Why do I need the impedance meter feature at all?

Successful neurofeedback builds on a good EEG signal. Using a distorted EEG signal is like trying to listen to a piece of music in the middle of a construction site. One important condition for a good EEG signal is good contacts of the EEG electrodes to the head. An impedance meter helps to achieve such good contacts. It is important that usage of the impedance meter is easy and fits in the process in a seamless way.

In addition, worn-out electrodes tend to produce high, noisy galvanic voltages that may reduce the quality of the EEG signal dramatically. More about that >here<.
The EEG NeuroAmp has a built-in impedance meter, which not only shows the impedance of each electrode on an easy-to read display, it also monitors the galvanic electrode voltages. If these are too high, there will be a warning signal.

In recent weeks, we received a couple of E-Mails or phone calls from concerned customers who thought that the impedance meter was broken. Either there was no impedance reading or the display was flashing and there were beeps. In fact, reason was not a broken NeuroAmp - it was a broken electrode cable (no reading) or a bad electrode with too high galvanic voltage (flashing display and beeping). Without the impedance check, the problem would have been not discovered probably. An EEG looks still like an EEG with a bad electrode- sometimes even with a broken one!

Why is the impedance of the electrodes important?

The modern EEG amplifiers have a high impedance to verify that the connection between the electrodes and the scalp is negligible and warn us if the electrode does not have any contact at all. But that is only partially true. In fact, the EEG electrodes not only collect the EEG signals, but also all kinds of electromagnetic pollution. The most important source of noise comes from power lines, which emit oscillations of electromagnetic signals of 50 Hertz (or 60Hz). The noise that a typical EEG electrode normally collects is much larger than the EEG signal that interest us. Typical values are: EEG signal: 10 to 100 microvolts, noise from the power line at 50Hz: 10 millivolts at 1 volt, a factor of 1000 increased to 100,000.

To address this problem, the EEG amplifiers typically tend to measure the EEG with two electrodes 'active' and 'baseline' or '+' and '-'. Both electrodes recorded the same noise, but measure different EEG signals, because they are placed at different points in the head.

The amplifier now subtracts the two signals, thus canceling out the noise. Only the EEG signal is left. This remains only work if the noise measured by the two electrodes is exactly the same. And this is why we, the impedance between the electrodes and the scalp is important: The size of the signal noise is very dependent on this impedance. In general, we can say that the smaller the impedance, the lower the noise signal.

The subway impedance feature allows us to check the quality of the contact of the establishment of the electrodes. Basically, you can try to achieve a very low impedance.

Normally, this requires a thorough cleaning of the application site and / or use of a peeling-gel. Knowing that the noise signal depends on the impedance and that both the noise of the signals must be exactly the same, we understand that the adequacy of both impedances is even more important than the impedance of the values themselves.

Is the impedance measurement harmful?

No, not at all. The impedance meter function of EEG devices uses a small measurement voltage in order to determine the impedances of the electrodes. This signal is so small that it cannot be felt by the body. EEG devices have to comply with the standard for electrical safety of medical devices, IEC 60601-1. Other equipment using similar measurement currents are e.g. body fat monitors or a scale with a body fat monitor.

Does the impedance meter function distort my EEG measurement?

That depends on the measuring method. There are EEG amplifiers that measure the impedances during EEG signal acquisition. This is normally done with a frequency that is high compared to the EEG frequency range, so that both ranges do not interact. Other devices have to be isolated from the EEG amplifier, either by unplugging or by switching an internal relay.

What is a DC offset, and why should I care?

EEG electrodes sometimes act like little batteries - they produce a DC voltage. The reason for this is a combination of the electrode material with the substances on the scalp (skin, sweat, fat, Ten20 paste, gold plating of the electrode, etc.). Although this voltage can be much higher than the EEG signals, these offset voltages do not influence the EEG measurement, because the amplifier amplifies and processes only AC voltages. But, in case these galvanic voltages get too high, the input stage of the amplifier could get saturated, so that no EEG signal is amplified. Furthermore, it has been observed that the oscillations of these galvanic voltages are often similar in amplitude and frequency to those of the EEG signals.
We recommend using only electrodes of the same material and to replace worn-out electrodes.

What can I do about line frequency pick-up?

Good electrode contact and good balancing are required for optimal noise reduction. Also, the electrode cables should be kept parallel as far as possible, e.g. by placing them in a helix cable or by braiding them. Despite these precautions you will still sometimes see a large interference at 50Hz (or 60Hz). We do not recommend suppressing this 50 or 60Hz line with a notch filter or other sharp filters. First of all, such filters add phase distortions and delays, and secondly, watching this "signal" is a very good and easy method to check if the contact

quality of one or more electrodes has deteriorated and the situation should be checked once more with the impedance meter function.
Neurofeedback training is mostly based on dynamically adapting thresholds so that an offset from line pick-up does not matter here. For a level reading you may use a sharp low-pass filter or notch filter in order to make this display independent from line pick-up because this reading does not need to be real-time.