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# MindWave Instruction Manual

September 10, 2010

The NeuroSky product families consist of hardware and software components for simple integration of this biosensor technology into consumer and industrial end-applications. All products are designed and manufactured to meet consumer thresholds for quality, pricing, and feature sets. NeuroSky sets itself apart by providing building block component solutions that offer friendly synergies with related and complementary technological solutions.

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# Introduction to the MindWave

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Thank you for purchasing NeuroSky's MindWave™. This Brain-Computer Interface (BCI) device turns your brainwaves into actions, unlocking new worlds of interactivity. The MindWave reports the wearer's mental state in the form of NeuroSky's proprietary Attention and Meditation eSense™ algorithms, along with raw wave and information about the brainwave frequency bands. The NeuroSky MindWave can be used with supported video games, research software, or a number of other applications for an enhanced user experience.

For any technical information updates and additional support questions not answered by this document, please register at the NeuroSky support website at <http://support.neurosky.com>. We also recommend you join our email list by filling out the form on <http://www.neurosky.com> to receive general information about NeuroSky, new products announcements, and any technical information updates.

## MindWave Product Contents

- MindWave headset
- MindWave Quick Start Guide (printed)
- MindWave USB adapter
- MindWave BCI Demonstration Software CD, containing:
  - MindWave Installation Software
  - **PDF documents:**
    - \* MindWave Instruction Manual
    - \* MindWave Quick Start Guide
- 1 - AAA battery

# NeuroSky Technology Overview

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## Brainwaves

The last century of neuroscience research has greatly increased our knowledge about the brain and particularly, the electrical signals emitted by neurons firing in the brain. The patterns and frequencies of these electrical signals can be measured by placing a sensor on the scalp. The Mind line of headset products contain NeuroSky ThinkGear™ technology, which measures the analog electrical signals, commonly referred to as brainwaves, and processes them into digital signals to make the measurements available to games and applications. The table below gives a general synopsis of some of the commonly-recognized frequencies that tend to be generated by different types of activity in the brain:

Brainwave Type	Frequency range	Mental states and conditions
Delta	0.1Hz to 3Hz	Deep, dreamless sleep, non-REM sleep, unconscious
Theta	4Hz to 7Hz	Intuitive, creative, recall, fantasy, imaginary, dream
Alpha	8Hz to 12Hz	Relaxed, but not drowsy, tranquil, conscious
Low Beta	12Hz to 15Hz	Formerly SMR, relaxed yet focused, integrated
Midrange Beta	16Hz to 20Hz	Thinking, aware of self & surroundings
High Beta	21Hz to 30Hz	Alertness, agitation

## ThinkGear

ThinkGear is the technology inside every NeuroSky product or partner product that enables a device to interface with the wearers' brainwaves. It includes the sensor that touches the forehead, the contact and reference points located in the ear clip, and the on-board chip that processes all of the data. Both the raw brainwaves and the eSense Meters (Attention and Meditation) are calculated on the ThinkGear chip.

## eSense

eSense™ is a NeuroSky's proprietary algorithm for characterizing mental states. To calculate eSense, the NeuroSky ThinkGear technology amplifies the raw brainwave signal and removes the ambient noise and muscle movement. The eSense algorithm is then applied to the remaining signal, resulting in the interpreted eSense meter values. Please note that eSense meter values do not describe an exact number, but instead describe ranges of activity.

## eSense Meter - General Information

The eSense meters are a way to show how effectively the user is engaging Attention (similar to concentration) or Meditation (similar to relaxation).

Like exercising an unfamiliar muscle, it may take some time to gain full proficiency with each of the eSense™ meters. In many cases, people tend to be better at one eSense than the other when they first begin. We recommend trying different tactics until you are successful with one. Once you see a reaction on the screen from your efforts, you will be able to duplicate the action more easily with additional practice.

Generally, Attention can be controlled through a visual focus. Focus on a singular idea. Try to “funnel” your concentration and focus your train of thought towards pushing up the meter. Other suggestions include picking a point on the screen to stare at or imagining the action you are trying to accomplish happening. For example, look at the Attention eSense meter and imagine the dial moving towards higher numbers.

For Meditation, it typically helps to try to relax yourself. Connect to a sense of peace and calm by clearing your mind of thoughts and distractions. If you are having difficulty engaging Meditation, close your eyes, wait a number of seconds, and then open your eyes to see how the meter has responded.

If you have trouble at first in controlling your eSense meter levels, be patient. Try different techniques and practice. Also be sure to read and try to understand the Technical Description in order to get a better idea about how eSense actually works under the hood.

## eSense Meter - Technical Description

For each different type of eSense (i.e. Attention, Meditation), the meter value is reported on a relative eSense scale of 1 to 100. On this scale, a value between 40 to 60 at any given moment in time is considered “neutral” and is similar in notion to “baselines” that are established in conventional brainwave measurement techniques (though the method for determining a ThinkGear baseline is proprietary and may differ from conventional brainwaves).

A value from 60 to 80 is considered “slightly elevated”, and may be interpreted as levels tending to be higher than normal (levels of Attention or Meditation that may be higher than normal for a given person). Values from 80 to 100 are considered “elevated”, meaning they are strongly indicative of heightened levels of that eSense.

Similarly, on the other end of the scale, a value between 20 to 40 indicates “reduced” levels of the eSense, while a value between 1 to 20 indicates “strongly lowered” levels of the eSense. These levels may indicate states of distraction, agitation, or abnormality, according to the opposite of each eSense.

The reason for the somewhat wide ranges for each interpretation is that some parts of the eSense algorithm are dynamically learning and at times employ some “slow-adaptive” algorithms to adjust to natural fluctuations and trends of each user, accounting for and compensating for the fact that brainwaves in the human brain are subject to normal ranges of variance and fluctuation. This is part of the reason why ThinkGear sensors are able to operate on a wide range of individuals under an extremely wide range of personal and environmental conditions, while still giving good accuracy and reliability.

## ATTENTION eSense

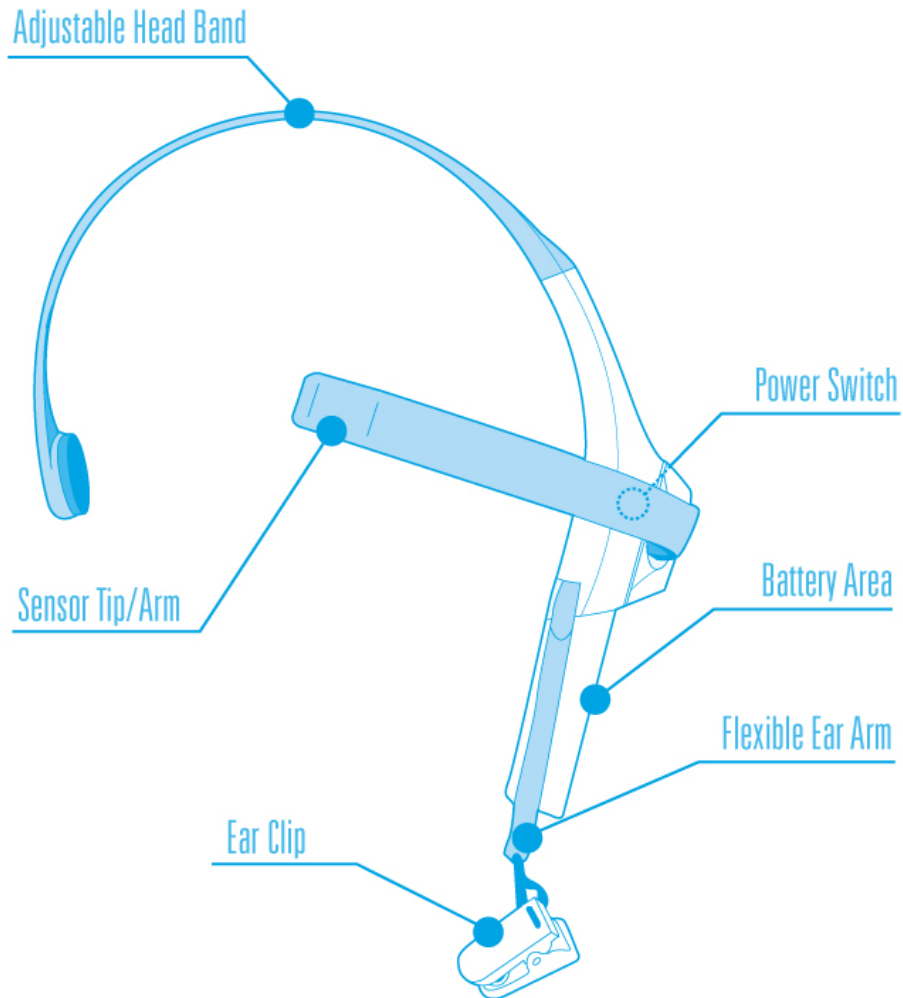
The eSense Attention meter indicates the intensity of a user's level of mental “focus” or “attention”, such as that which occurs during intense concentration and directed (but stable) mental activity. Its value ranges from 0 to 100. Distractions, wandering thoughts, lack of focus, or anxiety may lower the Attention meter level. See [eSense Meter - General Information](#) for details about interpreting eSense levels in general.

## MEDITATION eSense

The eSense Meditation meter indicates the level of a user's mental “calmness” or “relaxation”. Its value ranges from 0 to 100. Note that Meditation is a measure of a person's mental states, not physical levels, so simply relaxing all the muscles of the body may not immediately result in a heightened Meditation level. However, for most people in most normal circumstances, relaxing the body often helps the mind to relax as well. Meditation is related to reduced activity by the active mental processes in the brain. It has long been an observed effect that closing one's eyes turns off the mental activities which process images from the eyes. So closing the eyes is often an effective method for increasing the Meditation meter level. Distractions, wandering thoughts, anxiety, agitation, and sensory stimuli may lower the Meditation meter levels. See [eSense Meter - General Information](#) for details about interpreting eSense levels in general.

# Setting Up Your MindWave

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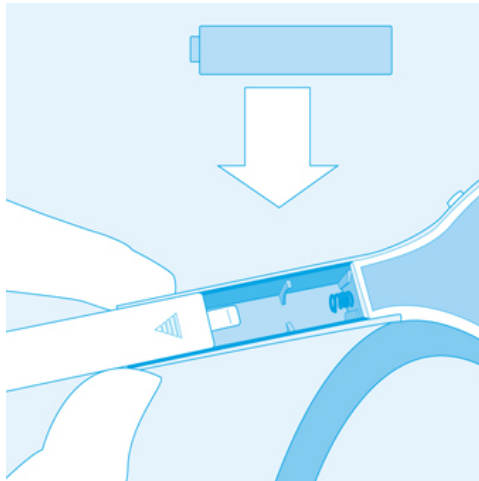


## Minimum System Requirements

	PC
<b>Operating system</b>	Windows XP/Vista/7
<b>Processor</b>	Core2Duo or greater
<b>Memory</b>	1GB
<b>Hard disk</b>	200MB
<b>USB</b>	An available USB port

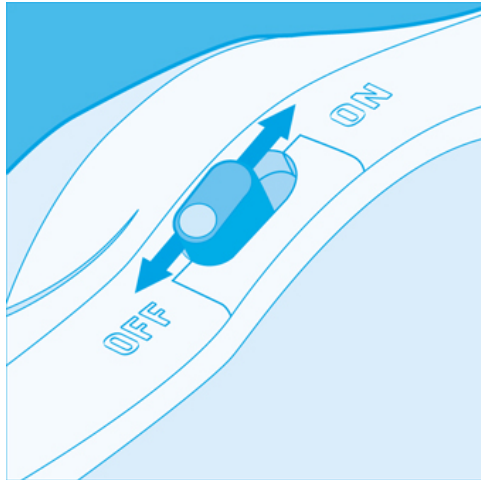
## Replacing The Battery

To install or replace the battery, slide open the battery cover. Remove any existing battery within and replace with a new AAA battery.



## Power

To power on the MindWave, slide the switch to the ON position. Power off the MindWave by sliding the switch to the OFF position.



## Wireless Adapter Setup

### Wireless Adapter Installation

**Important:** Please install the MindWave software **before** inserting the MindWave wireless adapter.

**Important:** You must properly install the supplied wireless adapter and its drivers in order to use the MindWave.

#### Windows

1. Insert the supplied MindWave Disc into your disc drive.
2. Run the `MindWave-Setup.exe` installer if prompted or double-click on `MindWave-Setup.exe`.
3. Follow the instructions on the installer.
4. Once the installer finishes, you may need to reboot.
5. Insert the MindWave wireless adapter.
6. Run the MindWave Manager program.
7. Click *Pair your MindWave...*
8. Select *Automatically scan for MindWaves in range (recommended)* and click *Continue*.
9. The MindWave Manager will scan for your MindWave. If found, the MindWave will display your MindWave's ID.
10. If your MindWave's ID is correct, click *Yes*.
11. Your MindWave is now paired.

**Note:** The MindWave's ID may be found under the battery door.

## Serial Port Name

Many applications will ask for you to enter the dongle's serial COM port name or number in order for it to find and connect to the RF dongle and get brainwave data. To find out which Windows COM port the RF dongle is assigned to, follow the instructions below:

### Windows

In Windows, open the Control Panel → System → Hardware tab → Device Manager → Ports. The port will appear as "MindWave USB Adapter (COM NN)" where NN is your COM port number.

## RF Connection Troubleshooting

Common causes for RF pairing failures and possible solutions:

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Pairing failed	Low battery	Replace the AAA battery in the MindWave with a new battery
	Strong radio interference	Extend the RF dongle using the USB extension cable and place it near the headset.
Light on dongle does not turn from red to blue	MindWave is not turned on	Turn the MindWave on
Light on the dongle does not return to red after turning off the Mind-Wave	It will take some time for the dongle to turn red after turning off all Mind-Waves	Normal operation
Light on Wave headset does not turn from red to blue	Dongle is not plugged in	Plug in the RF Dongle
	Dongle drivers are not installed	Install the RF Dongle drivers
	Dongle has already paired with a Wave (dongle blue light)	Unplug the RF Dongle from your computer, and then plug it back in
	Strong radio interference	Extend the RF dongle using the USB extension cable and place it near the headset.

# Using Your MindWave

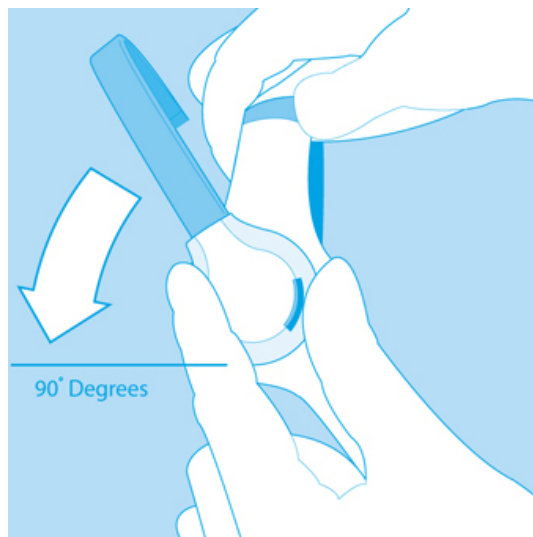
This chapter walks you through fitting the MindWave and installation of the included MindWave software on your computer. Be sure to first connect and pair the headset as described in the previous chapter first.

## Fitting the MindWave

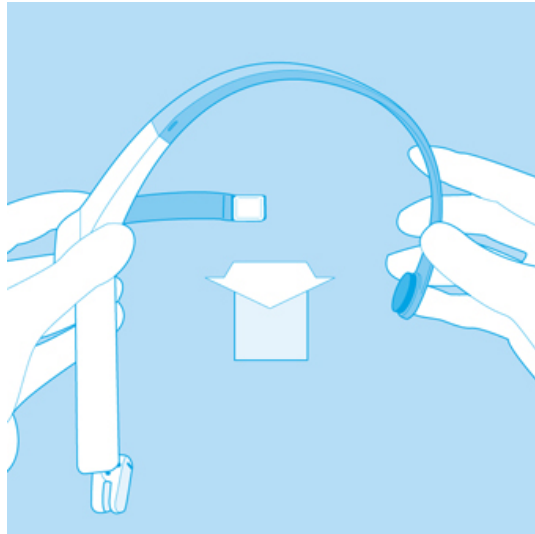
The MindWave is more than your average headset. It has the ability to use your brainwaves for exciting new applications.

**Important:** In order to take full advantage of these functions and features of the MindWave, the MindWave must be properly worn.

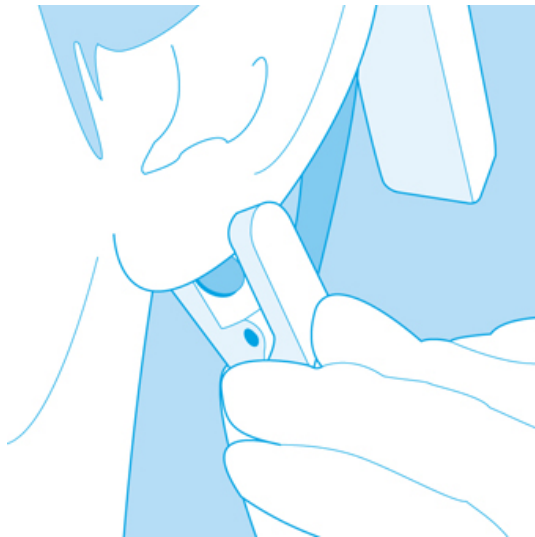
1. Orient the MindWave with the Forehead Sensor Arm on your left hand side. Rotate the sensor arm from its base by about 90 degrees. It can be rotated slightly more if necessary to get proper fit and comfort.



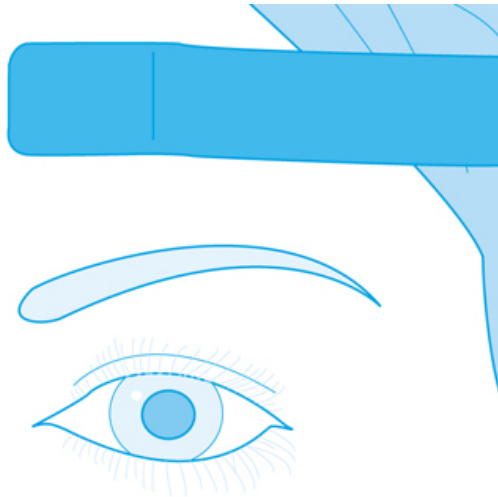
2. The overhead band of the MindWave is adjustable and can be extended to fit various sizes. Put on the MindWave. If the sensor does not make contact with the forehead or if the fit is not comfortable, remove the MindWave to readjust the overhead band and the Forehead Sensor Arm. The Forehead Sensor Arm is flexible and should arch inwards.



3. Allow the ear hoop to wrap around the back of your left ear and clip the earclip onto your earlobe.
4. Make sure the two metal contacts on the inside of both sides of the earclip make skin-contact with your earlobe or ear. Move any hair or obstructions out of the way. Readjust the earclip as necessary to make proper contact with your ear.



5. Adjust the Forehead Sensor Arm of the headset so that the Forehead Sensor makes contact with your forehead. This sensor must maintain contact in order to properly measure your brainwaves. The sensor should be comfortable, yet stay in position. Keep hair away from the sensor – the sensor must be able to directly contact the skin at all times.
6. This is how the MindWave should look when properly worn. During usage, if you are not receiving a signal, repeat the steps above to make minor adjustments to ensure the sensor and contacts have proper **skin contact**.



## Software Installation

### Windows XP/Vista

1. Insert the MindWave BCI Demonstration Software CD into the CD drive of your computer.
2. The CD will automatically bring up the Auto-Installer window. If it does not, execute the `AutoRun.exe` program from the disc.
3. An on-screen menu will come up that directs you to install each of the included software applications. Click on the buttons of the software packages you would like to install. Folders containing the setup files will be opened. Double click on the setup files to install.
4. Documentation for each software application is also available from the on-screen menu.

### Brainwave Visualizer

The Brainwave Visualizer is a colorful, interactive application controlled by your brain that shows you a graphical representation of your brain's activity. The Brainwave Visualizer includes the Brainwave Visualization, Brainwave Power Spectrum Graph, and the eSense Attention and Meditation meters.

The on-screen shapes morph and change color depending on your state of mind. Please refer to the included Brainwave Visualizer Manual for more details.

### The Adventures of NeuroBoy BCI Technology Demonstration

As NeuroBoy™, use your special telekinetic powers to push, pull, lift, or burn objects. Different objects in the world weigh different amounts, so you will need to hone your mental muscle to pick up the heavier items.

The game provides a 3rd-person environment. This demo requires a more powerful computer, but you may scale down the graphics to meet your computer's specifications. Please refer to the included manual for more details.

## Additional Products

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To find new and exciting ways to unlock the full potential of your MindWave, visit the NeuroSky Store for additional software and applications: <http://store.neurosky.com>

### MindSet Development Tools (MDT)

The NeuroSky MindSet Development Tools (MDT) is available for free from the NeuroSky Store, and provides all the tools and resources necessary to create and publish games and applications capable of taking advantage of the exciting new Brain-Computer Interface (BCI) technology of NeuroSky's MindSet or MindWave headset. The MDT includes drivers, sample code, and documentation describing how to develop applications for several software platforms, including PC, Symbian, and even lower level platforms such as microcontrollers like the Arduino™.

Languages directly supported include C/C++, C#, Java (through JNI), and J2ME. In addition, the MDT provides the ThinkGear Connector (TGC), a daemon-like software that runs on Windows or Mac OS X, and opens a TCP port on the user's local computer so that applications can connect to it and retrieve MindSet or MindWave data. As long as the TGC is running on one of the supported platforms and connected to a MindSet, then any application written in any language that can communicate through TCP sockets (such as Flash's ActionScript3 and scripting languages in general) can connect to the TGC to read data from the MindSet.

Create exciting new games that challenge people to use the power of their mind or retrofit your existing games with a new dimension of brainwave control.

The MindSet Development Tools (MDT) are available for *free* and can be downloaded from the NeuroSky Store at <http://store.neurosky.com>.

### MindSet Research Tools (MRT)

The NeuroSky MindSet Research Tools (MRT) enable researchers to use the MindWave as a data collection device. Using the cost effective and user-friendly features of MindWave in conjunction with the MRT allows researchers to broaden the scope of their research and to make efficient use of resources.

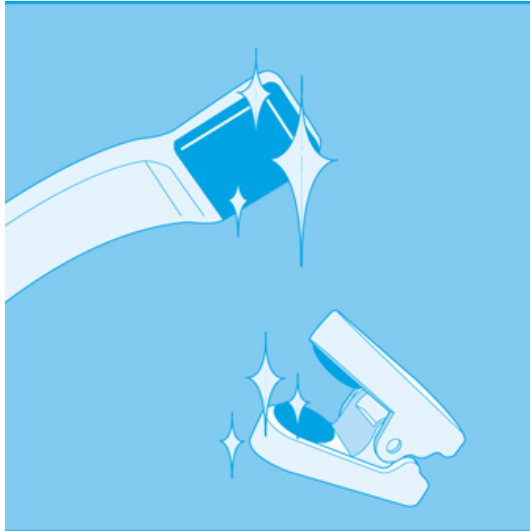
The MRT includes the NeuroView software, which make it easy to connect, graph, view, and record MindSet or MindWave data in real time. The MRT also includes the more advanced NeuroSky-Lab MATLAB module, which adds the ability to define custom MATLAB scripts and functions for customized processing and analysis of MindSet or MindWave data.

For more information on the uses and capabilities of the MindSet Research Tools, please visit: <http://store.neurosky.com/>.

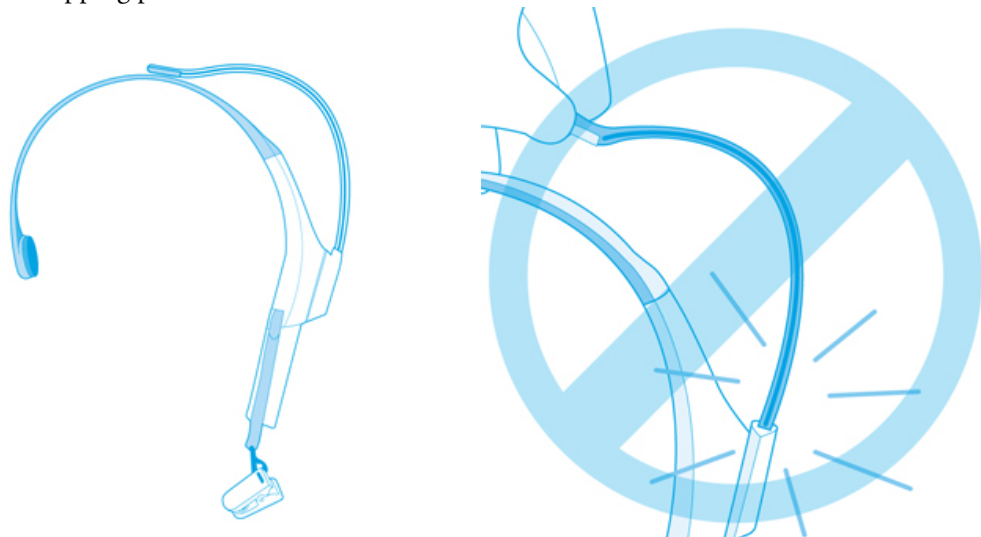


## Maintenance

- Clean the MindWave's sensor and ear contacts with alcohol-wipes (alcohol-based cleaner) periodically to ensure the best signal quality. Use a soft cloth to clean the MindWave casing



- For travel and storage, gently push the sensor arm up until it is aligned with the top of the head-set. Be careful not to overextend the maximum range of the boom by adjusting it beyond the natural stopping point



- Do not expose the MindWave to temperatures above 140°F (60°C)
- Dropping or throwing the MindWave may damage the MindWave

# Troubleshooting and Support

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***The MindWave does not turn on.***

The battery might be low. Please try replacing the battery and try again.

***I am having issues with my wireless RF connection.***

Please use the *RF Dongle* included with the MindWave, and then be sure to carefully follow the instructions under *Setting Up Your MindSet*, paying particular attention to *RF Dongle Setup*, *RF Mind-Wave Pairing*, and *Serial Port Name*. Then please check if your issue has been addressed in the *RF Connection Troubleshooting* section.

Also if you have a desktop computer, please use a usb extension cable to pull the RF dongle to a visible location.

***The signal quality status is consistently poor (fewer than three bars).***

Check that the forehead sensor and each clip contacts are making good contact with the skin. Make sure to remove all obstructions including hair and jewelry.

It usually takes three or four seconds for the headset to validate the signal after holding still. Also make certain to keep the sensor and contacts clean.

***The eSense meters do not move.***

Verify that the *RF* is paired correctly. You can use the Brainwave Visualizer to verify if the headset is transmitting. Select "Show data output" from the menu. If the numbers are changing, that means the headset is transmitting data to the PC.

Allow the eSense meters to go through a few moments to go through initialization before troubleshooting. If the meters do not move after 10 seconds, make sure the sensor rests on the forehead and the contacts are on the left ear. The sensor and contacts should make firm and consistent contact with your skin.

***I don't seem to be able to control the eSense™ meters.***

Like exercising an unfamiliar muscle, it may take some time to gain full proficiency with the eSense™ meters. First, be sure you understand how the eSense meters work and what they are measuring. Generally, we recommend engaging Attention by concentrating and Meditation by relaxing. Most importantly, be sure you have read the detailed explanation of eSense previously described in the eSense™ sections.

***I still have a problem, or my problem is not covered by this Troubleshooting section.***

For further technical support, please contact NeuroSky Support at <http://support.neurosky.com> or email <mailto:support@neurosky.com>.

