

EEG Measurements

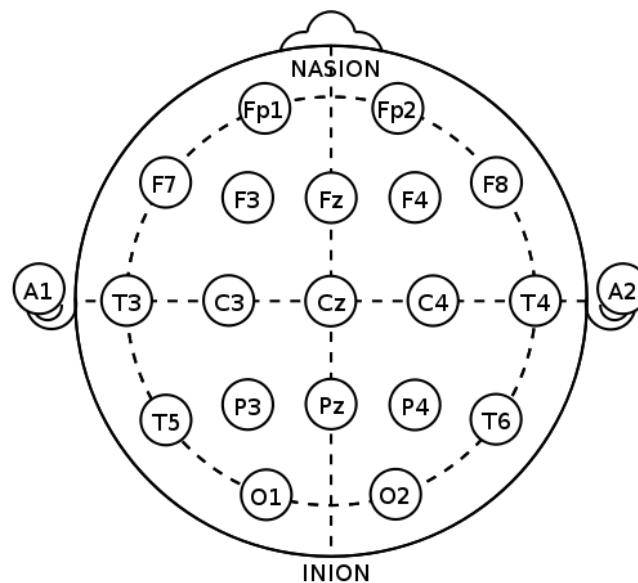
Preface

It is assumed that you have acquainted with Neurobit Optima manual and introduction to selected software.

Packages of example designs of signal processing and presentation for a few interoperating software applications can be found in *Designs* folder on CD delivered with the equipment.

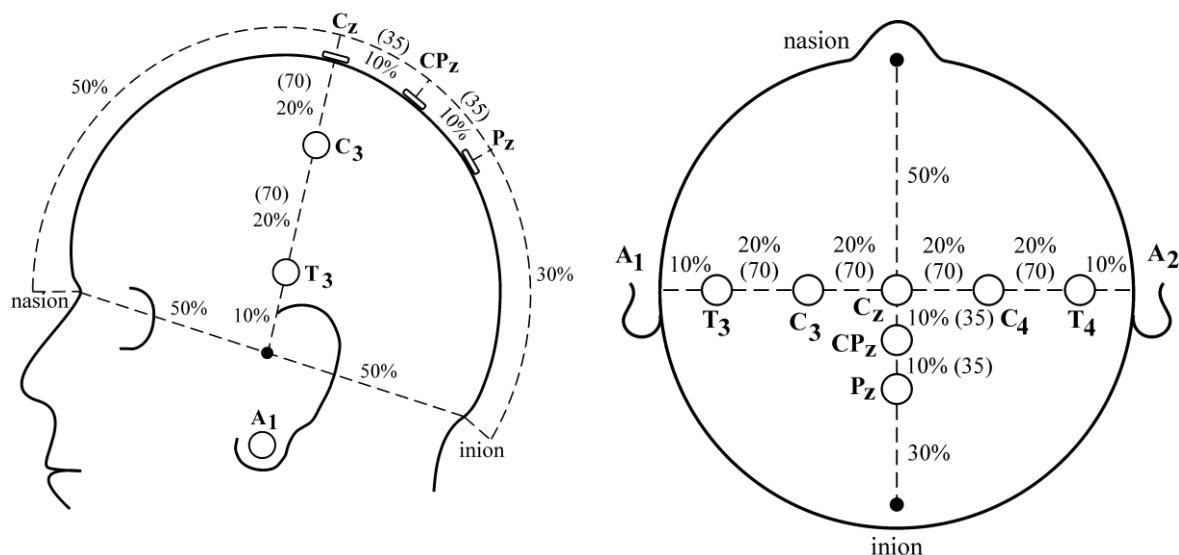
Electrode sites

EEG electrodes are usually placed according to 10-20 international system. It defines names of used sites and percentage distances between them.



Selection of sites depends on a measurement goal (e.g. it is defined by neurofeedback protocol).

The following pictures show selected sites often used in neurofeedback. For convenience, approximate distances in millimeters for adults are given in parentheses. For neurofeedback trainings, placing the electrodes with 1-2 cm tolerance usually suffices. Research or QEEG assessments require better accuracy.



Derivations

The two following systems of electrode connections to measurement device are in use.

Referential (monopolar) derivations

In this case voltages between selected head sites (e.g. C3, C4 etc.) and a common reference electrode of relatively stable potential (e.g. in A2 site) are measured. It is the most frequently used montage.

An example of electrode connections for 1-channel measurement:

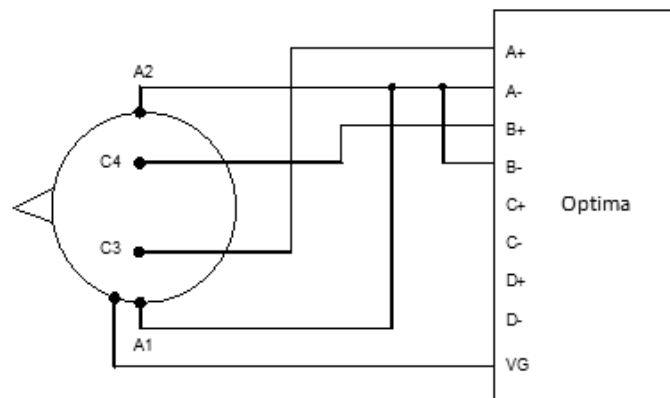
- A+ input: active electrode, for example in CZ site,
- A- input: reference electrode, e.g. in A2 site,
- VG (virtual ground) port: any convenient location, e.g. in A1 site,
- SH port (for shielded wires) is not used.

Example connections for 2-channel measurement:

- A+: first active electrode, e.g. in C3,
- B+: second active electrode, e.g. in C4,
- A- and B-: connected together with a special jumper to a reference electrode, e.g. in A2,
- VG: any convenient location, e.g. in A1 site,
- SH: not used.

For better stability, two reference electrodes in A1 and A2 sites connected together (and to negative inputs of measurement channels in use) are often used. It is so called *linked ears reference*. In this case VG port can be still connected nearby A1 with separate electrode, with some interval (>1 cm) from reference electrode placed in the same region.

The following diagram shows an example of 2-channel referential derivations with linked ears reference.



Bipolar derivations

In this montage voltages are measured between independent pairs of electrodes (e.g. C3-T3, C4-T4).

An example of electrode connections for 2-channel measurement:

- A+: C3,
- A-: T3,
- B+: C4,
- B-: T4,
- VG: any convenient location, e.g. in A1 site,
- SH: not used.

Application of electrodes

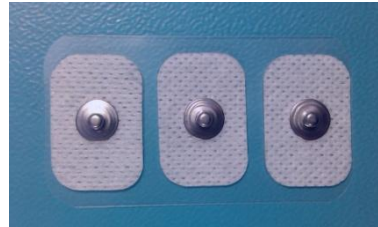
Depending on purpose, Neurobit Optima equipment can work with various types of EEG electrodes, methods of application and connection. Application of disposable electrodes with adhesive-conductive paste for typical referential derivations is described below.

Proper and adroit electrode application requires proficiency. For first trials reserve extra time.

The materials



a) EEG Ag/AgCl disk electrodes
product #201041



b) self-adhesive Ag/AgCl electrodes
#201046



c) set of wires with electrode snaps
and TP 1.5mm connectors
#206010 or #206012



d) jumper for connection of reference
inputs
#206006 or #206005



e) adhesive-conductive Ten20 paste
#301000 or #301001



f) NuPrep abrasive gel for skin
preparation
#301002 or #301003

g) disinfection pad (soaked with
isopropyl alcohol)

h) spatula

i) cotton swab (or cosmetic pad or
tissue)

Before first use of the paste, gel and other materials read instructions attached to them, especially safety information. You can also download instructions for the paste and gel in many languages from their manufacturer's website: <http://www.weaverandcompany.com/instructions-for-use.html>

Application procedure

1. Clip electrode cable near the neck (e.g. to collar) with a clamp seen on the cable. If necessary, gently draw wire ends from the band strapping the cable in such a way, that snaps freely (without tense) come to individual head sites intended for application of electrodes, without covering the face.
2. Apply disk electrodes in hairy sites and self-adhesive electrodes in hairless places according to the following instructions.

I. Skin preparation

The objective of this stage is reduction of electrical impedance of epidermis.

- a) Apply small amount of NuPrep abrasive gel on cotton swab of size similar to electrode diameter (or cosmetic pad or corner of a tissue).
- b) Part hair in the site of electrode application with two fingers of one hand.

- c) Wipe the skin in this site with the swab moistened with gel, performing 4-5 circular movements on area corresponding with electrode size. For children and old people apply little pressure; in other cases the pressure should be moderate. After this action the skin should be dry.

Remarks:

- Alternative way of skin preparation is the use of special alcohol pads with pumice. Having parted hair in the application site with two fingers of one hand wipe the skin with the pumice pad in a few circular movements, using moderate pressure. Before transition to next actions the site should dry.
- For disk electrodes: In case of routine neurofeedback sessions the stage of skin preparation can be often skipped (or limited to wiping the skin with regular alcohol pad and waiting until the site is dry), if nevertheless acceptably low impedance can be reached (green bars in impedance test described later).
- For self-adhesive electrodes: In case of routine neurofeedback sessions the skin preparation with abrasive materials (such as NuPrep gel or pumice pads) can be often replaced with the use of Ten20 conductive paste, if it suffices to achieve acceptably low contact impedance (green bars in impedance test described later). Take in a little paste with spatula and spread it with a few circular movements on the skin area a little smaller than electrode size. Next completely wipe off the paste with dry tissue (or cosmetic pad), trying not to spread the paste outside intended area for electrode.
- Abrasive materials and paste can be applied only on intact skin.

II. Sticking an electrode

Sticking a disk electrode in hairy site, with adhesive-conductive paste

- a) Fix a disk electrode in a snap of wire.
- b) Take in a little Ten20 paste with spatula. Part hair in the application site with two fingers of one hand. Spread the paste on the skin area similar to the electrode size with a few circular movements, applying slight pressure. Try to avoid contamination of adjoining regions with the paste.
- c) Take in Ten20 paste with spatula. Holding the snap of wire coat the electrode area with thin (about 1 mm) layer of the paste. Add a little more paste in the middle (gray contact field). Collect possible excess of the paste from the electrode edge. Avoid contamination of the other electrode side and the snap of wire.



- d) Put the electrode against the head site, moderately pressing the snap and doing with it a few tiny (1-2 mm), side movements in various directions. The paste should not visibly squeeze from under the electrode. Both too strong, and too weak pressure worsen the joint.



Sticking a self-adhesive electrode in hairless site, especially on mastoid process behind an ear

Stick the electrode with some pressure on its all area and next press the snap of wire on it. In case of application behind an ear the longer electrode edge should border on the ear.

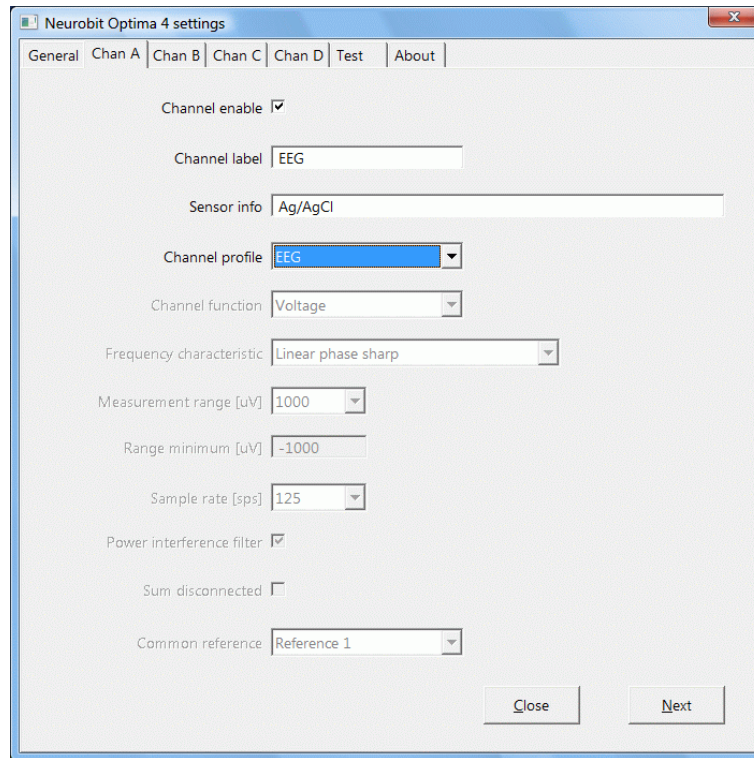


3. If you have soiled your hands with the paste, wash them.
4. Properly connect plugs of electrode wires to the measurement device. If necessary, use suitable jumper for reference electrode(s).

Configuration and tests

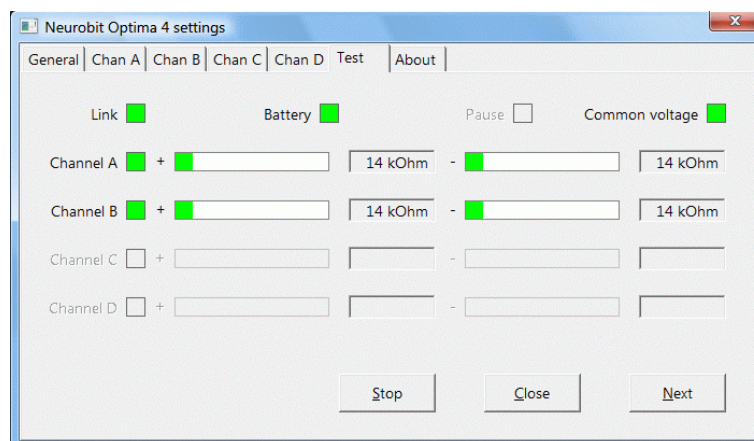
1. Turn on Optima device. Check configuration of measurement channels in the device settings window.

For channels in use „Channel enable” fields should be marked and in “Channel profile” fields EEG profile should be typically selected (or “EEG 250sps”, if higher sample rate is necessary). Channels not in use should be turned off (empty “Channel enable” field).



(For bipolar derivations, after initial selection of EEG (or “EEG 250sps”) profile setting default parameter values, it is necessary to switch to „User defined” profile, in order to set “No connection” option in “Common reference” field.)

2. Start the test of connection impedances on Test tab in the device settings window. All active indicators should be green. Impedance bars should be also green (the smaller impedance the better). In applications, where signal quality is especially important (e.g. QEEG assessment), impedance not exceeding 5 kOhm is the goal.



Typical problems:

- Red indicator for a given channel: check connections for that channel. Maybe no electrodes are connected to enabled channel, or an electrode connector is too shallowly inserted into a port, or corresponding electrode came unstuck. If electrode wires have been used for long time, a brake of conductor, not visible within insulation, can manifest in this way.
- Too high impedance for an electrode connected to a given port (especially red or yellow impedance bar): adjust application of that electrode. For example, it may require addition of Ten20 paste for disk electrode and/or moving it a bit sideways in a few directions. In extreme case it is necessary to unstick the electrode, clean the site with alcohol pad and repeat the electrode application process.
- Red „Common voltage” indicator: check connection and application of the electrode connected to virtual ground (VG) port.

When test result is correct, stop the test (and close the settings window).

Measurement session

Example screenshot for EEG measurement is shown below.



Measurements of tiny EEG signals (amplitudes in the order of microvolts) are susceptible to many physiological artifacts and external interferences. Thus control their sources, such as body movements, cell phones etc. More about various artifact types:

<http://emedicine.medscape.com/article/1140247-overview>

Dismantling of the electrodes

1. Disconnect wires from the device (if you are not going to repeat measurements with the same port connections soon).
2. Holding electrodes with two fingers disconnect wire snaps. Try not to dirty them with the paste.
3. Unstick the electrodes.
4. Clean the skin in electrode sites with alcohol pads (without pumice) and/or moisten paper towel.