ALPHA EPS GII

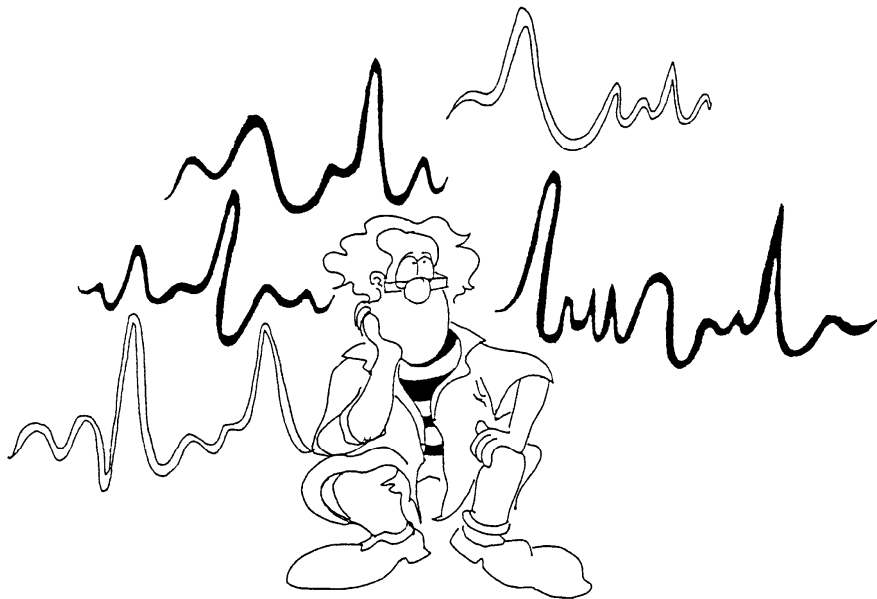## Electrode Positioning System
User's Manual

Version 4.12

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<div align="center">

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Note for those who purchased a computer from Alpha Omega Engineering: The computer and its software have their own warranty that is not included in the one-year warranty stated above.

Table of Contents

Table of Figures

1. INTRODUCTION

1.1 General Description

Alpha EPS is a modular multi-electrode micromanipulator that is used **to manipulate extra-cellular microelectrodes. The basic system can** independently control the vertical position of 4 electrodes in a resolution of $1\mu m$. The system can be upgraded in multiples of 4 to enable independent control of the vertical position of up to 32 electrodes.

The system is composed of:

1. **Printed Circuit Board (Control Board)**
    This board is plugged into a PC. Each card can control 8 channels (electrodes). To control more than 8 electrodes, it is possible to cascade several cards in the same PC.

2. **Electrode Driver Box**
    The driver box includes the motors; the feedback elements needed to control the movements of the electrode, and two D-type connectors. One connector (25-pin) is used to connect the Driver Box to the Control Board, and the second (9-pin) connector is use to connect the analog signals samples by the electrodes to the signal conditioning system. It is situated near the animal's head. Each box can control 4 channels (electrodes). It is possible to cascade several boxes to control up to 32 channels.

3. **Control Cable**
    This 6-meter long cable connects the control card, which is plugged into the PC to the electrode driver box (through the 25-pin D-type).

4. **Power Supply Cable**
    This cable connects to the control board, in the rear side of the board.

5. **Software Package**
    A user-friendly software package that runs under Windows 98/2000/NT/XP is provided. The software can be set to independently control any electrode. There is no limit, theoretically, to the number of electrodes that can be controlled by this software.

2. INSTALLATION GUIDE

2.1 Overview

Alpha EPS is modular and can be purchased in several forms. The hardware components that are included in each configuration are listed in Table 2-1.

Table 2-1 Hardware Components

# of Electrodes (channels)	# of Control Boards	# of Electrode Driver Boxes	# of Control Cables
4	1	1	1
8	1	2	2
12	2	3	3
16	2	4	4
20	3	5	5
24	3	6	6
28	4	7	7
32	4	8	8

2.2 Hardware Installation

2.2.1 Minimal PC Requirements

Note: The Control Board should be installed in a Pentium 2 PC or higher that runs Windows 98/2000/NT/XP (depending on the number of cards used, contact us for details).

- PC power supply of 300 Watt that has the voltages: -12V, +3.3V, +5V, and +12V.

- One Board (PCI) bus slot per 8 channels.

- Display (recommended resolution of 800 x 600 or higher).

- Mouse.

- CD-ROM driver for the installation of the EPS software.

2.2.2 Unpacking

Unpack the Control Board(s). Inspect the board(s) carefully for any transportation damage. Contact your dealer if any damage was caused. For future reference, write down the serial number of the board(s). The number is printed on the board near the center of the bottom edge.

Control Board(s) serial number(s) _____

2.2.3 Installing the Control Board in the PC

1. The Alpha EPS should be installed in a suitable computer with safety approval.

2. A technician, familiar with the PC should perform the installation.

3. The person responsible for the Alpha EPS installation should only access the areas designated for users.

4. Turn off the PC and all peripheral devices attached to it. Unplug all power cords from the wall outlet.

5. Remove the PC top cover (refer to your PC user's manual for instructions).

6. Select one of the available PCI expansion slots.

7. Remove the cover plate mounted on the PC rear panel of the selected slot.

8. Hold the Logic Board by the top edge. Align the board with the card support and the card slot, located on the main board. Insert the board in the card guide slots until it reaches the bottom of the expansion slot. Press the board evenly and gently, until it is firmly lodged in the expansion slot. Carefully guide the two 26-pin High-Density twisted cables connectors through the cutout window in the rear panel of the PC.

9. Align the hole in the card-retaining bracket on the Logic Board with the screw-hole in the rear panel of the PC and firmly close the screw from the card slot cover (that was removed earlier).

10. Connect the Power Supply 4-pin male connector to the 4-pin female connector located in the rear side of the Alpha PCI EPS board.
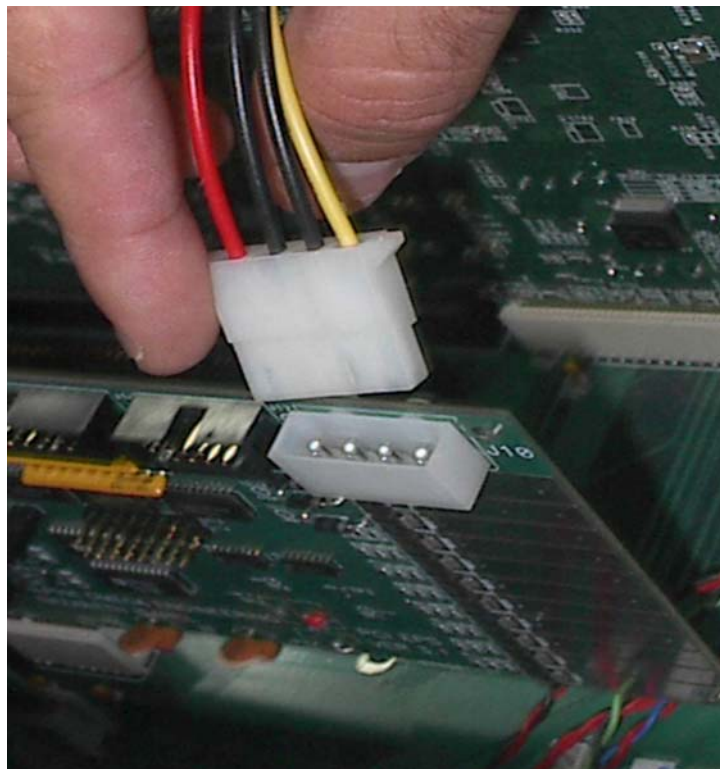
11. For users with more than 8 channels: repeat steps 7-10 for the second Logic Board.

12. Replace the PC top cover.

2.2.4 Installing the Joystick and Sound-Blaster Card

A joystick allowing the user to manipulate the electrodes from a remote location, e.g., near the animal can control the Alpha EPS. If the sound blaster card, along with the joystick and the speakers, are not installed, please install them following the installation instructions of the sound blaster.

Note: the joystick, sound blaster, and speakers are not supplied with the Alpha EPS package.

2.2.5 Locating and Connecting the PC to the Electrode Driver Box

You may place both parts of the system (PC and electrode driver box) in their final location, or in a temporary location, ensuring that the distance between the two sub-systems is less than 6m, to allow physical connection. When using one Alpha EPS box (4 motors), connect the 26-pin cable to the connector that resides down on the control board on one side. At the other end of the cable there are a female 25-pin D-type connector that should be connected to the male 25-pin D-type connector of the Alpha EPS box motors.
 If using two Alpha EPS boxes (8 motors), connect the same second 26-pin cable to the connector that resides up on the control board on one side. At the other end of the cable there are a female 25-pin D-type connector that should be connected to the male 25-pin D-type connector of the second Alpha EPS box motors.

2.3 Mechanical Installation

2.3.1 Driver Box Installation

It is possible to place the electrode driver box very close to the animal, since the box dimensions are small. To secure the box above the animal's head, you can use the round hook on the side of the box. Insert the hook inside a round rod and tighten it with an Allen screw.

2.3.2 Flexible Shaft Connection

Please refer to Appendix A for details about Flexible Shaft connection.

2.3.3 Ready to Go

➢ Reconnect all power cords.

➢ Turn on the PC.

➢ The PC detects any PCI Control Board that has been added. A "New Hardware Found" message will be displayed and the PC will look for a matching driver. The computer does this procedure automatically, however should any problems occur, the driver may be found at the installation CD (Drivers/ Win98 (2000 or NT)/ 'Alpha_EPS_GII.inf').

➢ Refer to "Software Installation Guide" for software installation.

➢

2.4 Software Installation

2.4.1 Overview

The Alpha EPS software is provided on a CD.   Either as a standalone system or as part of the AlphaLab Pro system.   Usually when purchased as part of the AlphaLab Pro, the software will be already installed.   The description below applies to installing the software form the standalone EPS GII system

2.4.2 Installation

1. Insert installation CD into the CD-ROM drive. Setup should commence automatically. If setup did not start automatically, click the letter of the CD-ROM drive to explore the CD and then click the Setup.exe icon to run setup.

2. The setup program will guide you through the installation procedure.

2.4.3 Alpha EPS Setup

When running the Setup program, the Alpha EPS setup displays the following dialog box on the screen.

Figure 2-2: Alpha EPS Setup Dialog Box

Install:

Click the Next button to start the process. During installation you can specify a different path (location) to which the Alpha EPS program will be installed.

Restart the computer:

After the completion of the installation process the computer must be restarted before the software can be operated.

Figure 2-3: Computer Restart
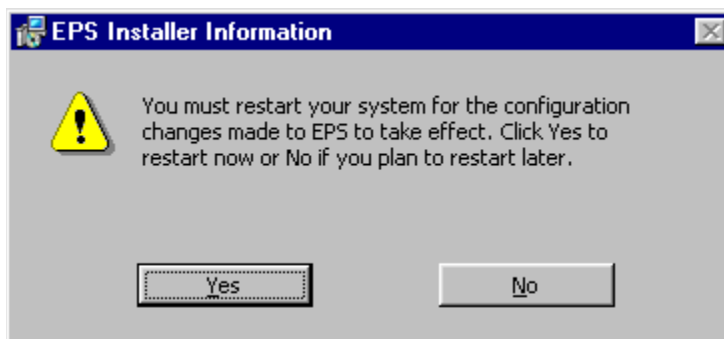
Click 'Yes' to restart the installation or 'No' to restart later.

2.4.4 Setting up the Driver

After software is installed and computer is restarted, the right driver for the PCI board should be selected as follows:

1. Go to Windows Device Manager list, and find the device listed under Jungo.

2. Right click on the device and click Properties.

3. Select Driver Tab and Update Driver.

4. Select the driver "Alpha EPS GII.inf" from the driver folder under the EPS GII setup library.

2.4.5 Setting up the BIOS (On certain computers only)

Some Pentium 4 or newer computers may experience "Blue Screen" errors or "System Lockup" when the EPS GII is started and used. In this case check the system BIOS of the computer by rebooting the system and hitting the BIOS entry key (i.e. : Delete of F10 key) at the beginning of the system restart.

Shut off the "PCI Serr Generation" item, save the BIOS, and restart the computer.

3. OPERATING THE EPS

3.1   Initializing the Alpha EPS

Note: Once the Alpha EPS hardware and software have been installed, the next step is to enter the program and set the parameters.

Double-click on the Alpha EPS icon to start the program:

Figure 3-1: Alpha EPS Icon

Or choose Programs → Alpha Omega Applications → Alpha EPS Application from the Windows Start menu.

The Alpha EPS program is started.

If you are running the system for the first time, or if you need to reconfigure the setup or change the system setting, click the Options menu and then click Initialize.

The Alpha EPS Initialization dialog box appears. Click the Refresh button and the dialog will display all connected boards (Figure 3-2).

Figure 3-2 Alpha EPS Hardware Initialization Dialog Box
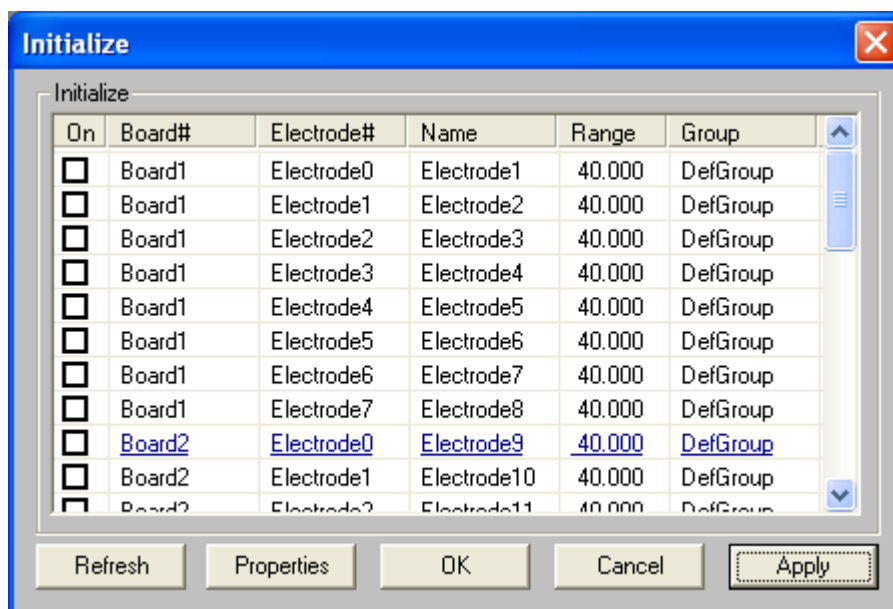
Check the boxes of the electrodes that will be used.

In order to change the properties of an electrode(s) highlight it and click the Properties button.

Note: You can use the "Shift" and the "Ctrl" buttons to choose the properties of more that one Electrode.

The Electrode Properties dialog will appear:

Figure 3-3: Electrode Properties dialog
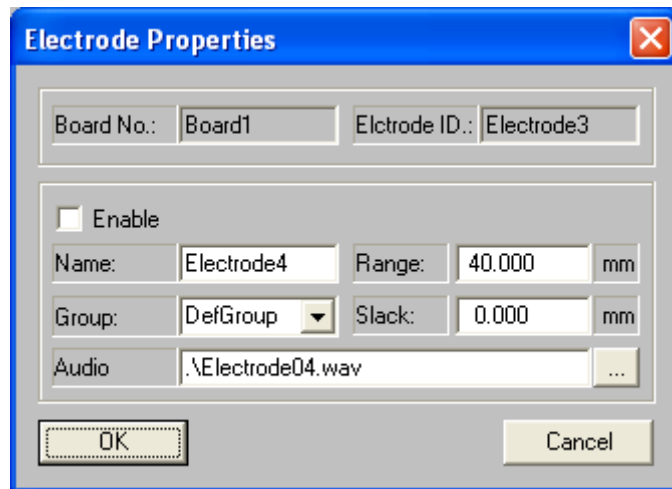
Editable fields:

Enable checkbox – if checked the electrode will be enabled.

Name – change the name of the electrode.

Slack - specify the number of micrometers the electrode will move (when the direction of the movement changes) to close the slack generated in the last (opposite direction) movement.

Range - the maximum range of the device is 40 mm, but the user can limit the range by specifying the desired range in the field.

Group - Specify the name of the group (window) in which the electrode will be grouped.

It is possible to group electrodes into different groups. An electrode can be grouped in any preferred order. Electrodes from different boards can be grouped together; electrodes from the same board can be grouped in different groups.

Note: All the Setup parameters can be altered from within the Alpha EPS program.

Once the electrode properties have been edited click OK. The Initialize dialog will appear and include the new property settings.

To finalize initialize process and start the Alpha EPS program click the OK button on the Initialize dialog.

When the Alpha EPS starts the program asks whether to reset the electrodes to zero position:

Figure 3-4: Electrodes reset dialog
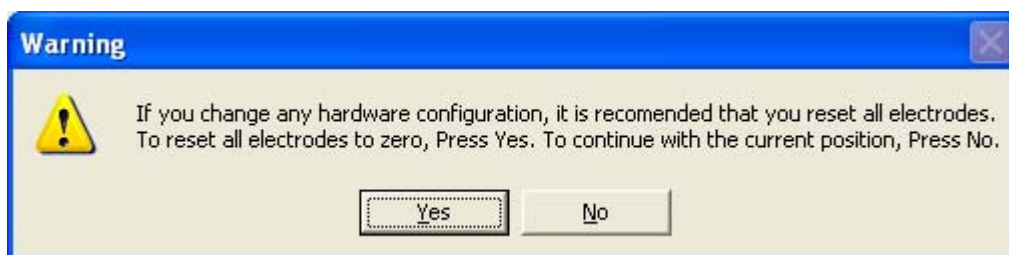
Click 'Yes' to reset all electrodes to zero position. Click No to open the EPS program and display the current electrode position that was previously saved.

If the EPS detects hardware changes the following message appears:

Figure 3-5: Hardware Changes Detected

Click Yes to Initialize EPS parameters or No to continue using current parameters.

3.2 Alpha EPS Windows Application

After initialization is finalized the Alpha EPS program starts and the following window appears:

Figure 3-6: Alpha EPS Main Screen
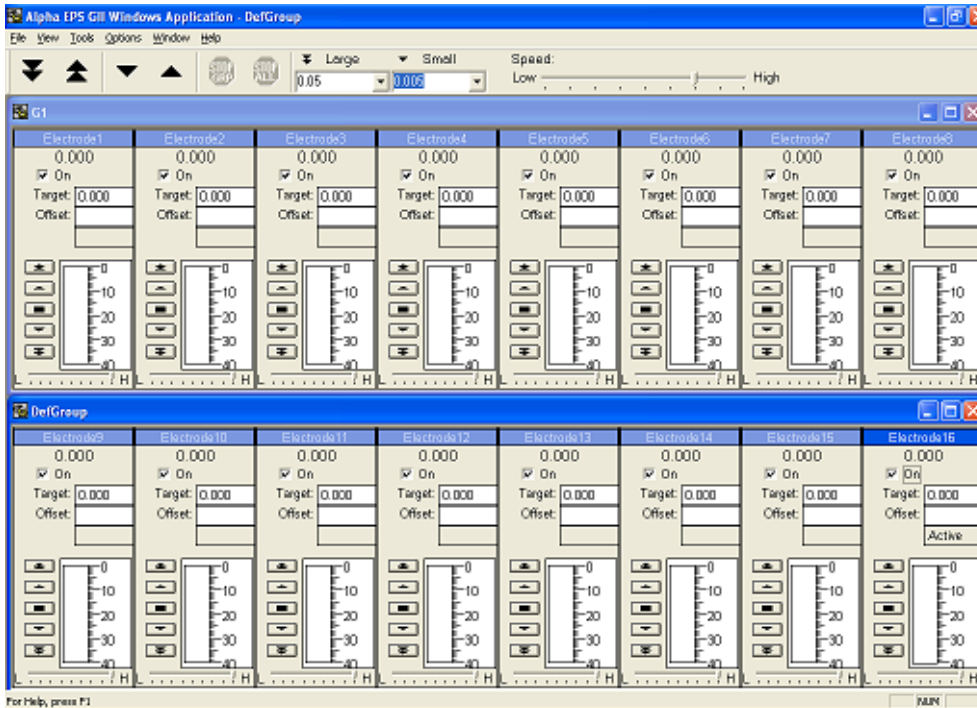
3.3 Operating the Motors

The user can advance the motors using windows buttons and controls, a mouse, a keyboard or a joystick. Description of the control is below.

3.3.1 Tools & Commands for Operating the Alpha EPS

The following buttons are displayed on the tool bar.

Figure 3-7: The Alpha EPS Toolbar
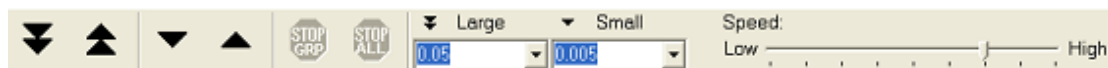
Following is a description of the various functions of the different buttons and fields.

▲	Advance all the electrodes in the highlight group that are in the ON position upwards by the small step value. The small step value is displayed on the tool bar and the user can change the value of this step.
▼	Advance all the electrodes in the highlight group that are in the ON position downwards by the small step value. The small step value is displayed on the tool bar and the user can change the value of this step.
⯭	Advance all the electrodes in the highlight group that are in the ON position upwards by the large step value. The large step value is displayed on the tool bar and the user can change the value of this step.
⯯	Advance all the electrodes in the highlight group that are in the ON position downwards by the large step value. The large step value is displayed on the

tool bar and the user can change the value of this step.

Stop the movement of all the electrodes in a group any time. While the electrodes are moving, this button is activated and its color changes to red.
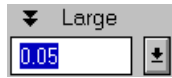
This box allows specifying the size of the **Large Step**.
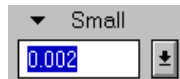
This box allows specifying the size of the **Small Step**.
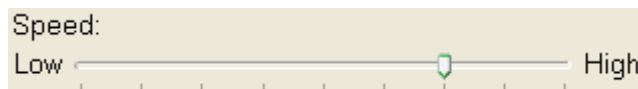
Speed:
Low ——————————————⊖——————— High

Electrode speed bar - Adjust the speed of all the electrodes in the highlight group that are in the ON position (highest speed is approximately 400 micron per second).

Stop the movement of **ALL** electrodes at any time. While electrodes are moving, this button is activated and its color changes to red. Shortcut: ESC

! See Technical Reference for more detailed information concerning speed and accuracy of the Alpha EPS system.

In addition to the buttons on the tool bar, the user can manipulate each electrode separately. Following are the buttons and fields the user can utilize.

Figure 3-8: Individual Electrode Manipulation

On /Off Field ——————————→

Target Field ←———————————

Advance Large Step Up
  Shift+PgUp

Advance Small Step Up
  PgUp

Stop electrode

Offset Field

Ruler

Advance Large Step
Down Shift+PgDown

Electrode Speed bar
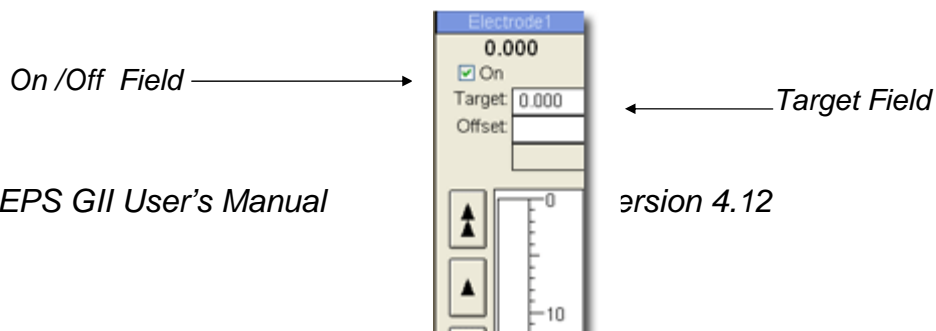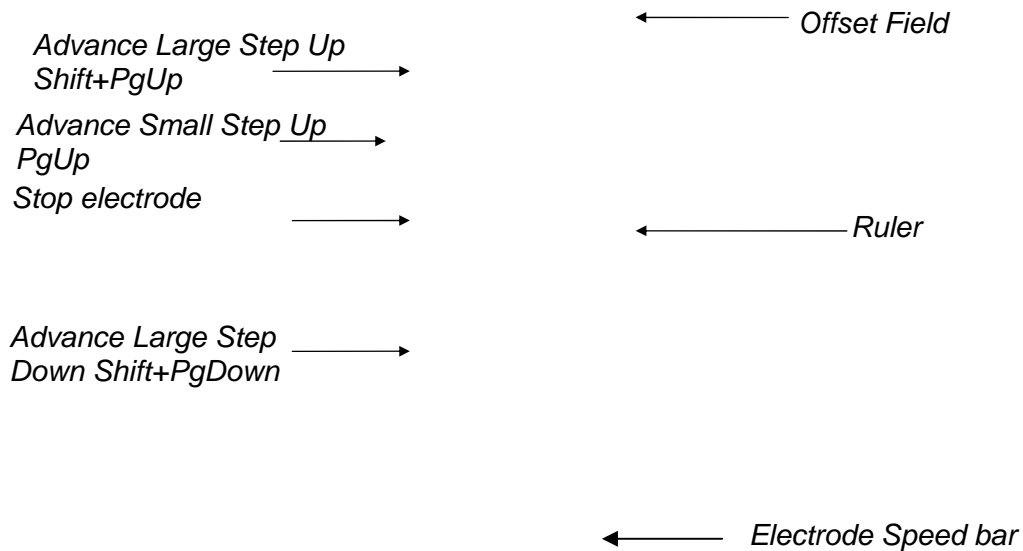
On/Off: When this field is in the 'Off' position none of the buttons affect this electrode, including the advance large or the advance small buttons.

Target: Sets the target depth of the electrode. The next time the electrode advances/ retracts it will move to the target specified in this field.

Offset Field: The user can enter an offset value (positive or negative). Pressing Enter after writing the value will force the electrode to move in an offset of the written value.

Movement Buttons   Act as the buttons in the Alpha EPS toolbar but work individually on the specific electrode.

Ruler: The ruler indicates the position of the electrode.

Speed Bar: Controls the motion speed of the electrode (similar to the toolbar).

In addition to the above controls, the user can perform the following operations from the Menu.

If, for any reason, the Alpha EPS was shut down while the motors were moving, the next time the program is opened the following dialog appears:

Figure 3-9: EPS begin initialization dialog
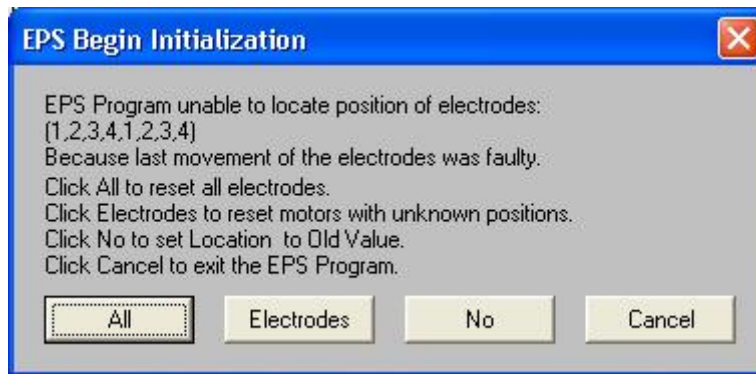
Press the appropriate button to continue working.

3.3.2 Alpha EPS Menu Options

File Menu:

Save As: Opens a dialog for saving the current view.

Open: Opens a dialog for opening an existed file. Shortcut: **CTRL+O**.
Close: Closes the Active group. Shortcut: **CTRL+F4**.

Save Electrode Info: Opens a dialog for saving the current electrodes positions into a text file.

Example of a saved file:

Friday, 06/06/03 10:13:47. Alpha-Omega Engineering

Group	*Name*	*Relative Pos(mm)*	*Absolute Pos(mm)*
Group1	*Electrode1*	*4.808*	*4.808*
Group1	*Electrode 2*	*7.900*	*7.900*
Group2	*Electrode3*	*2.541*	*15.541*
Group3	*Electrode4*	*22.610*	*22.610*

Restore Closed Groups: Opens a window to choose restoring some or all the closed groups.

Restore all Closed Groups: Restoring all the closed groups.

Exit: Exits the EPS application. Shortcut: **ALT+F4**.

View Menu:

Toolbar: Show or hide the toolbar.
Status Bar: Show or hide the Status Bar.

Tools Menu:

Set Zero Clicking this field does not affect the position of the electrode but it changes the scaling of the ruler of the active electrode. The current position display will be zero.

Unzero Clicking "Unzero" will recall the absolute scaling of the specific electrode.

Stop Electrode Stops the active electrodes.
Stop Group Stops the currently moving electrodes in the active group (similar to the Stop button at the toolbar).

Stop All Electrodes Stops all moving electrode (similar to the Stop All button at the toolbar).

Reset Group Reset all electrodes of a group (that are On) to the zero position.

Reset All Reset all of the electrodes that are On to the zero position.

Retract Opens the Retract dialog for specifying a point to retract all electrodes in the active group to.

Change Position Change the current position of a specific active motor without moving the motor.

Calibrate Opens the calibration dialog box.

Figure 3-10: Calibrate Dialog Box
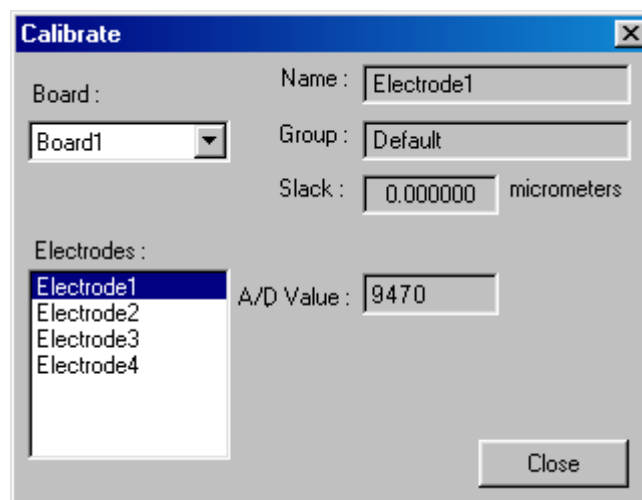
The Calibrate Dialog window enables to calibrate the A/D that is used to reset the positions of the electrodes to zero. The user is advised not to change the calibration without consulting Alpha Omega technical support, since the Alpha EPS might be damaged.

Remote Joystick   Opens the Joystick Control window used for controling the
Alpha EPS by using a joystick**.**

Figure 3-11: Joystick control Dialog Box
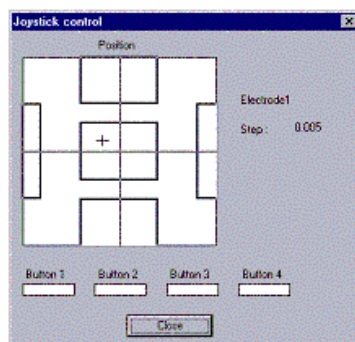
Note: before using the joystick control option, the joystick needs to be calibrated at the Windows Control Panel. To calibrate a joystick click the Windows Start button and then select Settings, Control Panel. Click on the Game Controllers icon. In the dialog box that appears select the joystick that is used and click the properties button. Follow the instructions that appear on the screen to proceed with the calibration process.

Controlling the Alpha EPS engines using a joystick

The joystick allows the user to select and maneuver an electrode up and down. To select the appropriate electrode move the joystick to the right. When the cursor is placed on the right rectangle (see figure 3-11) press Button1 on the joystick. If the speakers are connected a sound is generated stating the name of the electrode that was reached. To select an electrode with a lower number then the one that is currently selected move the cursor to the left rectangle and follow the same procedure.

In order to maneuver the electrode upward, move the cursor to the upper rectangle and press Button 1. To move the electrode downward, move the cursor to the bottom rectangle and press Button 1. The maximum movement size is defined by the small step that is set in the Alpha EPS main interface. To stop the electrode movement (in case the maximum step size has not been reached yet) press Button 2.

Note: Buttons 3 and 4 are saved for future use and are currently not functional.

Options Menu:

Initialize: Open the initialization dialog.
See section 3.1 (Initializing The Alpha EPS) for more details.

Run Script: Opens the Run Script dialog.
This mode enables the user to manipulate the electrodes according to pre-set instructions determined in an external script file.

All the movements and speeds of the different electrodes are recorded in the output file. The output file is generated if the "Print results to file" box is checked.

Figure 3-12: Run Script dialog
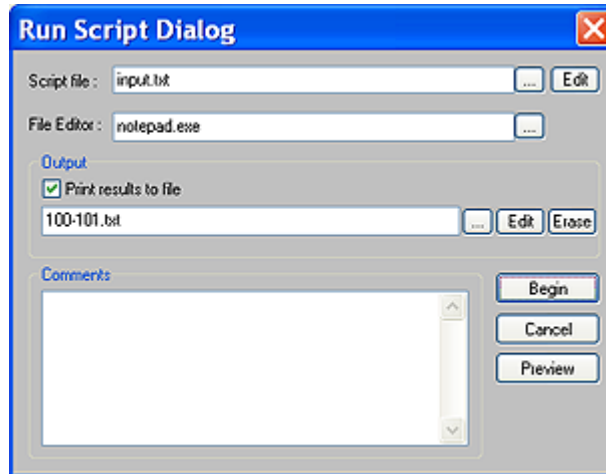
The script is simply a text file that contains a series of commands for the Alpha EPS.

A script file can be easily created using any word processing software
(in the above example Notepad is used).
The syntax of the commands (input.txt) is as follows:

- RESET #board #motor
- MOVE #board #motor offset times
- GOTO #board #motor position
- SPEED #board #motor slider_value
- DELAY d_value
- MESSAGE mes_string
- RENAME new_name

Notes:
- For RESET, MOVE, GOTO and SPEED: If #board value is –1 or #motor value is –1, it's mean that this command is for all the boards or for all the motors.
- For DELAY: d_value unit is second
- For SPEED: 'slider_value' values are between 0-400.
- For RENAME: rename the trace_ou.dat file to new_name.dat file. If the value is –1 then add next number to trace_ou#.dat

See this example to understand these commands:

Command line	Explanation
RESET 1 -1	Reset, from board 1, all electrodes (-1

	indicates all electrodes are to be reset. If a specific electrode needs to be reset write the number of the electrode instead).
MOVE 1 -1 10 10	Move, from board 1, all electrodes, 10mm, 10 times.
GOTO 2 3 1	Reposition, from board 2, electrode #3, to 1mm.
DELAY 25	Make a delay of 25 seconds

To open a script file use, the browse button [...] to locate it.
Select your favorite text editor (for example Notepad)
To edit the script file click the Edit button next to the script file field.

It is possible to log the results of the Alpha EPS movements. To use this feature check the "Print results to file" checkbox.

The output log file may be edited or erased by pressing the appropriate buttons next to the Output text file field.

Script Line Examples:

Command	Script Line	Movement
Move*	move 1 3 -0.025 3	advance the 3rd electrode in control board #1 0.025mm up, 3 times
	move 1 -1 10 2	advance all electrodes in control board #1 10mm down, 2 times
Goto	goto 1 2 18	advance the 2nd electrode in control board #1 to location 18mm
	goto 1 -1 23	advance all the electrodes in control board 1 to location 23mm
Delay	delay 18	make a delay of 18 seconds
Reset	reset –1 –1	reset all the electrodes in all boards to zero position

*Move: Use: Move brd elc ofs No.
Brd: is the board Number
Elc: is electrode Number
Ofs: is the movement requested in mm (positive value= down , negative value=up)
No.: Number of times this movement will be performed

Previewing the script file results

The **Preview** button enables the user to view what would be the results of running the script file without actually moving the motors. Preview is done on an Alpha EPS look alike interface.

To run the script file click the **Begin** button.

Windows Menu:

Cascade:
Arranges all opened windows (groups) in a cascaded (overlapping) order.

Tile Vertically:
Arrange all opened windows (groups) in a vertically tiled order.

Tile Horizontally:
Arrange all opened windows (groups) in a horizontally tiled order.

Arrange Icons:
Arrange all Minimized windows (groups) at the bottom of the main
Alpha EPS window.

Help Menu:

Figure 3-13: Help Dialog Box

Index: Contains a table of contents that provides access to a number of Alpha EPS on-line help subjects.
Using Help: Windows Help subjects.

Context Help: Dragging the mouse to a location on the screen showing the '**?**' symbol will cause the related on-line help subject (if available) to appears in a window on the screen.
About: display software version and manufacturer information.

3.3.3 EPS Shortcut Keys

CTRL+O: File Open: Open an existed file.

CTRL+F4:   File Close: Closes the Active group.

ALT+F4:   File Exit. Exits the EPS application.

ESC: Stops the current movement for all the electrodes.

PgUp:	Advances the current electrode one small step upwards.
PgDown:	Advances the current electrode one small step downwards.
Shift+PgUp:	Advances the current electrode one large step upwards.
Shift+PgDown:	Advances the current electrode one large step downwards.
CTRL+F6:	Moves to the next group.
Shift+CTRL+F6:	Moves to the previous group.

3.4 Using the EPS for Micro-Injection

With a special mechanical adaptation, it is possible to mount a syringe onto one of the EPS box motors and use the EPS software to control the injection of fluids into the brain.   To enable the MicroInjection function for a the first motor on the first board, add the following section to the EPS.INI file.

[Board1Electrode1]

MicroInjection=1

MIVolume=xxx

MIUnits=yyy

MIRange=zzz

If you are using the Client Server feature, these updates must be done on the server, and then retrieved by the clinet by using the "Get Server Settings" option.

Below is an explanation of the meaning of each one of the lines added:

MicroInjectio => 0 = disabled, 1 = Enabled

MIVolume = Total Volume of the syringe used

MIUnits = Units used in the syringe, for example ml, uL, CC etc.

MIRange = Total movemet range in mm of the syringe needed to inject its whole contents.

Below is an example of a syringe and the parameters needed for it.
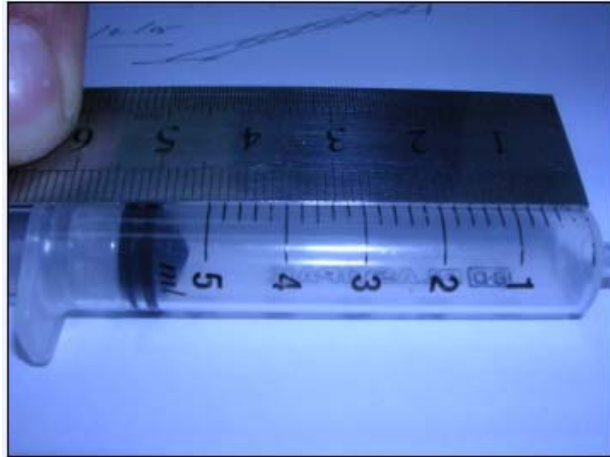
[Board1Electrode1]

MicroInjection=1

MIVolume=5

MIUnits=ml

MIRange=44

Adding the section above will show a new button in the EPS interface as shown below for the selected electrode (or motor) labeled MI for Micro Injection.   See figure below:
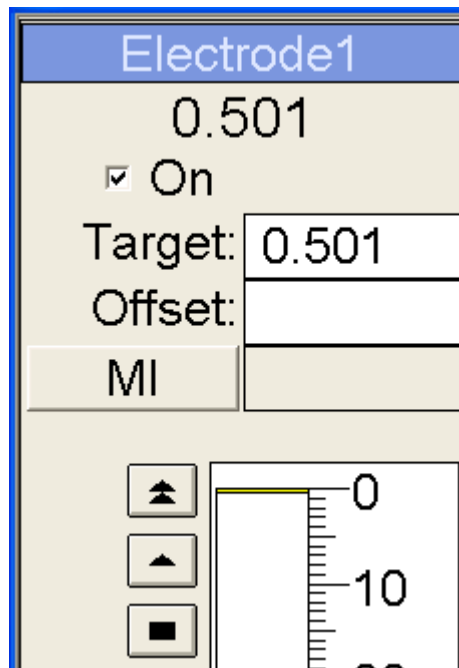
Micro Injection Button

When this button is pressed it opens a new dialog that shows the amount injected. See fugure below.
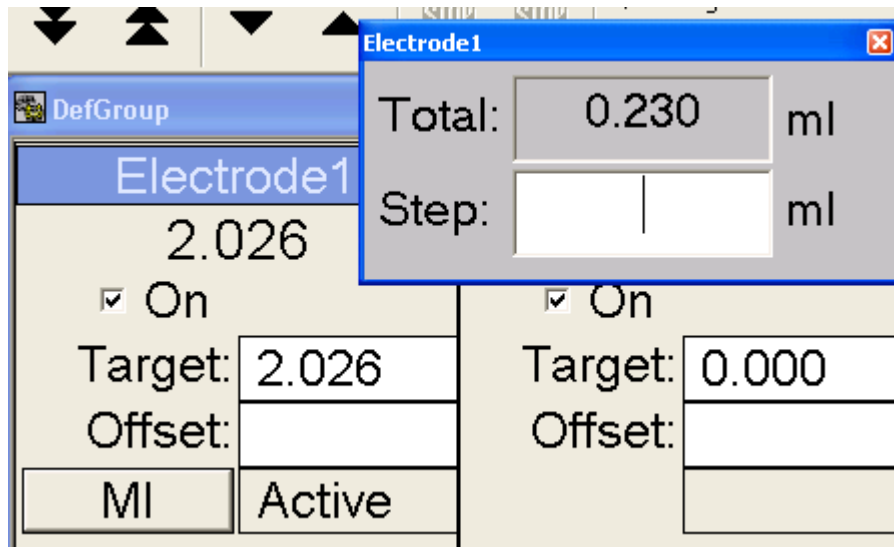
This Dialog can be moved and positioned any where on the screen.   It will show the total amonnt injected, and it also allows the user to specify how much to inject in the Step field.   The main EPS interface will still display the movement in millimeters as before.

3.5 Technical Reference

3.5.1 Shut Off

This is a TTL output signal that denotes a moving electrode. This output is usually high (+5V), but when any electrode is moved, it is changed to low and remains low till the moving electrode stops. This signal is useful when no recording is required when the electrodes are moved. It can be used to prevent recording the analog signals while any of the electrodes is moving.

The shutoff connector has 3 pins. The outer pins are Digital Grounds, and the inner pin is the Shutoff signal (see the diagram below).

Digital Grounds
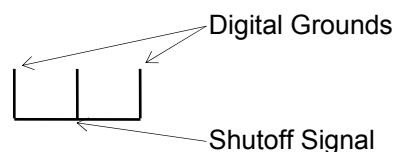
Shutoff Signal

Note: *At the rear panel of the MCP+ (Alpha Omega's Signal Conditioning System) a SHUTOFF control input is supplied. When this input is low, all analog inputs are disconnected from the recording electrodes and connected to ground.*

4.   EPS Client Server

The Electrode Positioning (EPS) Client is connected to the Electrode Positioning Server. The features of the client are as the features of the server except for the HW configuration settings.

Available client features:

- Independent electrodes position manipulation.

- Group/all electrodes positioning.

- Resetting motors. (It is recommended to do at the server because motor reset is performed at the beginning of the experiment.)

- Speed control.

- Error histograms.

4.1 Running the EPS Client

To run the EPS Client application

- In the EPS client computer desktop, click **EPS client** icon.

  OR

- Select **Start** > **Program** > **EPS client.**

Once the EPS Client is running, verify at the status bar that it is automatically connected to the server.

The status bar may indicate either of the following:

- Disconnected

- Working
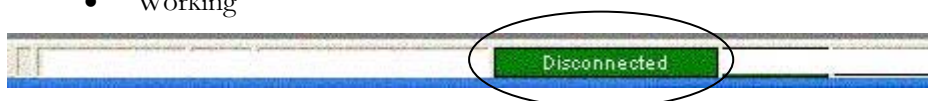
If the client is disconnected do, the following:

1. In the server, select **Options->TCP Server Options.**

   The following window appears:

2. Verify that the under **Status** appears **listen...** in **Connection** 1. If not, click **Start**.

3. In the client select **Options > TCP options**.

The following window opens:

Server IP address

	IP Address	Connection	Service Type		Status
	192.168.0.14	1	Non-Blocking	Start	Disconnected
	192.168.0.14		Non-Blocking	Start	Disconnected
	127.0.0.1		Non-Blocking	Start	Disconnected
	127.0.0.1		Non-Blocking	Start	Disconnected
	127.0.0.1		Non-Blocking	Start	Disconnected

Exit
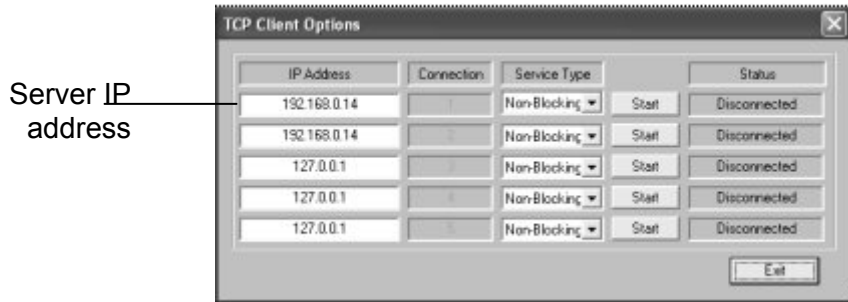
4. Under **IP Address (of connection1)**, enter the IP address of the server as it appears at the bottom of the **TCP Server Options** window.

5. To establish connection, click **Start**.

6. Under **Status**, view the client connection status.

7. To get the server settings, select **Options > Initialize > Refresh**.

Initialize

On	Board No.	Electrode ID.	Name	Range(mm)	Group
☑	Board1	Electrode4	Electrode5	40.000	DefGroup
☑	Board1	Electrode5	Electrode6	40.000	DefGroup
☑	Board1	Electrode6	Electrode7	40.000	DefGroup
☑	Board1	Electrode7	Electrode8	40.000	DefGroup

Refresh   Properties   OK   Cancel   Apply
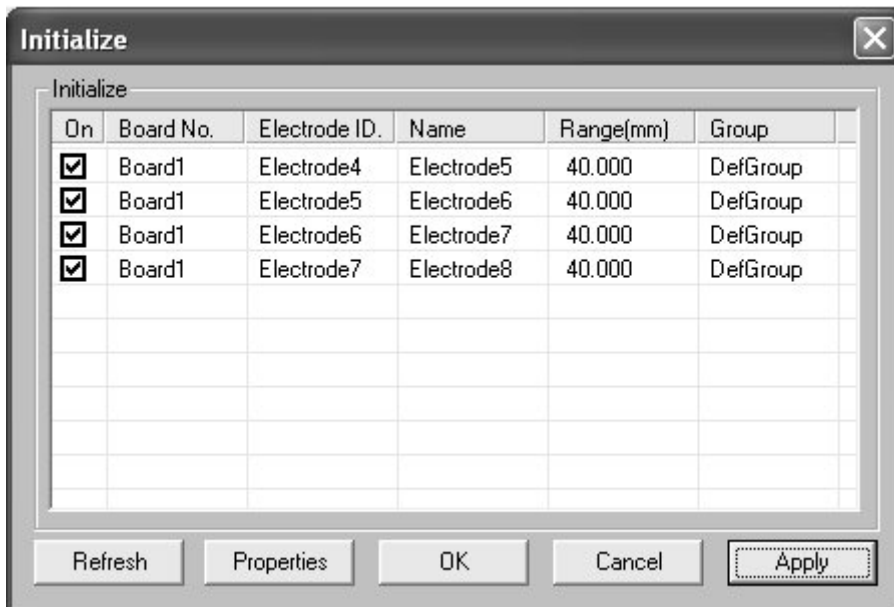
4.2 Defining a Workspace

Following is an example of a workspace that would be used for EPs client server apploication for two users. One user works on the server and the second works on

the client, when each one controls two of the four motors wothout disturbing the each other.

To define the workspace do the following:

1. Select **Options** > **Initialize**.

    The **Initialize** window opens:
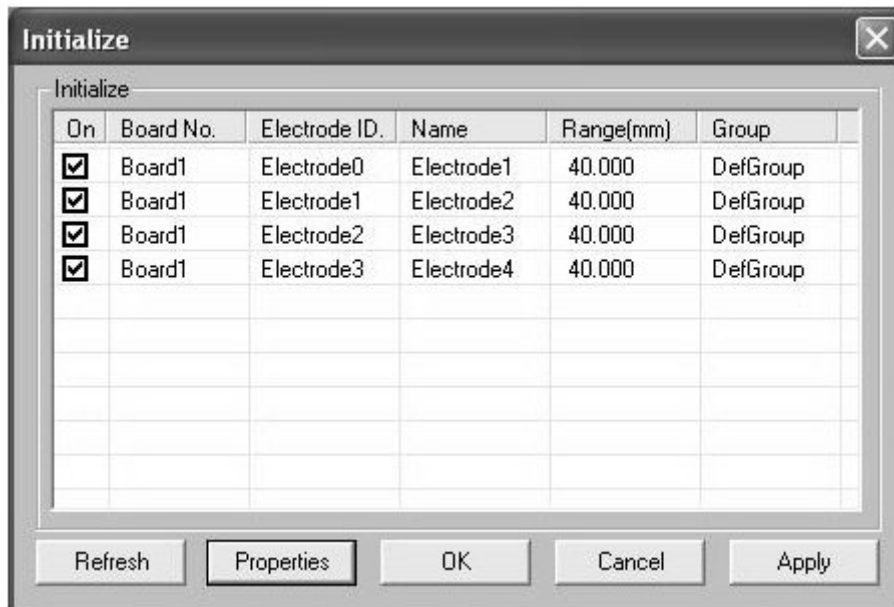
2. Under **On,** select the motors you wish to enable. In this training session select the first motor.

3. To view the electrode properties, click **Properties**.

    The **Electrode Properties** window opens:
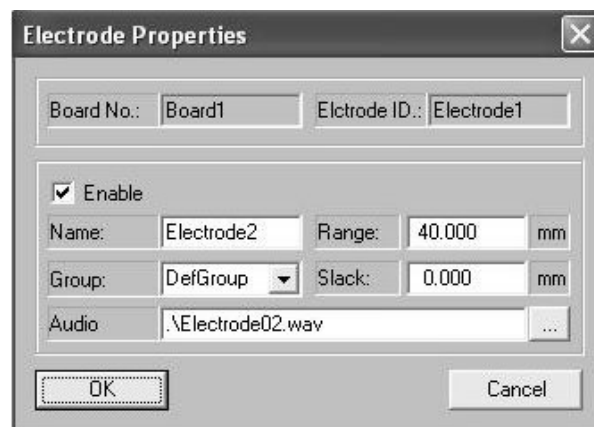
Now, you will do the following:

*   Move the first two motors into a group called Elec1-2.

*   Move the last two motors into a group called Elec 3-4

*   Name the electrodes elec1 – elec4.

1. In **Name** box, type elec1.

2. In **Group** box, type Elec 1-2 for motors 1 & 2 and Elec 3-4 for motors 3&4.

☑ **Note:** You may also change the range and the slack. The maximum range value is 40. Currently, leave the default.

3. Repeat steps 1 and 2 for the rest of the electrodes.

4. Click **Ok** to apply changes and to close the window.

5. In the warning click **Yes** and wait until reset is complete.

☑ **Note:** If any problem occurs while resetting the motors, an error message appears indicating the problem, with the motor number.

The main window with the new definitions appears.

1. In the EPS Client select **File** > **Get Server Settings**.

2. Verify that the EPS Client restarts with the same settings as the server.

3. In the client, close the Elec1-2 Group.

4. Click Save, to save the workspace.

5. In the server, close the Elec3-4 Group.

Each user may work without distracting the other user.

Appendix A: Flexible Shaft Placement

Flexible Shafts Assembly Instruction:

1. Remove the cover of the EPS box, by unscrewing the four screws marked by blue circles. Use an appropriate screwdriver (type of screw: M2x5).
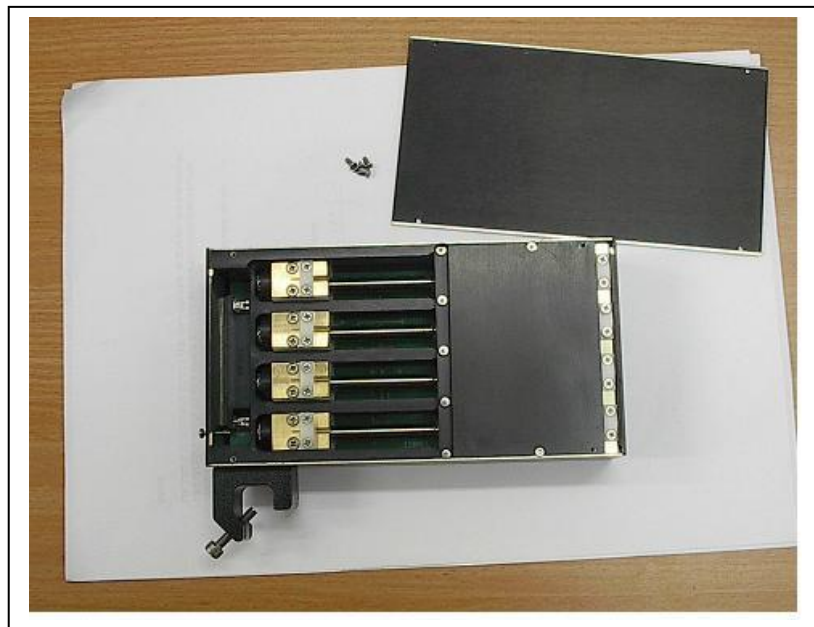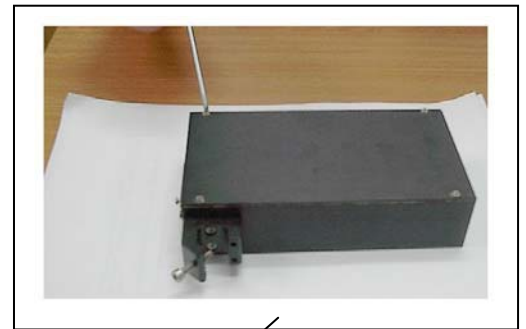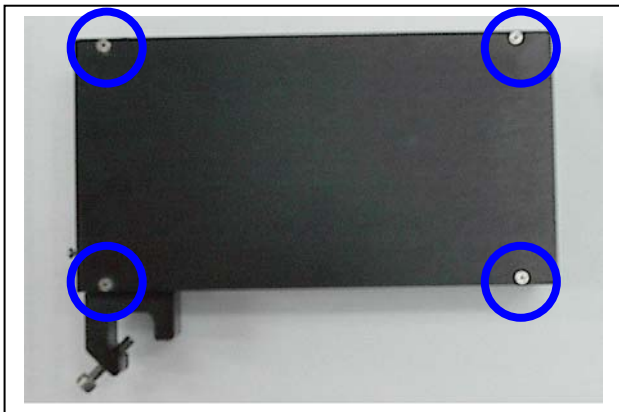
2. Bring the flexible shaft to working area.

Part 3
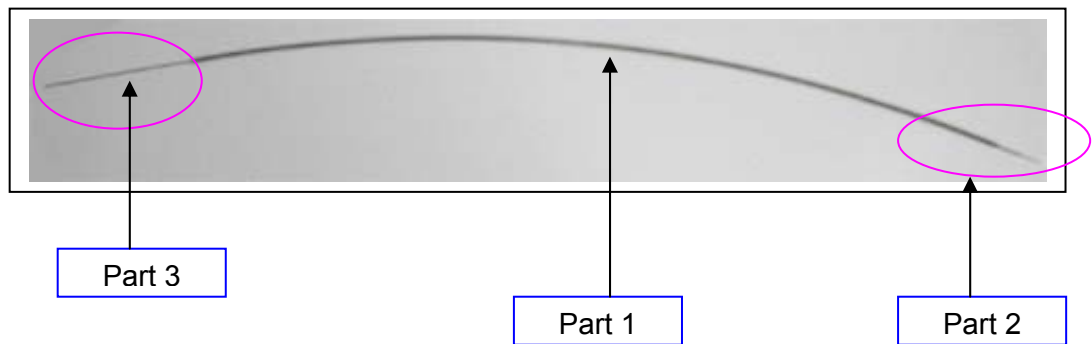
Part 1

Part 2

3. For clarification purposes, we'll divide the flexible shaft to three areas, as follows:
   - Part1: peek (polyetheretherketone) tubing, placed in the middle side of the flexible shaft.
   - Part2: shaft & short stainless steel tubing, placed in the right side of the flexible shaft (connects to the MT side).
   - Part3: long stainless steel tubing, placed in the left side of the flexible shaft (connects to the EPS side).
4. Refer to part 2 of the *flexible shaft assembly*.
5. Make sure that the *shaft* protrudes out of the *short stainless steel tubing*. The protrusion distance "L" is 6-7 [mm].

Shaft

L

Short s.s. Tubing

Peek Tubing
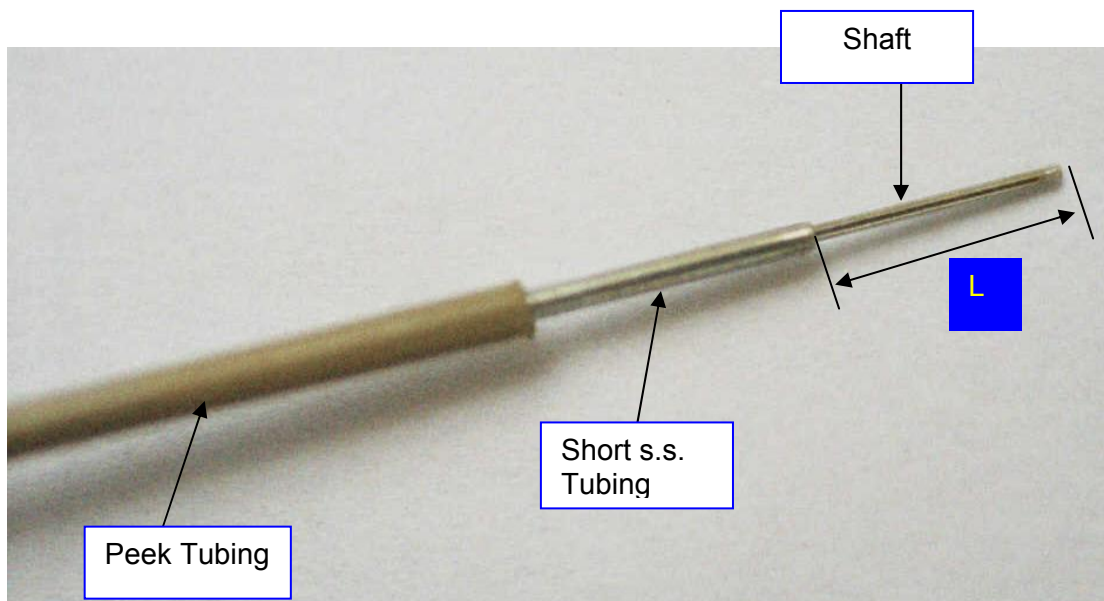
6. Choose the port you want to use, and then insert the *flexible shaft assembly* in. say we want to use port #3, thus we need to insert the *flexible shaft assembly* in port #3. To do that, we need to perform the following steps:
   - Unscrew the *port plate*, use appropriate screwdriver (M2x8).
   - Unscrew the *shaft plate*, use appropriate screwdriver (M2x8).

Port 1

Port 2

Port 3

Port 4

EPS Box

Port Plate
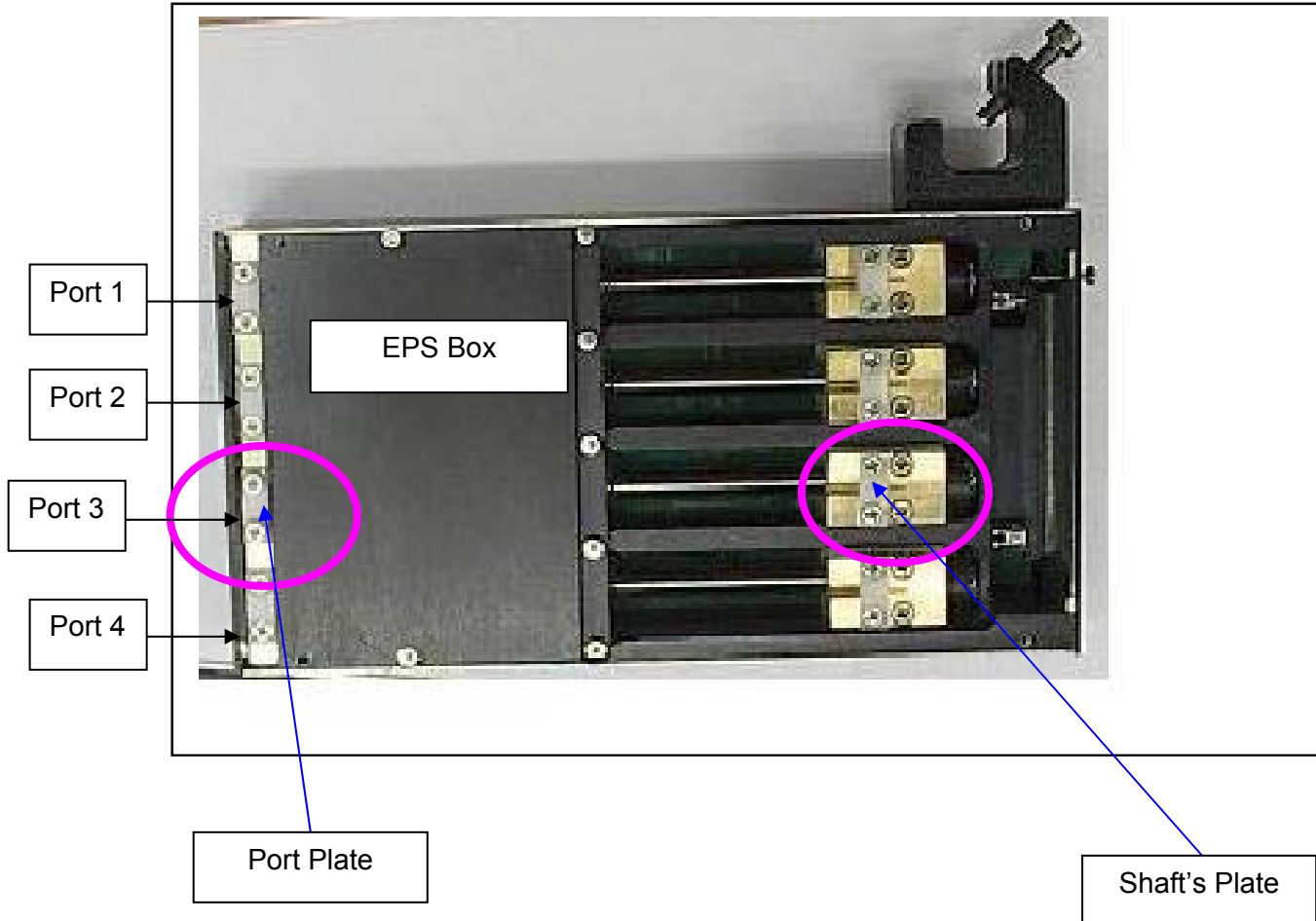
Shaft's Plate

- Insert the *flexible shaft assembly* inside the EPS box, through the *port plate*, ended in the *shaft's plate*, as seen in the following pictures.

Flexible shaft is inserted in the EPS box thru the *port plate*.

EPS Box

Port Plate
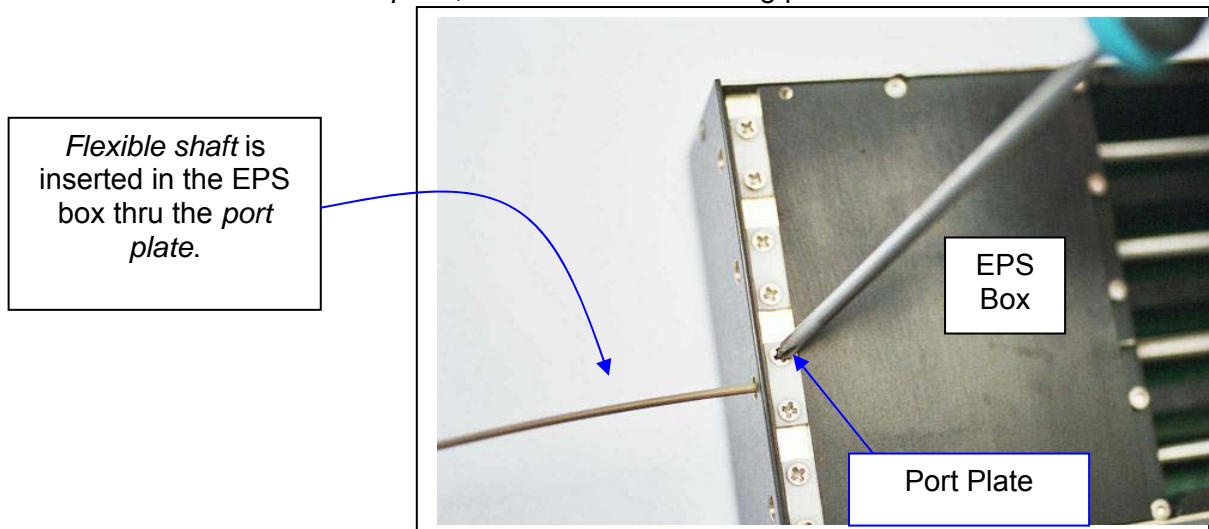
Ends in the *Shaft's plate*.
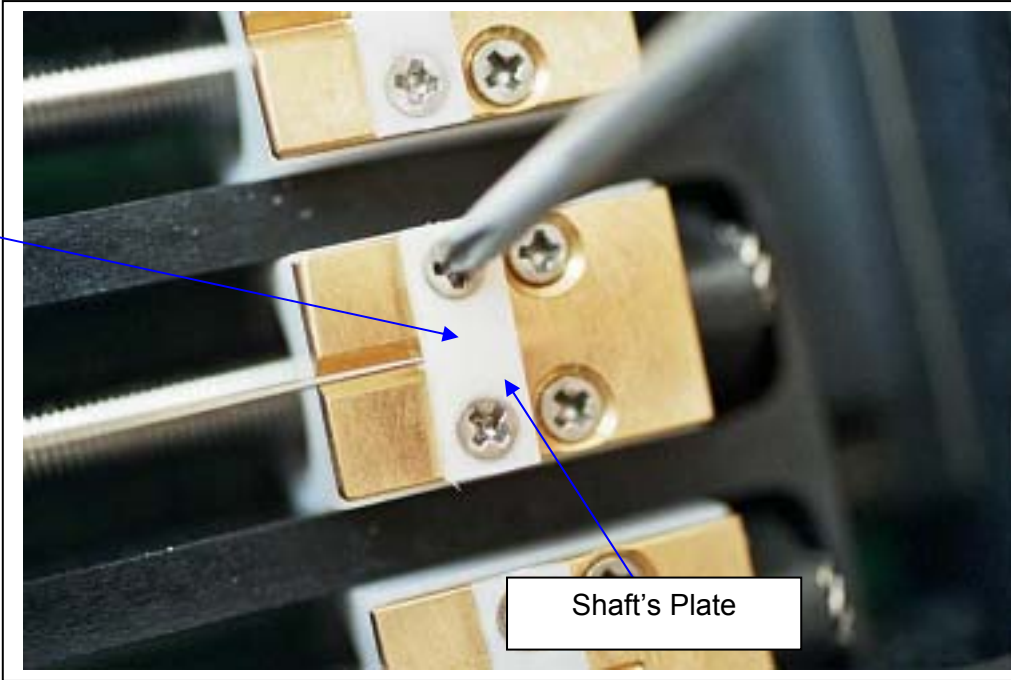
Shaft's Plate

7. Verify that the *shaft* does not pass through the groove of the *lower shafts plate* (gold color plate), as shown.
8. Lock the *shaft plate* on the *shaft*, by screwing the two screws on the *shaft plate*, as seen. Use appropriate screwdriver, type of screw: M2x8.

Shaft

Groove of the Lower Plate

Shaft's Plate

Lower Shaft Plate (gold color)
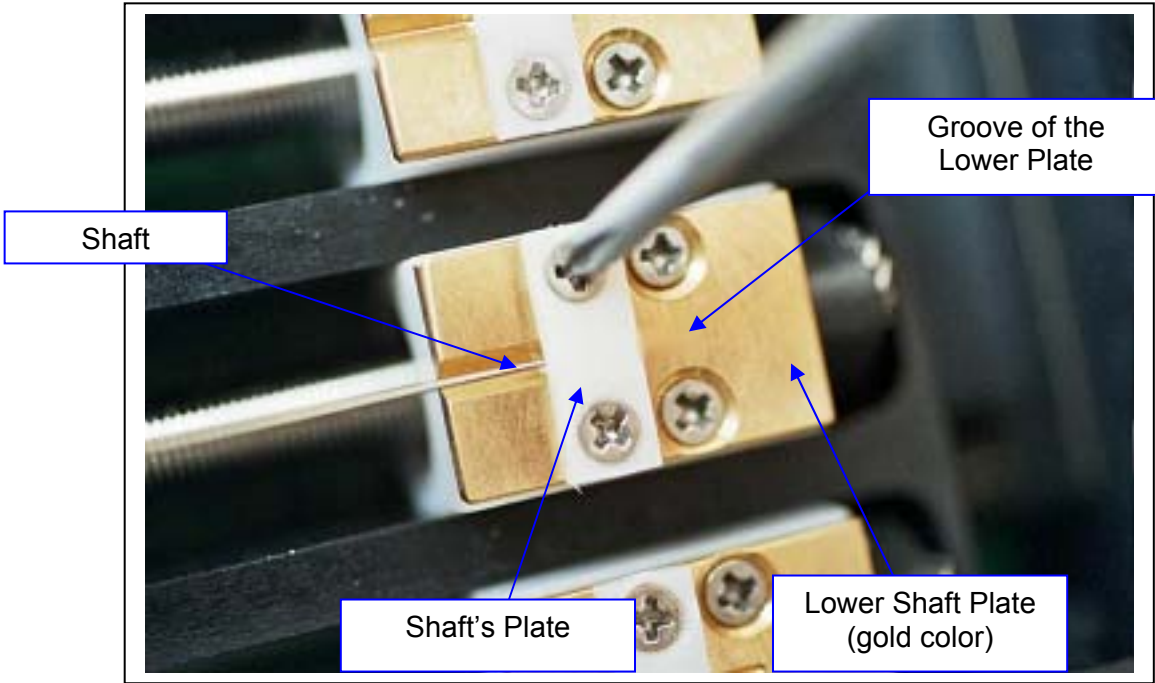
9. Verify that the right end of the *long stainless steel tubing* will be placed about 0.5[mm] away from the edge of the perpendicular beam, as shown.
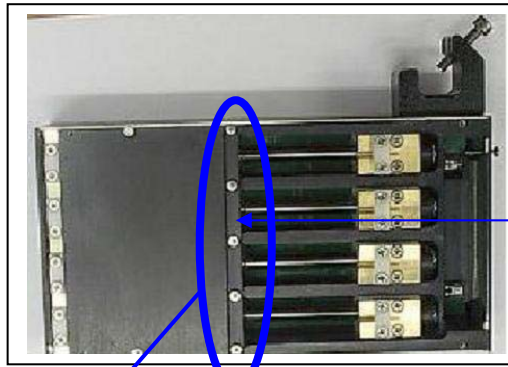
Perpendicular Beam
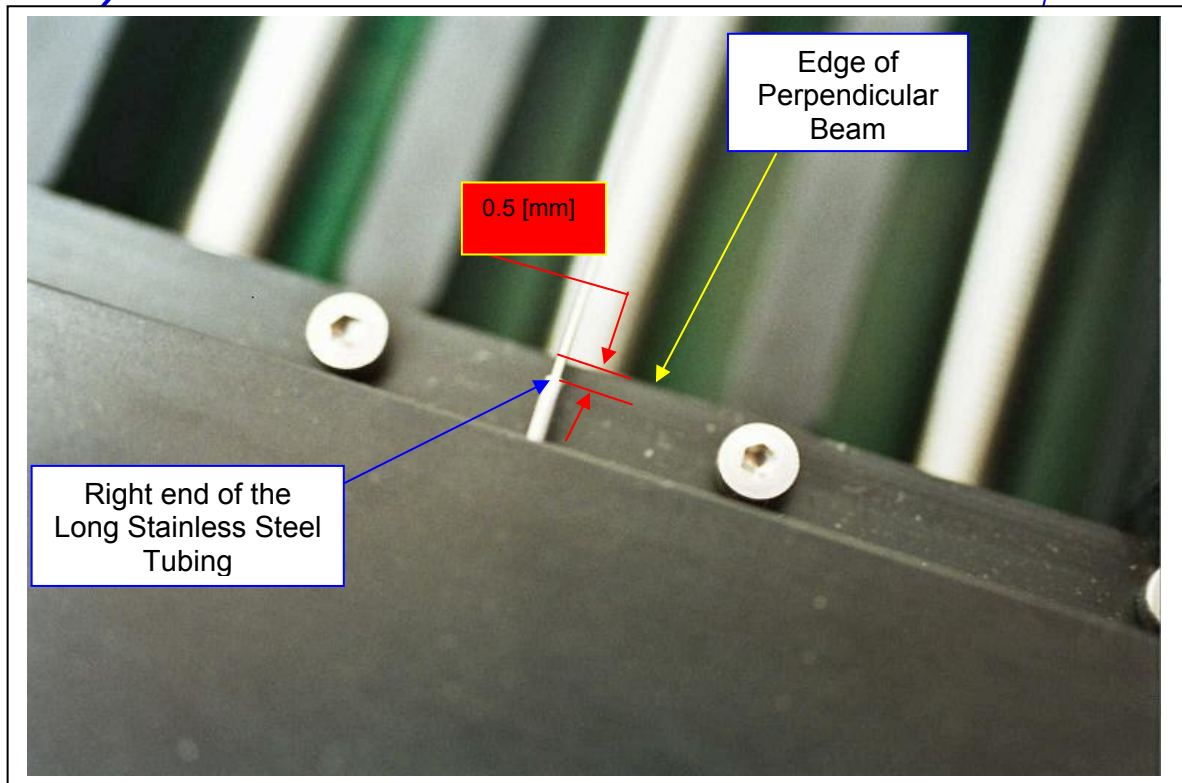
Edge of Perpendicular Beam

0.5 [mm]

Right end of the Long Stainless Steel Tubing

10. **Lock the *Port Plate* on the *Peek Tubing (it's very important to do the locking process on the Peek Tubing)*,** by screwing the two screws of the *Port Plate*, as shown. Use appropriate screwdriver. Type of screws: M2x8.
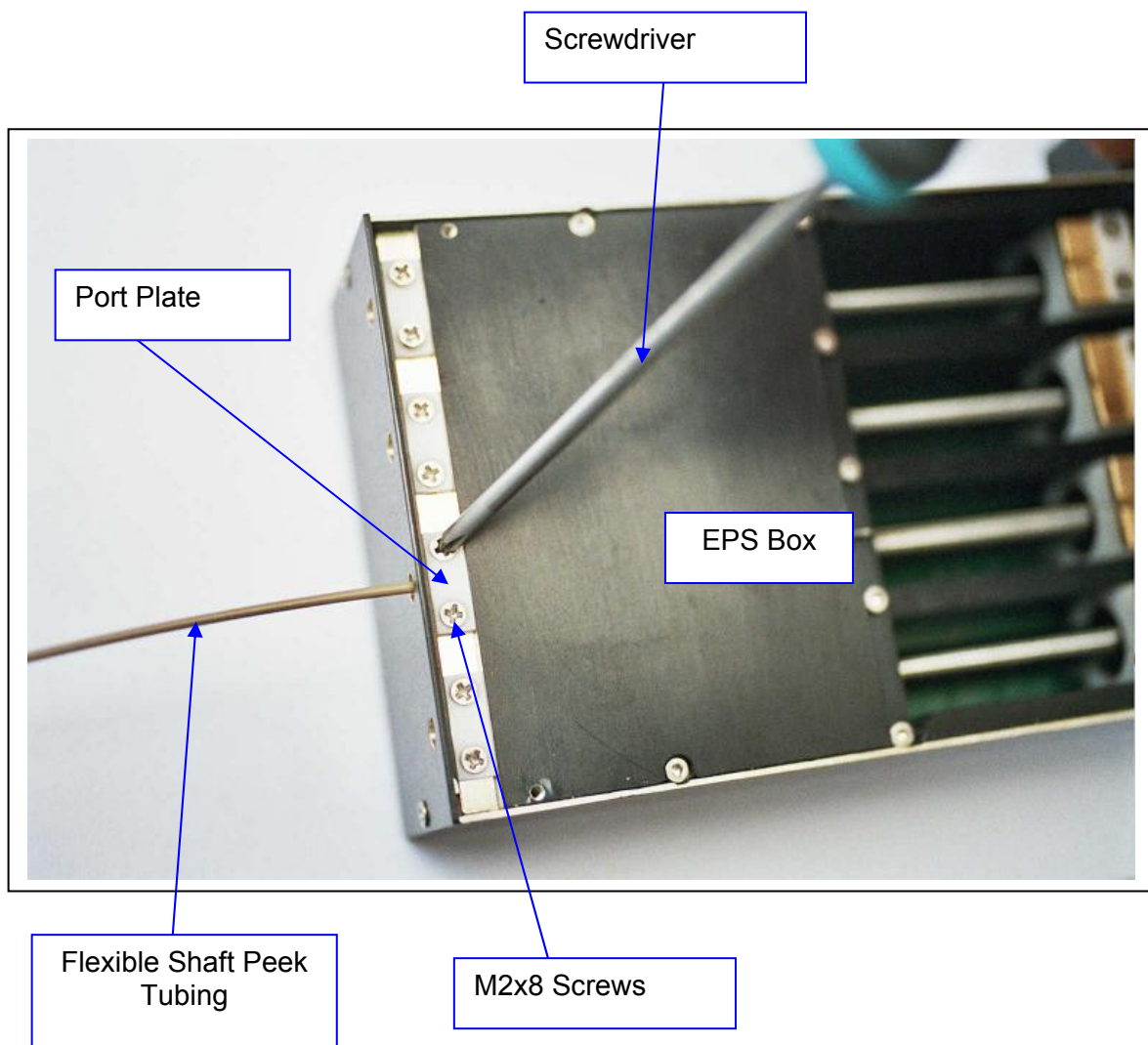
11. Verify you repeat all steps from 1 to 9, to every *flexible shaft* you need to assemble to the *EPS BOX.*
12. Steps 1-10 will end the assembly instructions of the flexible shafts to the EPS BOX.

Flexible Shafts Positioning Shape Affect on Slack

Due to their flexibility, after they are connected on both ends, Flexible Shafts affect the amount of slack in the movement whenever the direction of movement is changed. When such a slack exists the electrode will not move when movement direction is changed until the slack is covered.

Minimum slack – 0 microns
Typical slack – 20 microns
Maximum slack – 50 microns

Appendix B: MT Microdriving Terminal

Introduction

MT Major Components

The MT is assembled of 4 major parts (see Figure B-1):
1. XY Manipulator Table
2. Tubing holder
3. Z-Scale tower
4. Guiding Box (in some MT's)

Assembly procedure

WARNINGS

1. Extra care should be taken when tightening the MT screws. Screws that are over-tightened may cause irreversible damage to the drive or to the shafts. Special caution should be taken with the U0-7 and L0-7 screws (see Figure B-1).

2. After using the MT it should be stored with special care. Slide the electrodes up and down on a daily basis in order to prevent dirt from causing the electrodes to get stuck in the polyamide tubing.
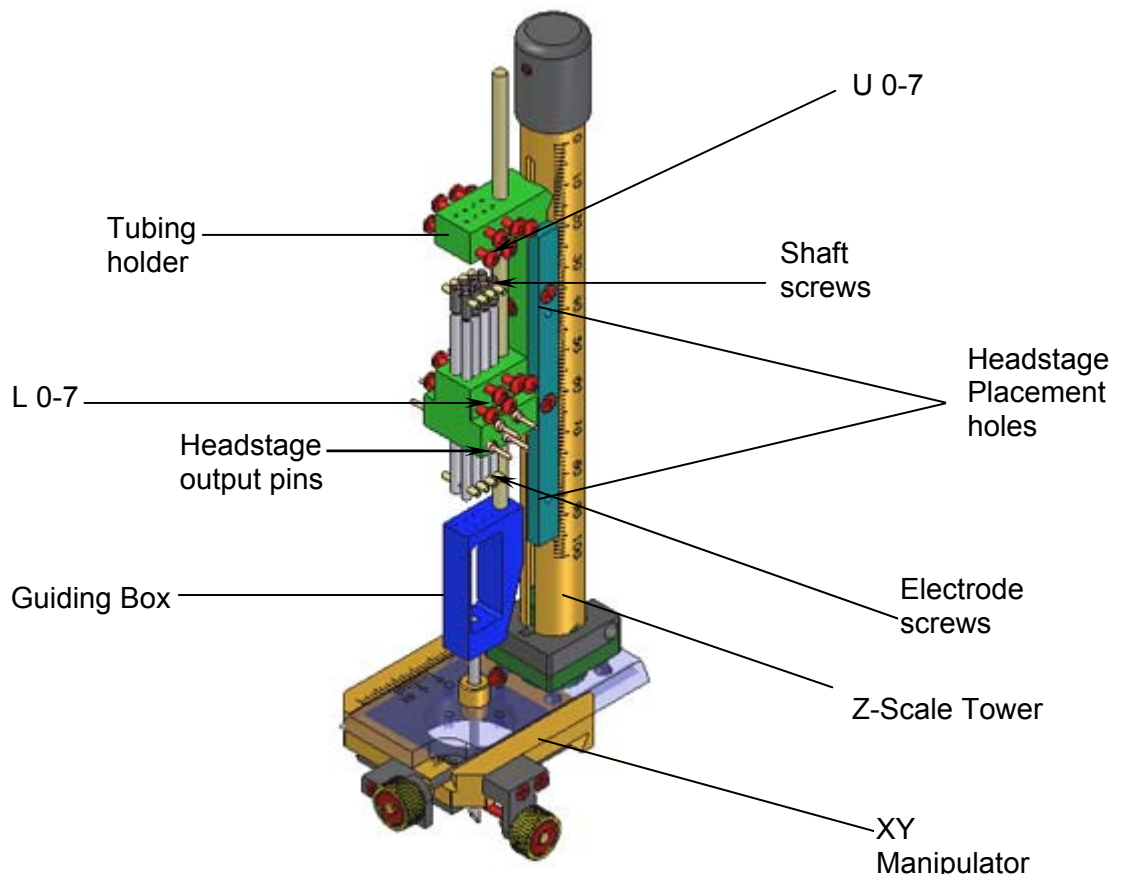
Figure B-1: Micro driving Terminal

Labels in figure:
- U 0-7
- Tubing holder
- Shaft screws
- Headstage Placement holes
- L 0-7
- Headstage output pins
- Electrode screws
- Guiding Box
- Z-Scale Tower
- XY Manipulator

Figure B-2: MT parts and screws

Legend:
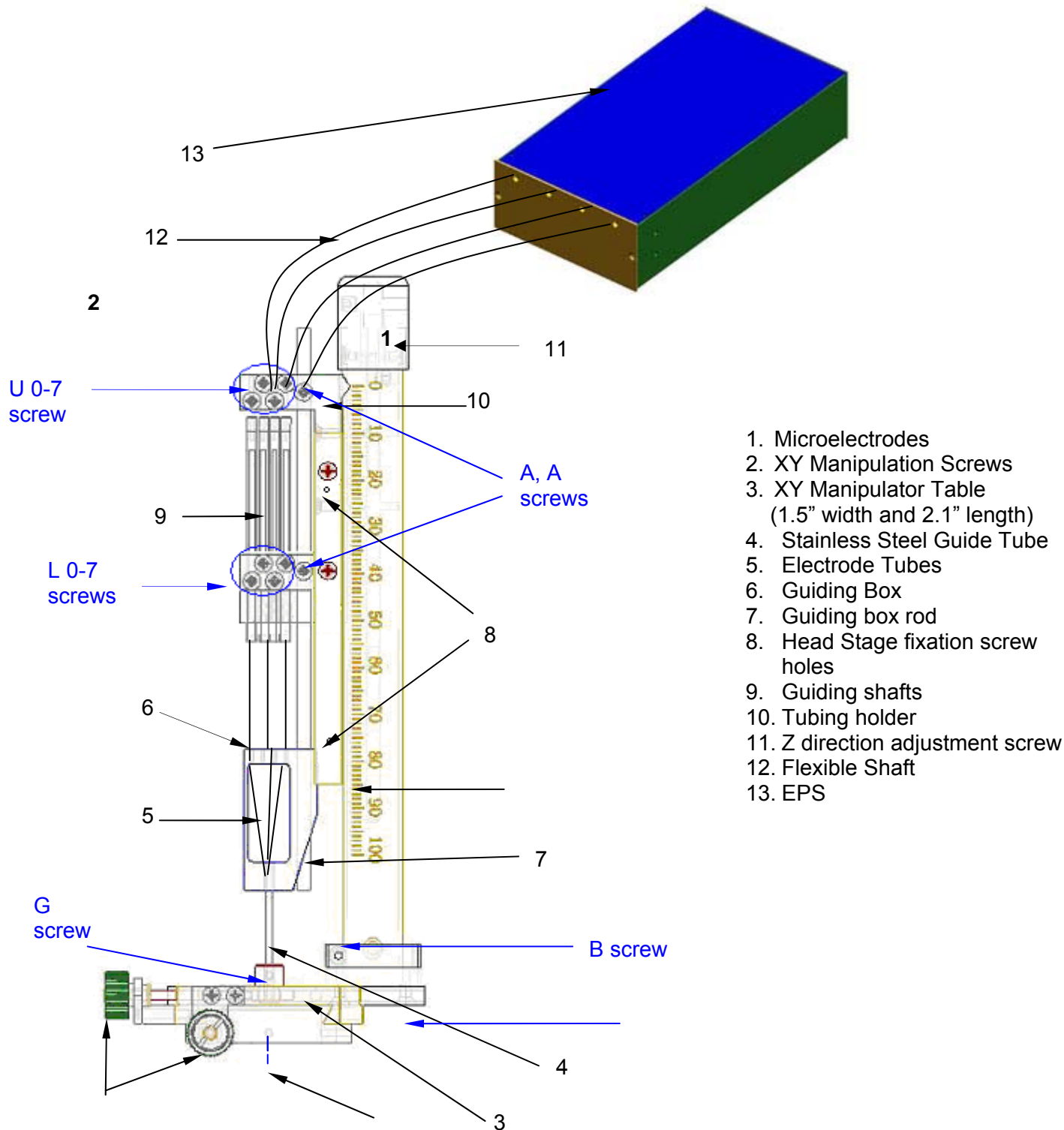
1. Microelectrodes
2. XY Manipulation Screws
3. XY Manipulator Table (1.5" width and 2.1" length)
4. Stainless Steel Guide Tube
5. Electrode Tubes
6. Guiding Box
7. Guiding box rod
8. Head Stage fixation screw holes
9. Guiding shafts
10. Tubing holder
11. Z direction adjustment screw
12. Flexible Shaft
13. EPS

Labels in figure: 13, 12, 2, 1, 11, 10, U 0-7 screw, A, A screws, 9, L 0-7 screws, 8, 6, 5, 7, G screw, B screw, 4, 3

General Description

The MT - Micro-driving Terminal (shown in Figure B-1) is used to maneuver up to 32 Microelectrodes using the EPS-Electrode Positioning System. The EPS is coupled to the microelectrodes with flexible shafts (see Figure B-2) that allow the electrodes to

be moved simultaneously or independently, manually or mechanically (using the EPS).

Main Features

The MT can handle up to 32 Microelectrodes.
The minimum distance between electrodes is 400 to 500 microns.
The MT allows vertical adjustment for initial position with range of 40 mm, and then allows vertical working range of 40 mm.
Each Microelectrode can be positioned independently with remote control. The positioning is controlled by the EPS.
The XY Manipulator Table allows a 16 mm movement in each direction. (Maybe less based on the layout of the electrodes)
The MT is connected to the EPS with Flexible Shafts so that the movements of the animal's head will not change the position of the Microelectrodes (the movements will be absorbed by the Flexible Shafts).
The MT's small dimensions make it possible to use two MTs to record from two different areas of the brain.
Special Configurations:

Standard electrodes can be used. The length of the microelectrodes should be calculated according to the specifications of the experiment and the recording chamber.
The Stainless Steel Guide Tube can be supplied in a variety of lengths.
The inner diameter can be supplied in wide variety of diameters to fit the electrode size and number.

Cautions

Both the electrodes and the Shafts are extremely delicate. As a result, improper use can cause damage to these very important parts of your system. **The screws should be handled with care, closing them too tight will cause damage to the components.**
The three main dangers are: inadvertent pushing of the electrodes forward, driving the motors against infinite load and accidentally applying backpressure to the motors. To prevent these kinds of accidents, **it is important to be constantly aware of the state of the screws on the MT, and to couple and decouple the electrodes with extreme care**.
If the screws holding the electrodes in place (L0-7) are not tightly closed when the electrodes are connected to the flexible shafts, the electrodes will slide forward into or onto whatever is at the end of the MT.

If the screws holding the electrodes in place (L0-7) are not released when the electrodes are driven with the stepper motors, the motor will be pushing against an infinite load and could be damaged.

If the screws holding the flexible shafts in place (U0-7) are closed onto the inner shaft of the flexible shaft, it will be prevented from moving, and again the motor will be pushing against infinite load. It is important to make sure that the upper screws close onto the external metal sleeve and not onto the shaft itself.

If, when the shafts are connected to the electrodes, one is not careful to hold the shaft on the inner shaft itself (and not on the metal sleeve), the shaft will be pushed back towards the motor.

For proper operation of the electrodes, make sure that the electrodes are always free of dirt after use. When not in use you should move the electrodes at least once a day.

Preparing the MT for use

The MT is supplied assembled. In order to place the electrodes and the flexible shafts in place the following actions need to be taken:

Electrode Placement (refer to Figures B-1 and B-2 for screws location)

Loading the electrodes into the stainless steel guide can be accomplished in two ways:

Front Load

- Separate the Z Scale Tower from the XY Manipulator Table by releasing the B screw using a standard M2 Allen Wrench.

- Carefully insert the electrodes into the Electrode Tubes. Do not bend the electrodes or damage their tips.

- Slide the electrodes down the Stainless Steel Guide to the point where they will reach the tip of the Guide.

- Release the L0-7 screws, then release the Electrode screws using the provided Mini Hex Wrench (0.028"). The Electrode screws must be released with extreme care - due to their miniature size they might get lost.

- Insert the upper end of the electrodes to the Flexible Shaft Terminals.

- Tighten the Electrode screws and the L0-7 screws.

Back Load

Back load is recommended only if the diameter of the upper end of the electrode is the same as the diameter of the body of the electrode. In any case back load should be done with extra care so that neither the tip nor the glass coating of the electrode will get damaged.

- Insert the upper end of the electrodes through the Stainless Steel Guide and slide them into the point where they are inside the guide.

- Maneuver each electrode into the Electrode Tubes.

- Follow the three last steps of Front Load.

Flexible Shafts placement into the MT

Before you connect the flexible shafts to the MT, make sure they are connected to the EPS and the EPS motor box is sitting or fixed to the experiment frame. The Flexible shafts should be connected to the MT after the MT has already been installed on the recording chamber on the animal's head. To attach the flexible shafts to the MT follow these steps:

- Release both the U0-7 screws and the Guiding Shafts upper screws (again, handle the miniature screws with care).

- Insert the internal tip of the Flexible Shafts into the holes in the upper side of the Tubing Holder and inside the Guiding shafts.

- Once the Flexible Shafts are in place Tighten the Flexible Shaft screws to lock them in place.

- Lower the metal sleeve of the Flexible Shaft till it goes inside the hole at the top of the Tubing Holder.
- Tighten the U0-7 screw to lock the metal sleeve in place.

Electrode and Guide Movements

The following movements can be accomplished using different settings of the screws:

1. Guide only (no movement of electrodes) – Only in MT's with a guiding box

2. Guide with all electrodes – Only in MT's with a guiding box

3. All electrodes

4. Single electrode

Guide Only (no movement of electrodes)

This configuration is rarely used, although one could imagine it being used to draw the guide back, away from electrodes of which relative positions need to remain fixed (say, for purpose of measuring relative depth). By closing the L0-7 screws, the electrodes are fixed in place.

Following, open both the A screws, separating the guide from the Z screw, and the G screw – decoupling the guide from the X-Y positioner. Now the guide is completely free to move, and can be positioned by hand. A disadvantage of using this method is that free movement will prevent accurate positioning of the guide.

Guide with all electrodes

This configuration is used in order to advance the guide and electrodes together into the brain. This is done in order to reach deep structures in the brain. By advancing the electrodes within the guide, one ensures that they will travel in a straight line, and not splay or bend, as bare microelectrodes tend to do within the brain. In order to achieve this type of movement, the U0-7 and L0-7 screws are closed, fixing the electrodes to the Z screw, and the AA screws are closed, fixing the guide also to the Z screw. Now, as the Z screw is advanced, both guide and electrodes will move together. The G screw must be open in order to allow the guide to move freely in the X-Y positioner.

All Electrodes (guide is fixed if exists)

This configuration is used to advance the electrodes out from the guide and into the brain. Advancing in this manner ensures that electrodes that have been aligned relative to one another remain aligned. Also, movement in this manner extends the reach of the device, since it does not come at the expense of movement with the EPS. In order to advance in this manner, the L0-7 screws must be closed – locking the electrodes to the Z screw – and the AA screws must be open – so that movement of the Z screw does not move the guide. The G screw must be closed in order to prevent the guide from slipping. Now movement of the Z screw will drive all of the electrodes without moving the guide.

Single Electrode

To allow individual electrodes to be moved with the Micro drive, it is necessary to disconnect them from the Z screw. Opening the lower screws (L0-7) does this. The upper screws (U0-7) must be closed. Otherwise the motors will flex the flexible shafts rather than driving the electrodes.

Electrode and Guide movement summary table:

Screws Movement	U0-7	L0-7	A, A	G	Mover
Guide Only	Locked	Locked	Opened	Opened	Manual
Guide with all electrodes	Locked	Locked	Locked	Opened	Z Screw
All electrodes (Guide Fixed)	Locked	Locked	Opened	Locked	Z Screw
Single electrode	Locked	Opened	Locked	Locked	EPS

Recording Procedures

General Recording Procedures

- Adjust the guide so that it is not longer than the chamber depth. Otherwise, attaching the MT to the chamber will cause damage to the brain.

- Set the X-Y positioner to the desired recording position.

- Attach the MT to the chamber.

- Insert flexible shafts – see instructions above

- Advance guide with electrodes together to appropriate depth.

- Advance electrodes together (guide fixed) until electrodes are outside of guide, and perhaps until some specific structure is reached.

- Advance electrodes individually, isolating units on each electrode.

- Record

- Pull electrodes back together (guide fixed) until electrodes are well within guide.

- Pull electrodes and guide back together until guide is well out of the brain.

- Disconnect flexible shafts from the MT.

- Remove MT terminal from chamber.

- On the lab bench, advance all electrodes (guide fixed) until they are out of the guide. Now, using binoculars, it is possible to measure the relative vertical depth of the electrodes.

Specific recording procedures

Procedure for Cortical Recording

1.   Choose electrode lengths such that when the Z screw is at 10mm, the electrode tips are 1mm inside the guide. Measure the depth of the chamber, and set the guide length such that the guide just barely touches the durra. There will be no need to move the guide during the experiment.

2.   Before attaching the MT terminal to the chamber, fill the chamber with 2% agar. This will significantly improve the stability of recordings

3.   Move electrodes together (guide fixed) until cells appear. Back up 1 mm from this point. Since the electrodes penetrating the durra together   can press the durra inward, backing up a little bit will release pressure and improve stability.

4.   Now begin moving electrodes individually and isolate units.

5.   Record.

6.   Back up all electrodes (guide fixed) until they are well within the guide. Remember that this means backing up by at least the sum of how much the electrodes were advanced together in step 3 and how much each of them was advanced individually in step 4. It is probably best to back up 4 or 5 mm more than this, to make sure that the electrodes are within the guide.

7.   Disconnect the flexible shafts from the electrodes and remove the MT terminal from the chamber. Measure relative depths.

GP Recording in Cats

Our Instrument distances:

Vertical distance from the upper border of the center to the dura -

15 degree chambers at 0,0-22 mm
Vertical distance from tip of needle to caption (regular 14g bevel) -6 mm.

Stereotaxic Coordination

Stereotaxic Coorditations are taken from Snider, R.S. and Niemer, W.T. A STEREOTAXIC ATLAS OF THE CAT BRAIN. Chicago, Illinois: The University of Chicago Press, 1961.

- A-P range of Globus Pallidus: A15.0 - A9.0

- A-P range of Nuc. Entopeduncularis: A13.5 - A10.0

- In A12.0   The medio-lateral range of GP is from L9 to L10.5

                    The Vertical range is H0.5 - H2.5
                    The upper limit of cortex at A12.0 is about H18.0

Chamber Position - Vertical Approach

Center of the chamber is located vertically at A12.0, L10.0.

Guide position X=0, Y=0, or X=-1, Y=0 (more lateral penetration will take us to putamen).

Vertical distance from durra to upper border of GP is about 15mm.

Procedure for GP Recording in Cats

1. Insert all electrodes in a way that the Z screw is at 5-mm from top (back spare distance). Electrode tips will be 1mm inside the caption tubes.
   All electrodes are 10 - 50 μm below "upper limit" of EPS, after taking the slack in down direction.
   All screws except -7 are locked.

2. Put the chamber on the durra and measure the distance from the top of the chamber to the surface of the durra in penetration coordination. Don't put agar.

3. Put the drive on the chamber, insert the flexible shafts through U0-7 and connect them to the electrode holders. Lock U0-7.

4. Turn on MCP8, and measure impedance.

5. Open G and move all electrodes with the guide till they touch the durra. Move further (9mm) till 6mm above target.
   Lock G when done.

6. Open AA and move all electrodes (with the guide fixed) another 4mm (all distance). (Keep in mind that the tips of the electrodes are now -3 mm from the tip of the guide!) Lock AA when done.

7. Open L0-7, and start moving with single electrodes till you get at least three (+/-) well-isolated units in each of electrodes.

8. Record.

9. Lock L0-7; disengage (with small forceps) the flexible shaft from the electrode holder. Open U0-7 and remove the flexible shaft.

10. Mark the location of the tips of the microelectrodes with 17.5μA, 15 second cathodal (electrode tip negative) current.

11. Open AA, take all electrodes out with the Z back to the captions (e.g. the all distance) (See #6; 4mm) plus the back spare distance (see #1; 5mm).
    Lock AA when done.
    Open G; move back with the guide and the electrode up to 0mm from top. Lock G when done.
    Release the drive from the chamber (Warning: electrodes that were more than 5mm might be out of the captions).
    Cover the chamber.

12. Perfuse the animal.

13. Open AA, Push all the electrodes (with the Z screw) until they are out of the guide, and measure under binocular the relative vertical depth of each electrode.

14. Write the paper!

Procedure for GP recording in monkey (vertical approach)

GP distance from the dura (A12, L6-24mm, L10-18mm, but at L6 GP is longer, therefore we assume that the upper border of GP is 20mm below dura.

1. Insert all electrodes, in a way that the Z screw is at 3mm from top (back spare distance=3), the electrodes are 10 -50 μm below "upper limit" of EPS, after pulling the slack downwards.

2. Put the drive on the chamber, insert the flexible shafts through U0-7 and connect them to the electrode holders.

3. Turn on MCP8, and measure impedance.

4. Open G and move all electrodes with the guide, till they touch the durra. Move further 18mm till they reach 2mm above the upper border of GP.
    Lock G when done.

5. Open AA and move all electrodes (with the guide fixed) another 3mm (all distances=3) Lock AA when done.

6. Open L0-7, and make a continuous move of 1mm, with each electrode. Make sure that all electrodes are moving.

    If everything is OK, the electrodes are now 1 mm below the tip of the guide and 1 mm above the upper border of GP.

7. Move with single electrodes till you get at least one well-isolated unit in each of the electrodes.

8. Record.

9. Lock L0-7; disengage (with small forceps) the flexible shaft from the electrode holder. Open U0-7 and remove the flexible shaft.

10. Optional: Mark the location of the tips of the microelectrodes with 17.5μA, 15 second cathodal (electrode tip negative) current.

11. Open AA, take all electrodes out with the Z back to the captions (e.g. the whole distance)(see #5; 3 mm) plus the back spare distance (see #1; 3 mm). Lock AA when done.

12. Open G; Move back with the guide and electrode up to 0 mm from top.
    Lock G when done.
    Release the drive from the chamber (Warning: electrodes that were moved more than 3 mm might be out of the captions).

    Flush and cover the chamber.

13. Backup data.

14. Open AA, Push all the electrodes (with the Z screw) until out of the guide, and measure with binoculars the relative vertical depth of each electrode.

The Double MT

General

The Double MT (see figures 3 and 4) introduces a sophisticated solution for the researcher who wishes to investigate and record from two areas of a chamber simultaneously. This appendix provides information on how to configure the Double MT in various angles.

Figure B-3: Double MT front side

Figure B-4: Double MT angle setup
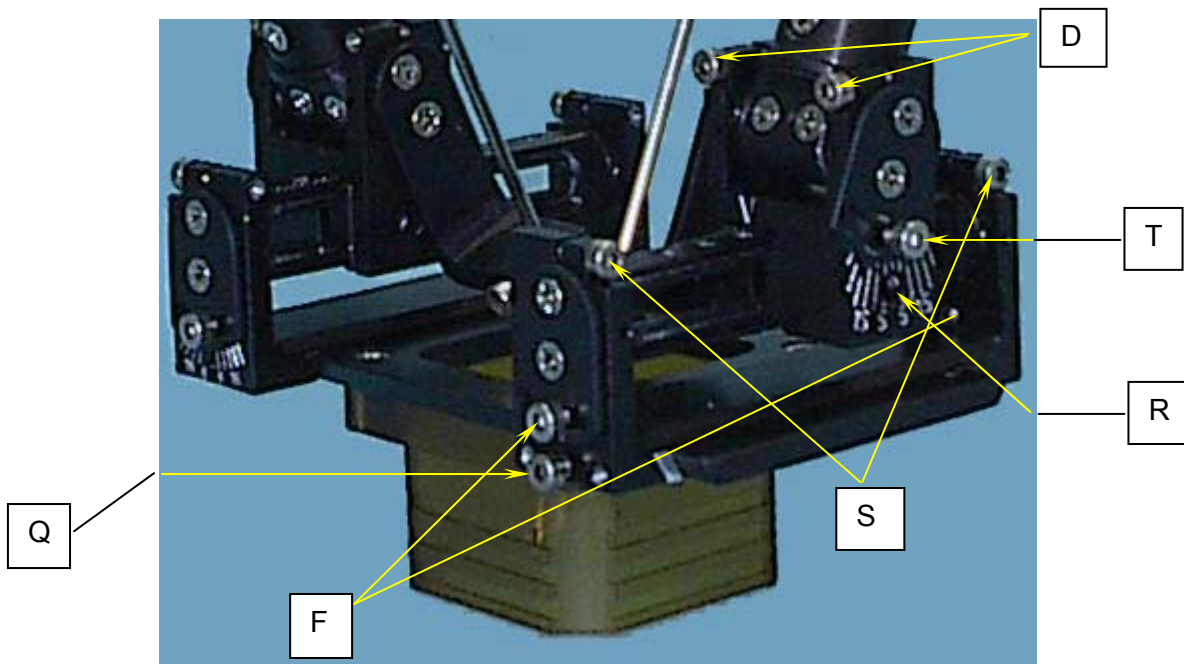
Angle Configuration

Figure B-5: Close up on angle configuration screws

* To understand the description below refer to figure 3 – front side view of the Double MT.

The two Z-Scale Bars (Towers) can change posture in two directions while being fixed to the XY-Manipulator Table. They can be moved backwards and forward and they can be spread to the left and right sides.

Backward – Forward movement

Using a 1.5 mm Allen screw driver untighten both D screws and the T screw.

Left – Right movement

Using a 1.5 mm Allen screw driver untighten both S screws and both F screws.

Moving the Z-Scale Bars on the base XY table (left – right only)

Using a 1.5 mm Allen screw driver untighten the Q screw.

Moving the Z-Scale Bars on the upper XY scale (backward - forward only)

Using a 1.5 mm Allen screw driver untighten the T screw and move the Z-Scale Bar forward or backward to allow a 2.5 mm Allen screw driver placement in the R screw hole. Untighten the R screw and move the position the Z-Scale Bar to desired location.