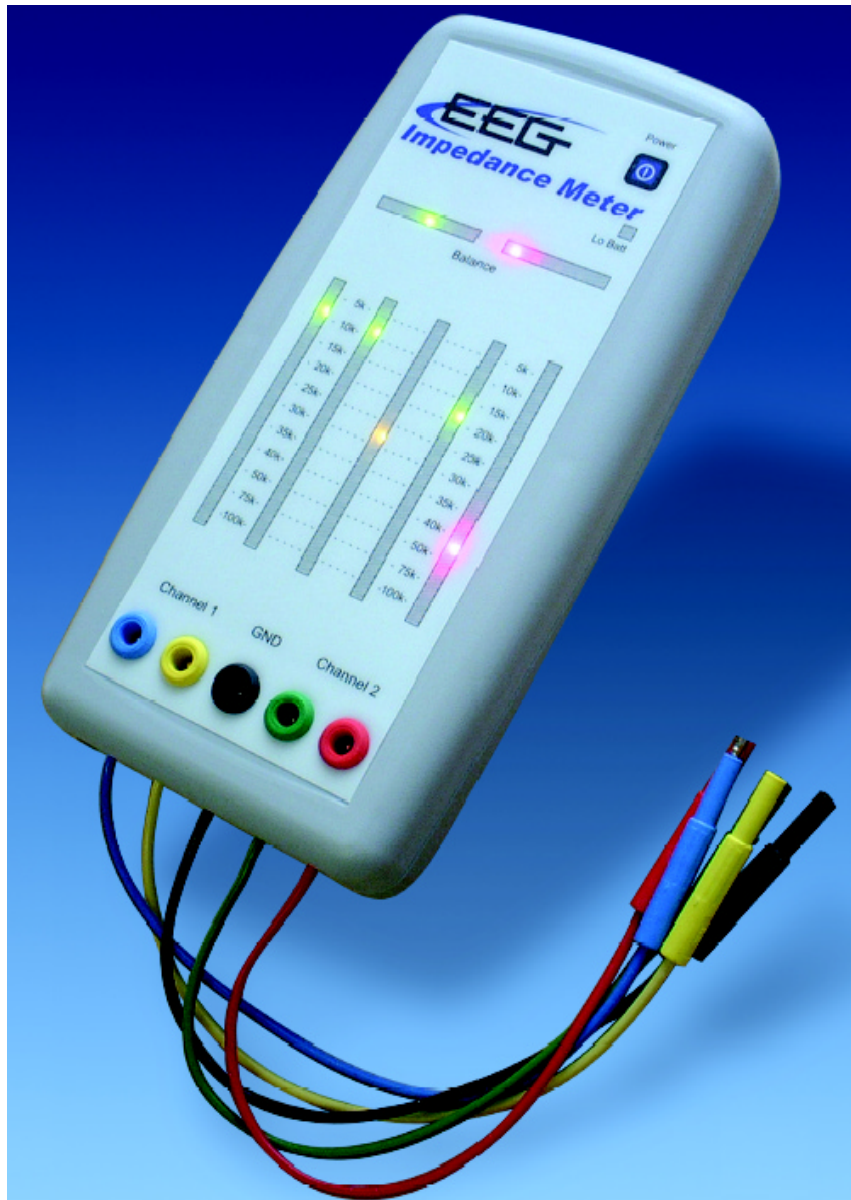


EEG Impedance Meter

Manual



EEG Info

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Product Name: EEG Impedance Meter

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Overview

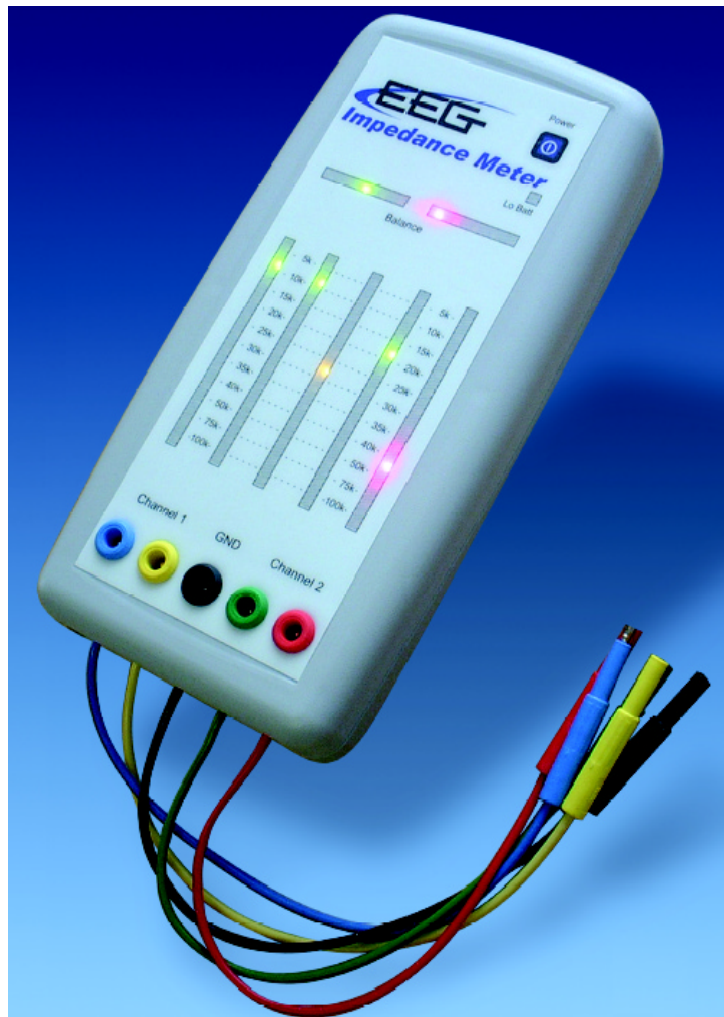
This inline impedance meter connects easily between your amplifier and the EEG-electrodes and works with any of the leading amplifiers including Procomp, Brainmaster, Neurocybernetics and J+J.

Colored light bars you indicate how good your impedance is at each electrode site, and you can go straight to the problem. Save valuable adjusting time and look much more professional by identifying electrode problems instantly and easily, and go straight to the source.

No more disconnecting electrodes from the amplifier, and connecting them two at a time into an impedance meter.

No more switching between software programs, and trying to find the icon on your PC for your impedance checking software.

One swift touch of a button on the impedance meter, sitting right in arms reach, and you are looking at your impedance and balance measures with a simple and beautiful colored display.



In the past, clinicians who have avoided using an impedance meter usually saying that it is too much hassle and too time consuming. With an impedance meter this simple and easy to use, the job of applying electrodes becomes so much easier that putting on electrodes WITHOUT this impedance meter will forever seem like too much of a hassle and too time consuming.

Features

Handling & Usage

- in-line measurement
- no reconnection of electrodes required
- bright easy-to-read LED bar display
- balance display for optimum EEG signal noise reduction

Power Supply

- long battery life (more than 100 uses on a charge)
- operated with 2 x AA batteries (normal or rechargeable)
- auto power off
- reverse battery protection

Measurement

- wide impedance range (<5k...100k)
- cancellation of electrode galvanic voltages
- cancellation of power line pick-up (notch filters)
- automatic low-power one channel operation

1 Description

1.1 Purpose

The EEG Impedance Meter is a battery operated device. Its purpose is to help to achieve good electrode contacts during EEG measurements / neurofeedback. It displays the impedances of up to five electrodes independently and in real time. The unit is intended for use during the electrode placement or re-checking process only; during the EEG measurement / neurofeedback training phase it must be turned off.

1.2 Function

The EEG Impedance Meter connects between EEG electrodes and the EEG amplifier. It can be used for one channel operation (three electrodes: Ground, Active, Reference) or two channel operation (five electrodes: Active1, Reference1, Ground, Active2, Reference2). During the electrode placement process, the unit is turned on and shows the actual electrode – scalp impedances by means of one LED display bar per electrode. In addition, one balance bar per channel shows the balance between the impedances of the respective active and reference electrode. Optimum balancing of the impedances within one channel maximizes noise canceling by the EEG amplifier. During the EEG measurement / neurofeedback training phase it must be turned off, because its measurement signals would disturb the EEG measurement. When turned off, the unit is galvanically disconnected from the electrodes.

The unit is battery operated. It requires two standard AA batteries or rechargeable batteries. Rechargeable batteries may be charged with any standard battery charger. If the batteries need to be replaced, an indicator light blinks.

There are two power management features that maximize battery life: One-channel operation and auto-power-off. If only one EEG channel is used (three electrodes), the LED display for the channel not in use is turned off. If the unit is not turned off manually, it will turn off itself after five minutes.

Display and Buttons

(see picture on page 6)

ON/OFF Button

The ON/OFF button is a push button covered by the front panel thus preventing it from being contaminated accidentally. Pushing the button toggles the unit on and off. If the unit is not turned off manually, it will do so automatically after five minutes.

Low Battery indicator

The Low Battery indicator next to the ON/OFF button starts blinking if the battery voltage drops below 2V indicating that the batteries need to be replaced.

Although the device does work with lower supply voltages, the accuracy of the measurements is not guaranteed anymore, if the LoBatt indicator blinks.

Impedance Bars

The figure below shows the impedance ranges as well as the colors of the 12 LEDs each impedance bar consists of. The unit requires a minimum of three electrodes to be connected in order to perform a valid measurement. As long as less than three electrodes are connected, only the lowest LED of the center bar is lit indicating that the unit is turned on.

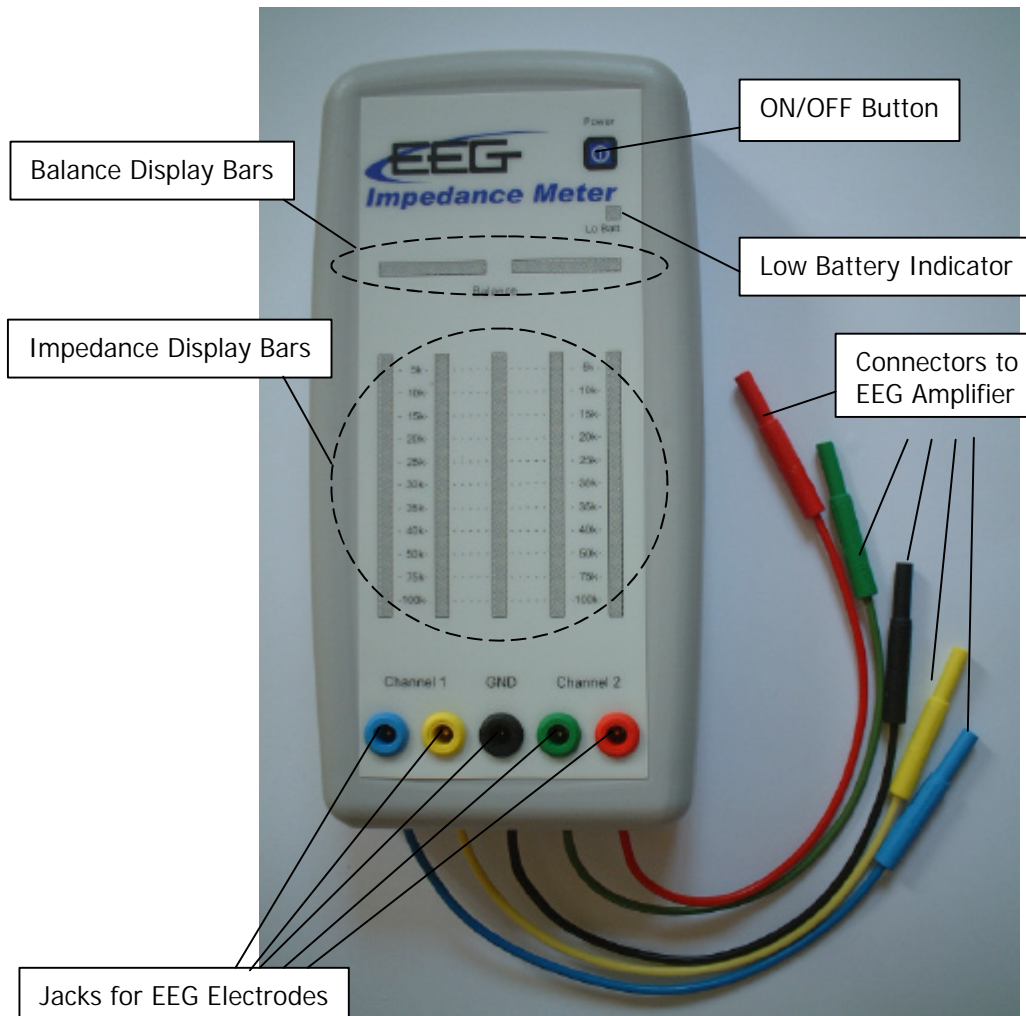
0	...	5k	}	Green
5k	...	10k		
10k	...	15k		
15k	...	20k	}	Yellow
20k	...	25k		
25k	...	30k		
30k	...	35k		
35k	...	40k	}	Red
40k	...	50k		
50k	...	75k		
75k	...	100k		
100k	...	140k		

Balance Bars

The balance bars show how well the impedances of the two electrodes of an EEG channel are balanced. (see figure below)

< -20%	-20...-10%	-10...+10%	+10...+20%	> +20%
RED	YELLOW	GREEN	YELLOW	RED

EEG Impedance Meter outline



1.3 Symbols

Meaning of the symbols on the back label of the EEG Impedance Meter:



Conformity symbol



Type BF equipment



Manufacturer



Production year

1.4 Electromagnetic Compliance

The EEG Impedance Meter has been tested according to IEC 60601-1-2:2001 and complies with:

- IEC / CISPR 11, Class B (RF emission)
- IEC 61 000-4-2 (Electrostatic Discharge - ESD)
- IEC 61 000-4-3 (RF susceptibility)
- IEC 61 000-4-6 (RF asymmetric)
- IEC 61 000-4-8 (LF magnetic field)

2 Safety Instructions

Please take the time to read this manual carefully before using the EEG Impedance Meter for the first time in order to familiarize yourself with its operation. This manual is part of the product and must be available anytime. Use the device only for the intended purpose (see section 1.1).

CAUTION

- US Federal Law restricts this device to sale by, or on order of, a physician or any other practitioner licensed by the law of the state in which he or she practices to use or order the use of this device.
- The EEG Impedance Meter may be used only by accordingly educated persons, who can ensure sound handling practices.

WARNING

- Do not operate EEG Equipment and EEG electrodes within 3m of an operating cellular phone, similar radio transmitting device, other powerful radio interference producing sources such as arc welders, radio thermal treatment equipment, x-ray machines, or any other equipment that produces electrical sparks.
- All electrical connections are totally isolated from line (110 or 220VAC) power due to battery operation.
- As soon as at least one electrode is attached to a person, none of the other electrodes must come into connection to any conductive material.
- After use, disposable electrodes may be a biohazard. Handle, and when applicable, dispose of these materials in accordance with accepted medical practice and any applicable local, state and federal laws and regulations.
- Reusable electrodes present a potential risk of cross-infection especially when used on abraded skin, unless they are restricted to a single patient or sterilized between patients. If sterilizing electrodes, employ only gas sterilization.
- Not to be immersed in water.
- Take care in arranging patient and sensor cables to avoid risk of patient entanglement or strangulation.
- Not to be connected to a patient undergoing MRI, electro surgery or defibrillation.

ATTENTION

- An EEG Impedance Meter damaged by static electricity is not covered under warranty. Although great care has been taken to employ effective ESD protection circuitry in the product, it is recommended to take anti-ESD measures such as anti-static mats or a humidifier to condition hot, dry air.
- Not for diagnostic purposes, not defibrillator proof, not for critical patient monitoring.
- Remove batteries when the device is not being used for an extended period of time. Please dispose of battery following local regulations. We recommend the usage of rechargeable batteries, 1.2 ... 1.5V (AA NiCd or AA NiMH). NOTE that there are AA cells with 3 V (Lithium). Such batteries would destroy the EEG Impedance Meter !
- The EEG Impedance Meter is intended to help to achieve good electrode contacts. It does not make any statement about the quality of the EEG signal. It is in the responsibility of the practitioner to decide if the EEG signal is suited for the intended purpose.

CONTRAINDICATIONS

- None specific for the impedance meter

NOTE

- The unit is not susceptible to electromagnetic disturbances below IEC60601-1-2 immunity test levels, as long as the EEG electrode cables are not longer than 3m.
- If you suspect a problem with electromagnetic interference, contact EEG Info or BEE Systems for a technical note on identification and remediation.
- No preventative inspections required; maintenance must be performed by qualified personnel.
- The supplier will make available, upon request, circuit diagrams, component parts lists and description or other information required for the repair of product by qualified personnel.

CARE AND MAINTENANCE

- This product has been developed and produced with great care and should also be handled with care. If you follow the recommendations you will prevent premature expiry of the warranty and enjoy the safe use of your product for years.
- Use only in conjunction with standard EEG amplifiers. Other accessories may damage the product, impair performance and breach the regulations. Inappropriate use may have dangerous consequences or at least damage the device and render the warranty invalid.
- Do not attempt to open the product and repair it yourself. The manufacturer accepts no liability for any damages thus incurred. Inappropriate handling may damage the device and render the warranty invalid.
- Remove dead batteries promptly to prevent corrosion damage.
- Do not use or store the product in dusty, wet or dirty environments.
- Wipe EEG Impedance Meter with a clean cloth, dry or moist or with a small amount of alcohol or isopropyl.
- Store the unit out of reach of children to prevent them from injuring themselves or others and to avoid damage to the product. Especially keep out of reach of small children, as some removable parts could be accidentally swallowed.

CALIBRATION

- Factory testing and calibration ensure equipment accuracy, no calibration is required.

STORAGE

- Store in its original case at up to 90% humidity / 30°C

3 Set-Up

3.1 Unpack your EEG Impedance Meter

Please check if the unit is damaged. If so, don't use it and return it for replacement.

ATTENTION

Packing material can be hazardous if swallowed. Store it out of reach of children or dispose properly.

3.2 Insert Batteries / Battery Low Indicator

The battery compartment of the EEG Impedance Meter is located at the underside in the back. Slide the cover to the back to open. It is important to insert the batteries as shown in the compartment, otherwise the unit will not work.

IMPORTANT:

ONLY USE AA 1.5V BATTERIES OR 1.2V RECHARGABLES (NiCd or NiMH).

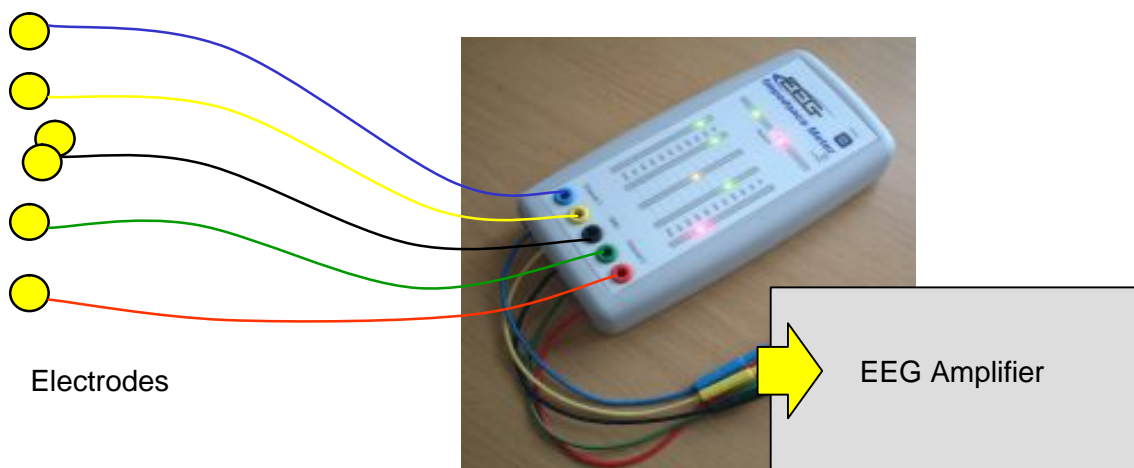
NOTE: THERE ARE 3 V LITHIUM BATTERIES WITH THE SAME SIZE - **NEVER** USE THEM, THEY WOULD DESTROY YOUR EEG IMPEDANCE METER !

RECOMMENDATIONS:

1. Replace the batteries as soon as you notice the LoBatt indicator blinking. Although the unit will operate for some time, accuracy of the measurement is not guaranteed anymore.
2. Use rechargeable batteries (NiCd or NiMH) in order to save the environment and for your convenience. There are battery chargers that take care of two or even four or eight batteries simultaneously. Get one of them and have one set of batteries charged all the time.

3.3 Set-Up in your EEG System

Connect the EEG Impedance Meter as shown in the figure below. The EEG Impedance Meter is connected 'between' your electrodes and your EEG amplifier. For this purpose, the cables with the plugs connect to your EEG amplifier, whereas the electrodes are plugged in the EEG Impedance Meter instead.



For your convenience, all five connections are marked by different colors. Make sure that the black wire marked with 'GND' is connected to the 'Ground' of your EEG amplifier and your ground electrode is plugged in the middle black jack.

The two connections left to the ground jack are for channel one and the two on the right for channel two of your EEG neurofeedback set-up. If you need only one channel, leave the second unconnected.

The EEG Impedance Meter is designed to sit on top or next to your EEG amplifier or amplifier cable head. Place it in a way so that you can read the display easily during the electrode placement process.

4 Operation

4.1 General

The EEG Impedance Meter is intended to be used during the electrode set-up process or for re-checking the electrode contacts. The EEG Impedance Meter needs to be turned off during the EEG session, because its measurement signals would distort the EEG measurement. When turned off, the unit is completely galvanically disconnected from the electrodes and the EEG equipment.

See chapter 1.2 for a detailed description of the display.

4.2 Electrode Placement

When you are about to start hooking up your patient, turn the EEG Impedance Meter on by pressing on the power button once. A short beep and a red light at the lower end of the center bar indicate that the unit is turned on.

The EEG Impedance Meter requires at least three electrodes to be hooked-up for a valid measurement. So, after you placed the first three electrodes for one EEG channel, the unit will start to show the three impedances independently plus the balance bar showing how well the impedances of Active and Reference match. If you do not see any reading after placing the three electrodes, at least one of them is still quite badly connected with an impedance of more than 140 k Ω . Make sure that you clean the skin with alcohol or even better a small amount of abrasive gel before placing the electrode with a sufficient amount of conductive paste. Then, try to optimize the impedances by removing hair, pressing on the electrodes or improving contact by re-cleaning the site and / or using more conductive paste.

The best results can be expected, when all impedances are in the 'green range' (better than 20 k Ω) and the impedances matched (balance bar shows green).

As soon as you are happy with the results, turn off the EEG Impedance Meter by pressing the power button. After a short beep all displays turn off indicating that the EEG Impedance Meter is disconnected from your EEG equipment.

4.3 Re-Checking the Impedances during a Session

You may re-check the quality of the electrode connections at any time by turning the EEG Impedance Meter on. Note that during that phase no EEG measurement is possible, because the measurement signals distort the EEG signals.

If your neurofeedback software uses an auto-threshold feature, stop / pause the session before you turn the EEG Impedance Meter on in order to not disturb the auto-threshold mechanism.

5 Cleaning and Disinfection

As the unit is not in direct contact with patients, no disinfection is required. Clean your EEG Impedance Meter with a clean cloth, dry or moist or with a small amount of alcohol or isopropyl.

6 FAQ and Troubleshooting

6.1 Frequently Asked Questions

Why would I need an impedance meter at all?

Successful neurofeedback builds on a good EEG signal. If it is distorted, it is like hearing music next to a loud building 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. An impedance meter sitting in the shelf is worthless!

Do I need an Impedance Meter despite the high input impedance of my EEG Amp?

Modern EEG amplifiers do have such a high input impedance that the impedance between electrodes and scalp is negligible with regard to the EEG signal. But not with regard to noise pick-up! EEG electrodes and the long cables pick up noise such as electromagnetic fields from the power lines, fields from thunderstorms, long-wave radio transmitters, etc. The most important noise source is pick-up from the power lines, which results in signals that are by a factor of up to a hundred thousand larger than the EEG signal. To cope with that, most EEG amplifiers simply subtract the two signals gained from the 'Active' and the 'Reference' electrode thus canceling out the noise, which is supposed to be equal for both electrodes. We just need to make sure that the noise pick-up by both electrodes is exactly the same. In general, we can achieve that by two means: 1. arrange both EEG electrode wires so that they are as close as possible and 2. make sure that both electrode contacts are of equal quality. Because the input impedance of the EEG amplifier is that high, the absolute impedance values between electrodes and scalp almost do not matter. However, it is important that they are matched. That is why the EEG impedance meter has the balance bar feature that helps to balance the two impedances of 'Active' and 'Reference' electrodes.

Is the impedance measurement harmful?

No, not at all. Of course, the impedance meter uses a 'measurement signal' to determine the electrode - scalp impedances. This signal is so small that it can not be felt by any means. The EEG impedance meter conforms to the IEC 60601-1-2, which is the standard that defines the electrical safety of medical devices. Other equipment using similar measurement currents are e.g. body fat monitors or a scale with a body fat monitor.

Does the EEG Impedance Meter distort my EEG measurement?

Yes and no - yes, because its measurement signals are larger than typical EEG signals. You can see these signals if you leave your EEG amplifier on during the impedance measurement. From that, it is obvious that you cannot measure impedances and EEG simultaneously. No, because the unit is completely galvanically disconnected from the electrodes and your EEG amplifier when it is turned off. So, turn the EEG Impedance Meter on while you are placing the electrodes and watch how you are doing. When you are done and want to start the neurofeedback session, turn the EEG Impedance Meter off. You can re-check the impedances at any time, but during that time, you will not measure EEG signals. If your neurofeedback software uses an auto-threshold feature, stop / pause the session before you turn the EEG Impedance Meter on in order to not disturb the auto-threshold mechanism.

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

Sometimes, EEG electrodes act like a little battery: they produce a DC voltage. Although this voltage can be much higher than a typical EEG signal, it does not influence our EEG measurement, because the EEG amplifiers do not amplify DC signals. However, a classical impedance measurement set-up would be distorted heavily. Moreover, a standard DC

impedance measurement would 'charge' these little batteries. Therefore, the EEG Impedance Meter uses AC to measure the electrode impedances. This cancels out possible DC offsets and avoids that charging effect.

How does the EEG Impedance Meter work?

The EEG Impedance Meter uses a weak AC signal to determine the electrode - scalp impedances. The voltages used are smaller than $0.2V_{rms}$ and the currents are smaller than 5µA_{rms}. Four to five times a second the unit applies a small current and then measures a voltage to determine the impedances using Ohm's law.

6.2 Troubleshooting

Problem	Reason	Solution
Cannot turn unit on	Battery empty	Replace batteries (2 x AA battery or rechargeable)
	Battery inserted incorrectly	Insert batteries according to the symbols in the battery case
Even with three electrodes connected there is no impedance display other than the lower middle red light	One or more contacts have still more than 140kΩ	Improve contact quality by: <ul style="list-style-type: none"> • Skin preparation with alcohol or better abrasive gel • Application of sufficient amount of conductive gel
Display is fidgety	Measured value is at the border between two display LEDs	This is normal and no fault condition
LED bars run up and down randomly	The unit is exposed to a strong electromagnetic field (e.g. long-wave radio transmitter)	The unit is not affected by levels lower than those according to IEC 60601-1-2. If, however, there is a larger electromagnetic field where you intend to operate the unit, we cannot guarantee proper operation. We recommend appropriate shielding of the room where the equipment is to be used.

7 Maintenance / Disposal

The only maintenance required is replacement of the batteries if the Low Battery indicator starts blinking. In order to prevent damage due to corrosion, remove the batteries, if you do not use the device for some time.

Dispose of the unit as electronic device in accordance with any applicable local, state and federal laws and regulations.

8 Technical Data

Measurement	Impedance Range	0 ... 140k Ω , indicator for > 140k Ω
	LED steps	red: >100k, 100k...75k, 75k...50k, 50k...40k
		yellow: 40k...35k, 35k...30k, 30k...25k, 25k...20k
		green: 20k...15k, 15k...10k, 10k...5k, <5k
	Balance bars	red: more than +/-20%
		yellow: +/-10% ... +/-20%
		green: less than +/-10%
	Measurement frequency	Half cycle: 110ms, full cycle: 220ms
Max. electrode voltage	0.2Vrms	
measurement current	< 5 μ Arms	
Max current (fault cond.)	< 25 μ A	
Power	Operating Voltage	1.5V...4V (2xAA batteries or rechargables)
	Power Management	Auto power off after 5 minutes
	Power consumption, ON	90/150mA (1/2 channels, @ 3V)
		110/180mA (1/2 channels, @ 2.4V)
	Power consumption, OFF	70 μ A
Reverse Battery Protection	Unit is not harmed by wrong battery insertion	
Signals	Low Battery Indicator	Blinks if supply voltage below 2V
	ON/OFF Beep	1.6kHz, 200ms
Classification according to 60601-1		Class II, Type BF
EMV Compliance with 60601-1-2		IEC / CISPR 11, Class B (RF emission) IEC 61 000-4-2 (Electrostatic Discharge - ESD) IEC 61 000-4-3 (RF susceptibility) IEC 61 000-4-6 (RF asymmetric) IEC 61 000-4-8 (LF magnetic field)
Mechanical	Jacks	For shrouded plugs 4mm, Multicontact Medical Line
		Colors: Blue, Yellow, Black, Green, Red (left to right)
	Cables	Silicon isolated ultra-flexible; length: 16cm (6")
	Plugs to EEG amplifier	Shrouded plugs Multicontact Medical Line
	Size (LxWxH)	183 x 93 x 30 mm
Weight with Batteries	400 g	

9 Warranty

The EEG Impedance Meter is guaranteed to be free from defects in material and workmanship for 1 year from the date of purchase.

In the unlikely event that repair is necessary, call EEG Info to receive a Return Authorization. Then send the unit back by a traceable method--Neither BEE Systems nor EEG Info will be responsible for items not received. We will repair or replace your unit(s) free of charge.

This warranty does not apply to damage incurred through accident, alteration, or abuse, nor to damage created by static electricity. Do not use this equipment in dry, static area unless using an anti-static mat or anti-static spray on carpeted areas.

We may refuse to honor this warranty if the unit has been opened or non-authorized repair attempts are detected.

We accept no liability for accidental damage or for consequential damages, including, for example lost profit, downtime, damage or replacement of devices or property from a breach of the warranty.

IMPORTANT: Remove dead batteries promptly to prevent corrosion damage.

10 Copyright Notice

This hardware contains proprietary embedded software code, which is the property of BEE Systems LLC; it is provided under a license agreement containing restrictions on use and disclosure and is also protected by copyright law. Reverse engineering of the software or the hardware is prohibited.

Due to continued product development the embedded software may change without notice. The information and intellectual property contained herein is confidential between BEE Systems LLC and the client and remains the exclusive property of BEE Systems LLC.

If you find any problems in the documentation, please report them to us in writing. BEE Systems LLC does not warrant that this document is error-free.

CE Declaration of Conformity

For the following item

EEG Impedance Meter

Is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility (89/336/EWG).

For the evaluation of above mentioned Directives, the following standards were applied:

EN 60601-1-2:2001

Kichberg, 28.6.2005



Company
BEE Systems LLC
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CH-9533 Kirchberg / SG

Name: Dr. Bernhard Wandernoth
Title: Managing Director