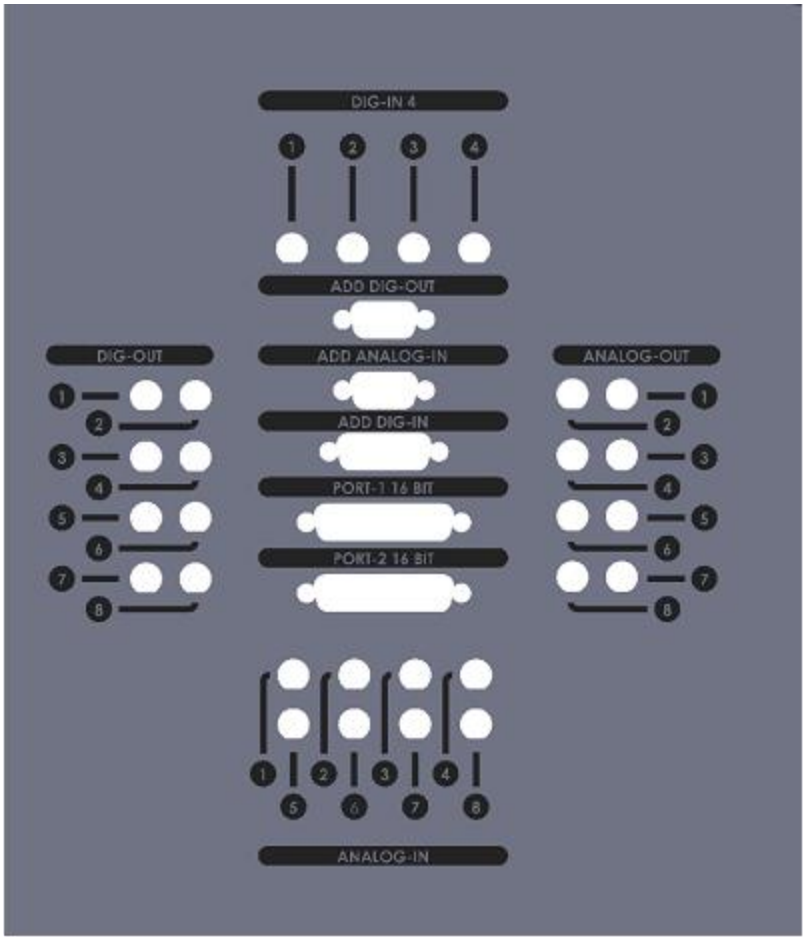
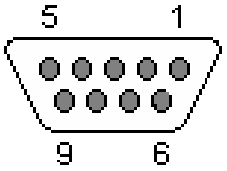


Figure 133: Input/Output Panel Diagram

6.12.1. ADD DIG-OUT Pinout

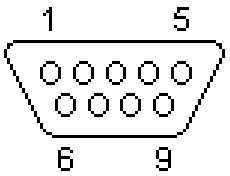
The connector type for the digital outputs is the D-Type 9-Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	D.Out 1	6	D.Out 6
2	D.Out 2	7	D.Out 7
3	D.Out 3	8	D.Out 8
4	D.Out 4	9	GND
5	D.Out 5		

6.12.2. ADD ANALOG-IN Pinout

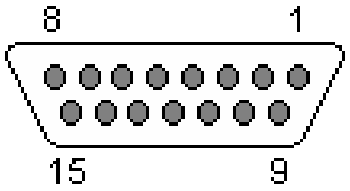
The connector type for the analog inputs is the D-Type 9-Pin Male. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	A.In 9	6	A.In 16
2	A.In 10	7	A.In 15
3	A.In 11	8	A.In 14
4	A.In 12	9	A.In 13
5	GND		

6.12.3. ADD DIG-IN Pinout

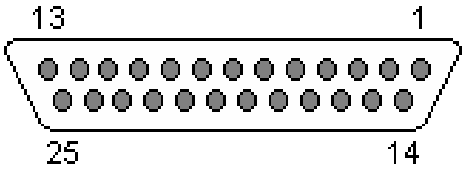
The connector type for the single bit digital inputs is the D-Type 15-Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	D.In 5	9	D.In 13
2	D.In 6	10	D.In 14
3	D.In 7	11	D.In 15
4	D.In 8	12	D.In 16
5	D.In 9	13	GND
6	D.In 10	14	GND
7	D.In 11	15	GND
8	D.In 12		

6.12.4. PORT-1 16 BIT, PORT-2 16 BIT Pinout

The connector type for the 16 bit digital inputs is the D-Type 25-Pin Female. Pin numbers shown in the figure are the actual numbers imprinted on the connector.



Pin Number	Use	Pin Number	Use
1	D.In 1	14	D.In 2
2	D.In 3	15	D.In 4
3	D.In 5	16	D.In 6
4	D.In 7	17	D.In 8
5	D.In 9	18	D.In 10
6	D.In 11	19	D.In 12

Pin Number	Use	Pin Number	Use
7	D.In 13	20	D.In 14
8	D.In 15	21	D.In 16
9	Strobe	22	GND
10	GND	23	GND
11	Ready	24	GND
12	GND	25	GND
13	GND		