EPOC+

EPOC+ User Manual

This document is intended to help you get started using the EMOTIV EPOC+ and includes common tips for using it. If you have any queries beyond the scope of this document, please contact us through our online support.

Introduction

About

The EMOTIV EPOC+ is a portable, high resolution, 14-channel, EEG system. It was designed to be quick and easy to fit and take measurements in practical research applications. It is compatible with all EMOTIV software products.

EMOTIV products are intended to be used for research applications and personal use only. Our products are not sold as Medical Devices as defined in EU directive 93/42/EEC. Our products are not designed or intended to be used for diagnosis or treatment of disease.

Technical Specifications

Headset Version	EPOC v1.0	EPOC+ v1.1	EPOC+ V1.1A
Number of Channels	14 (plus CMS/DRL references, P3/P4 locations)	14 (plus CMS/DRL references, P3/P4 locations)	14 (plus CMS/DRL references, P3/P4 locations)
Channel names (International 10-20 locations)	AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4	AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4	AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4
Sampling Method	Sequential sampling. Single ADC	Sequential sampling. Single ADC	Sequential sampling. Single ADC
Sampling Rate	128 SPS (2048 Hz internal)	128 SPS / 256 SPS (2048 Hz internal)	128 SPS / 256 SPS (2048 Hz internal)
EEG Resolution	14 bits 1 LSB = 0.51µV (16 bit ADC, 2 bits instrumental noise floor is discarded)	14 bits 1 LSB = 0.51µV (16 bit ADC, 2 bits instrumental noise floor is discarded), settings can be changed to 16-bit	14 bits 1 LSB = 0.51µV (16 bit ADC, 2 bits instrumental noise floor is discarded), settings can be changed to 16-bit
Bandwidth	0.2 - 45Hz, digital notch filters at 50Hz and 60Hz	0.2 - 45Hz, digital notch filters at 50Hz and 60Hz	0.2 - 45Hz, digital notch filters at 50Hz and 60Hz
Filtering	Built-in digital 5th order Sinc filter	Built-in digital 5th order Sinc filter	Built-in digital 5th order Sinc filter

Dynamic Range (input referred)	8400 uV(pp)	8400 uV(pp)	8400 uV(pp)
Coupling Mode	AC coupled	AC coupled	AC coupled
Connectivity	Proprietary 2.4GHz wireless	Proprietary 2.4GHz wireless, BLE and USB (Extender only)	Proprietary 2.4GHz wireless, BLE and USB (Extender only)
Battery Capacity	LiPo battery 680mAh	LiPo battery 680mAh	LiPo battery 680mAh
Battery Life (typical)	12 hours	12 hours	12 hours
Impedance Measurement	Real-time contact quality using patented system	Real-time contact quality using patented system	Real-time contact quality using patented system
IMU Part	IDG500	LSM9DS0	ICM-20948
Accelerometer	-	3-axis +/-8g	3-axis +/-4g
Gyroscope	2-axis +/-8g	3-axis +/- 500 dps	Interpreted as Quaternion
Magnetometer	-	3-axis +/- 12 gauss	3-axis +/- 4900 uTesla
Motion Sampling	128 Hz	32 / 64 / 128 Hz (User Defined)	32 / 64 Hz
Motion Resolution	10 bit	14 / 16-bit (User Defined)	14 / 16-bit (User Defined)
Quanterion	No	No	Yes
Sensor Material	Ag/AgCl + Felt + Saline	Ag/AgCl + Felt + Saline	Ag/AgCl + Felt + Saline

Safety Precautions

- EPOC+ is a consumer product; it is not intended to use for in-patient healthcare or in hazardous environments.
- EPOC+ is designed to use at room temperature; rapid changes in temperature will affect the performance of the amplifiers and increase the noise floor.
- EPOC+ uses saline based sensors and every effort has been made to protect the electronics from water ingress, however it is not waterproof. Please do not submerge your headset.

WARNING: EPOC+ is powered by a Lithium-Polymer battery that is rated for operation in <45C environments. It is not user replaceable, please contact support if you suspect a fault or have any questions.

WARNING: Do not open the enclosure. Doing so will void the warranty and can damage the headset.

WARNING: Do not charge EPOC+ while wearing the device. In the unlikely event if your PC has a faulty power supply, you and your headset could unintentionally become the ground path. If EPOC+ detects a USB connection when turned on, it will stop communicating. If you would like to use it tethered, please use an EMOTIV Extender. Extender provides USB isolation and charging protection while tethered.

Regulatory Compliance

EMOTIV products are intended to be used for research applications and personal use only. Our products are not sold as Medical Devices as defined in EU directive 93/42/EEC. Our products are not designed or intended to be used for diagnosis or treatment of disease.

The EPOC+ has been tested for EMC and Safety compliance as a consumer product under the CB scheme. The following table outlines the compliance testing that has been obtained:

FCC ID Number **2ADIH-EPOC02** and IC ID Number: **12769A-EPOC02**

EMOTIV has undertaken testing and confirms:

This device complies with the radio equipment directive (2014/53/EU).

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and radiates radio frequency energy. If it is not installed and used in accordance with the instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver

is connected

- Consult the dealer or experienced person for help

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Note: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Our USB dongle has FCC ID Number **XUE-USBD01.**

Type	Standards Tested
EMC and Telecom: Class B	TSI EN 300 440-2 V1.4.1
	EN 301 489-1
	EN 301 489-3

	AS/NZS CISPR22 :2009
	AS/NZS 4268 :2008
	FCC CFR 47 Part 15C
Safety	EN 60950-1:2006
CB Certificate (TUV Rheinland Japan)	JPTUV-029914

Getting started

Package Contents

Within the EPOC+ package, you will find the following:


1. Headset
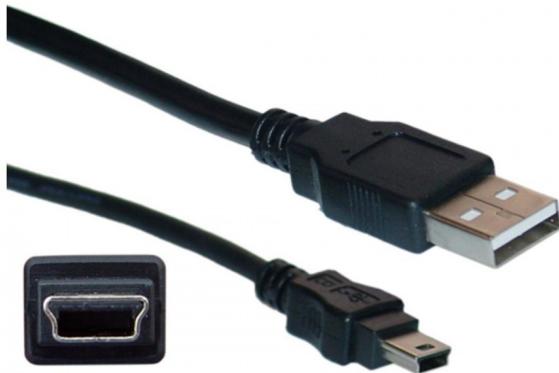
2. Hydrator Pack

3. Hydrator Fluid
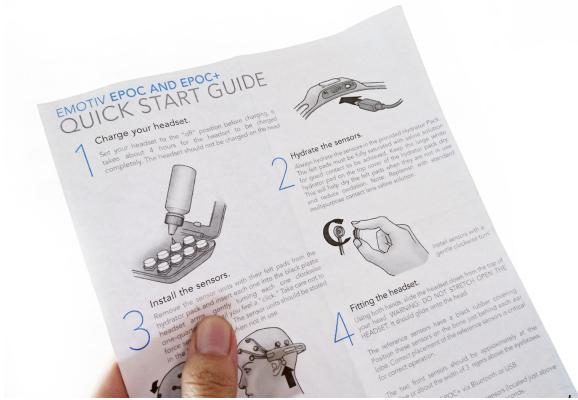

4. Universal USB Receiver

5. Mini-B & a USB cable
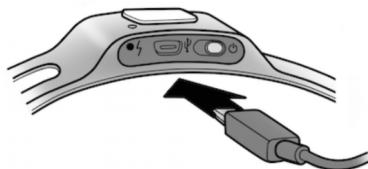
6. Quick Start Guide

Assembly - Quick Start

1 Charge your headset.

Set your headset to the "off" position before charging. It takes about 4 hours for the headset to be charged completely. The headset should not be charged on the head.
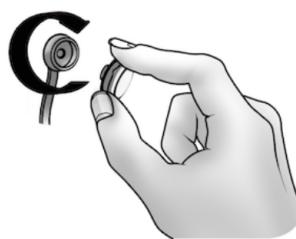
2 Hydrate the sensors.
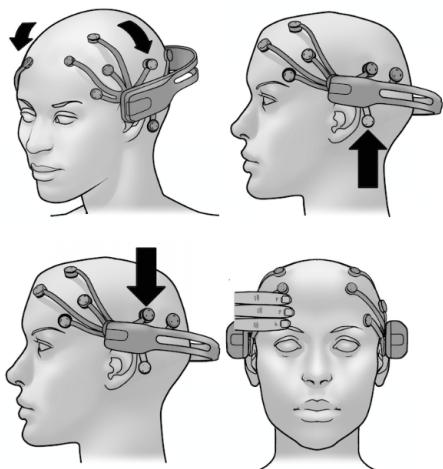
Always hydrate the sensors in the provided Hydrator Pack. The felt pads must be fully saturated with saline solution for good contact to be achieved. Keep the large white hydrator pad on the top cover of the hydrator pack dry. This will help dry the felt pads when they are not in use and reduce oxidation. Note: Replenish with standard multipurpose contact lens saline solution.

3 Install the sensors.

Remove the sensor units with their felt pads from the hydrator pack and insert each one into the black plastic headset arms, gently turning each one clockwise one-quarter turn until you feel a "click." Take care not to force sensors in place. The sensor units should be stored in the hydrator pack when not in use.

Install sensors with a gentle clockwise turn.

4 Fitting the headset.

Using both hands, slide the headset down from the top of your head. WARNING: DO NOT STRETCH OPEN THE HEADSET. It should glide onto the head.

The reference sensors have a black rubber covering. Position these sensors on the bone just behind each ear lobe. Correct placement of the reference sensors is critical for correct operation.
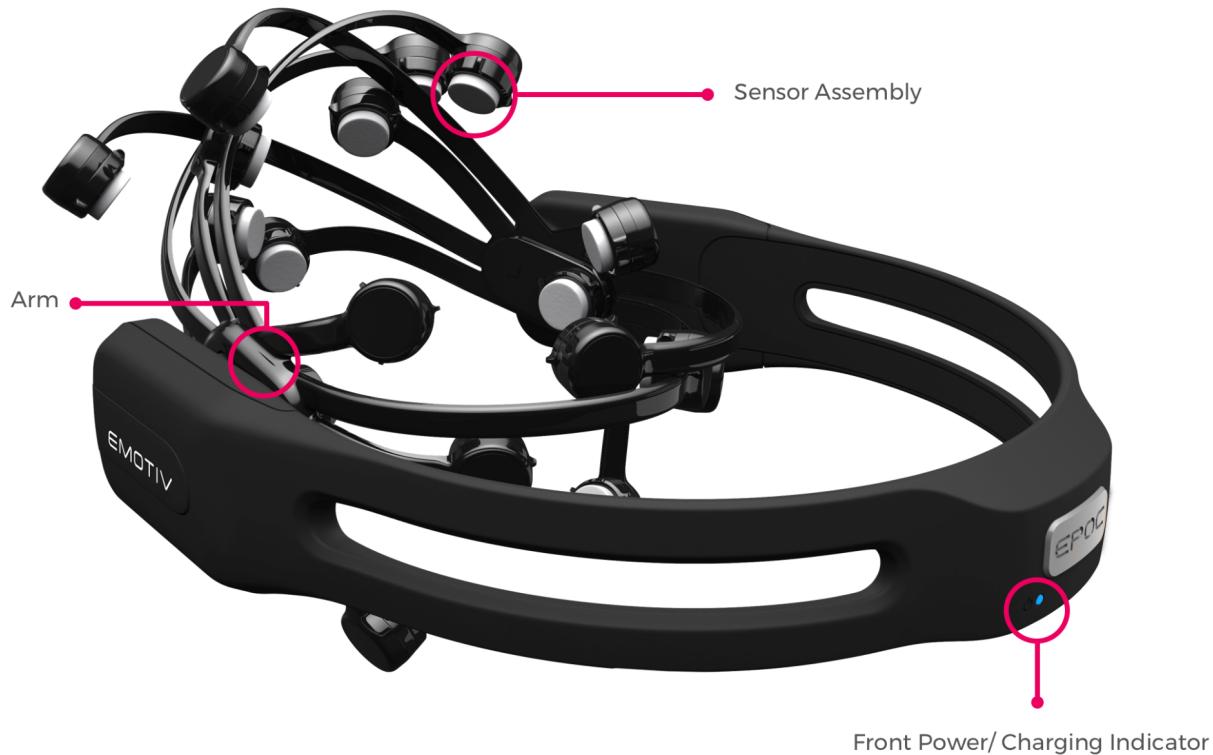
The two front sensors should be approximately at the hairline or about the width of 3 fingers above the eyebrows.

Pair your EPOC/EPOC+ via Bluetooth or USB.
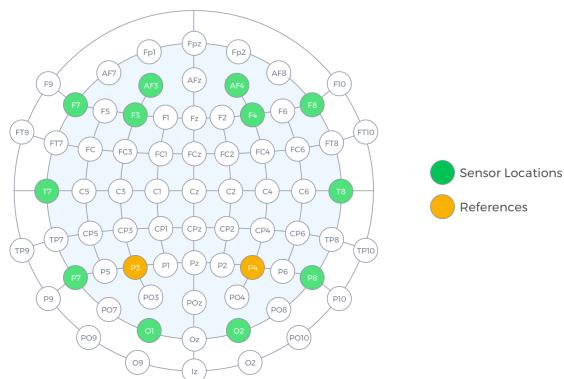
Press and hold the 2 reference sensors (located just above and behind your ears) for about 20 seconds.

Using your headset

EPOC+ Headset Details

Sensor Assembly

Arm

Front Power/ Charging Indicator

The EPOC+ has two electrode arms each containing 9 locations (7 sensors + 2 references). Two sensor locations (M1 / M2) already have rubber sensors fitted because they are the alternative positions for the default references (P3 / P4).

● Sensor Locations

● References
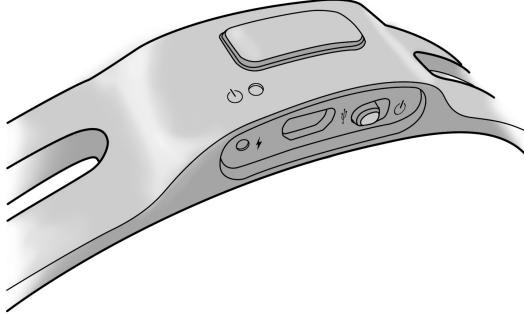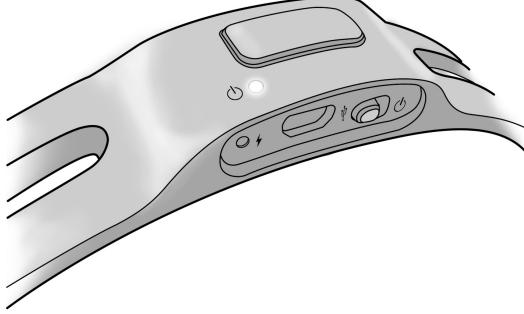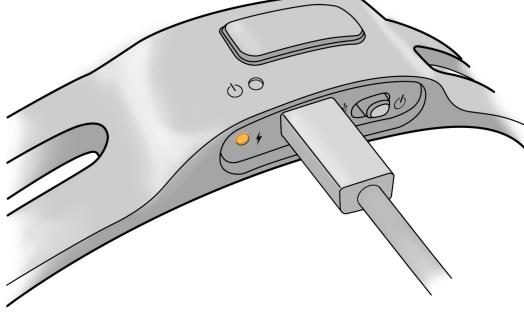
The EPOC+ is designed to provide good coverage of the frontal and prefrontal lobes and also provides coverage of the temporal, parietal and occipital lobes. The images shown above are the sensor locations for the EPOC+ using the international 10-20 system.

LED Indicators

The USB port, power switch and LED indicators are part of the control board which sits in the middle of the EPOC+ headband. The power LED is located on the top surface and the charging LED is on the USB face.

The following table outlines their behavior:
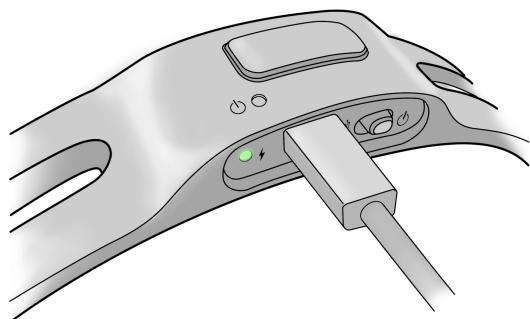
Action	Power LED	Charging LED	
Power OFF / Battery Flat	Off	Off	
Power On	White	Off	
USB Connected / Charging	Off	Orange	

|			
Charging Complete	**Off**	**Green**	
Firmware Failure	**Fade On - Fade Off**	**Off**	
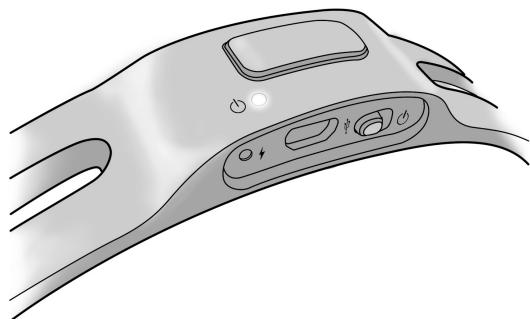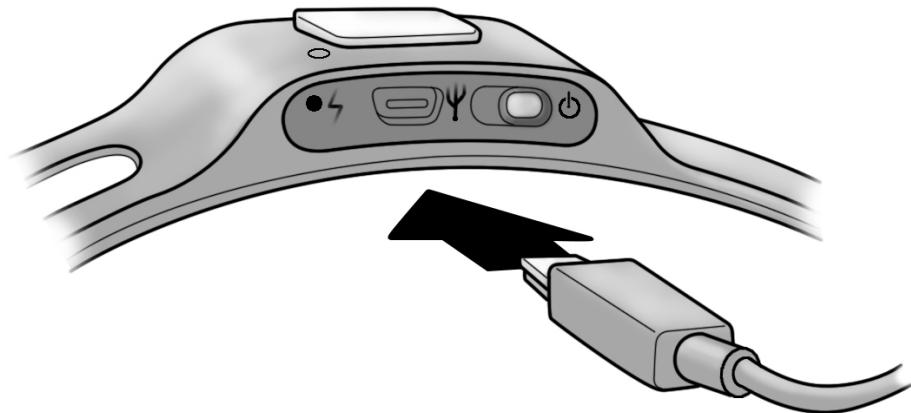
Charging

It is recommended that your headset is fully charged prior to capture recordings. The charge time depends on the remaining capacity in the Lithium Polymer cell and can take up to four hours. If the power LED does not glow white when you turn it **On**, your EPOC+ requires charging. Please plug-in the provided USB Mini-B cable into the headset as shown above to USB port.

Note 1: The headset will charge faster if it is connected to a dedicated USB port.

Note 2: If the headset is heavily depleted or hasn't been used for a few months, leave it connected for 24 hours.

Universal USB Receiver (Dongle)

The universal USB receiver (dongle) uses a proprietary 2.4 GHz protocol to stream data from the headset. We recommend using this to connect to your headset on a PC or Laptop; once connected it remembers the serial number of the headset pairs to allow easy reconnection. The dongle pairing also allows multiple headsets to co-exist and provides a reliable high speed connection over Bluetooth Low Energy (BLE).

The headset supports BLE which allows connection to mobile devices (Android/iOS) and some computers. EmotivPRO does support the native BLE radio on MacOS devices (2015 or later). On PC's however the implementation of Bluetooth varies by manufacturer and it is not guaranteed to work and so we recommend using the dongle.

There are two green LED's on the top surface of the dongle and plastic lies at the bottom. The following table explains about LED's.

Action	LED Left (under power icon)	LED Right

Powered Up Looking for headsets	Off	Slow flashing
Receiving data	On	Fast flashing
Paired by not connected	On	Slow flashing
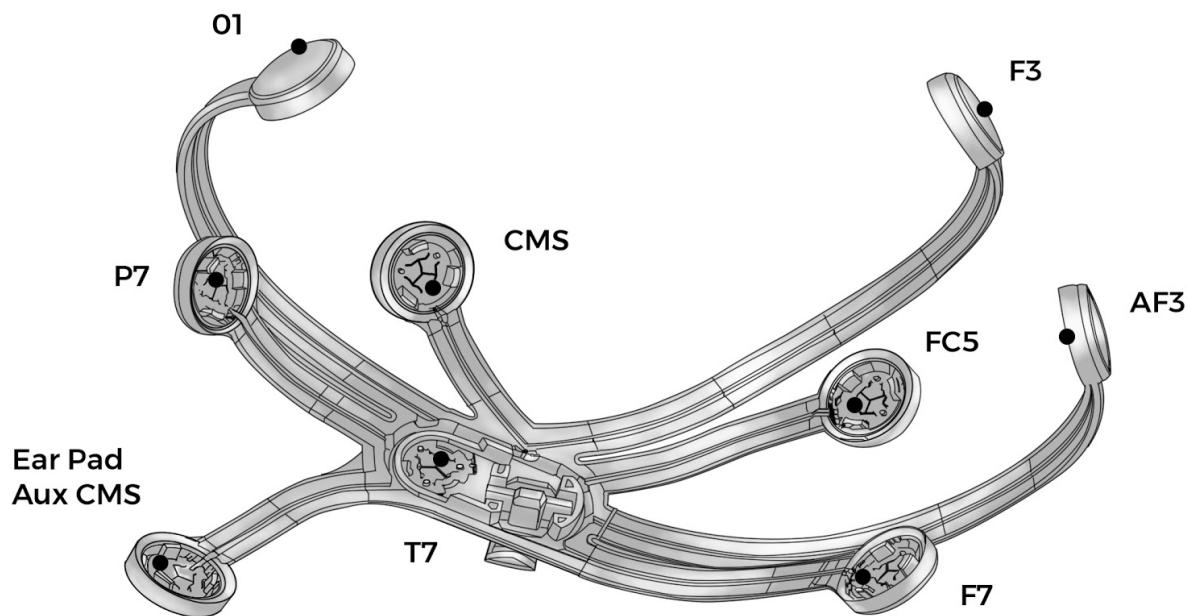
TROUBLESHOOTING

Electrode Arms - Alternative References

The following images display the arms of the headset to allow you to identify each sensor for troubleshooting.
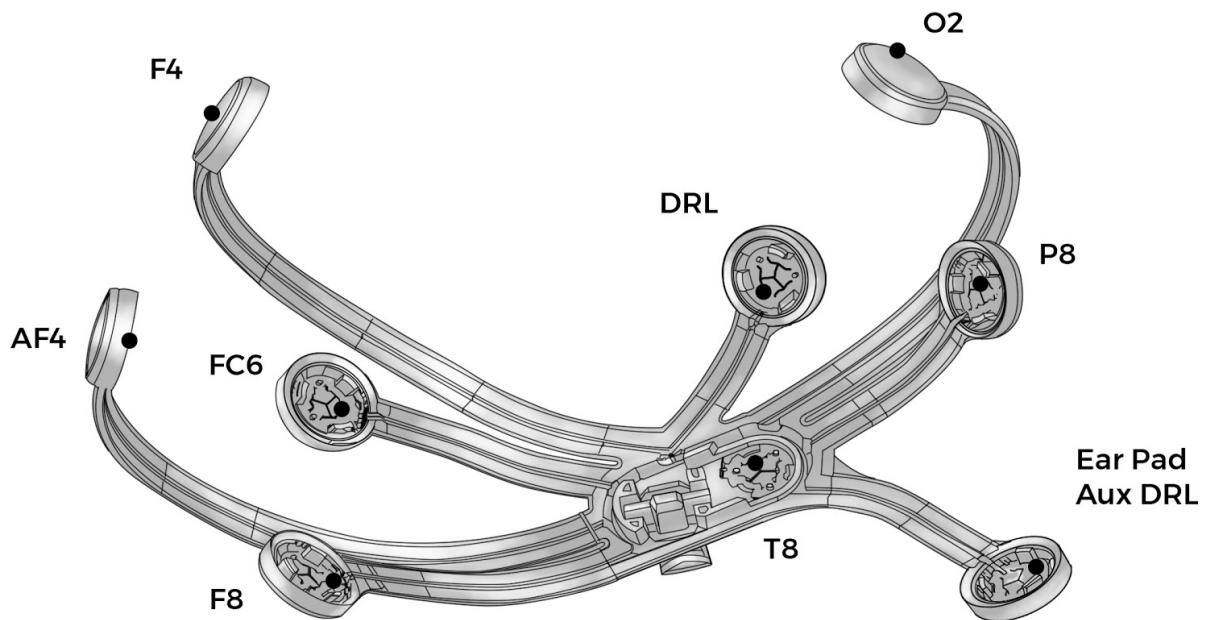
Left
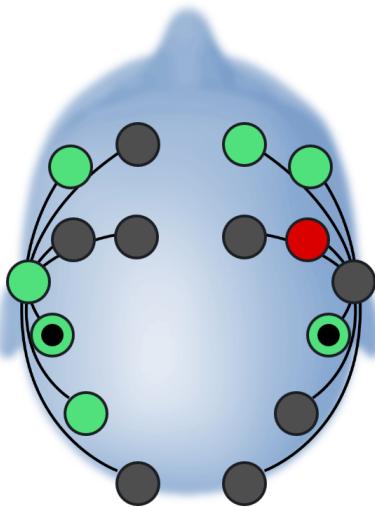
Right

The DRL(P4) / Aux DRL (M1) and CMS (P3) / Aux CMS (M2) channels are wired together to allow the user to change the location of the references. If you are having problems getting good contact quality due to thick hair, please try the second position.

Contact Quality

Contact quality is measured for each position and displayed in the sensor map as shown

below.

There are four states:

Color	Status
Black	No contact is detected
Red	Poor Contact Quality
Orange	Average Contact Quality
Green	Good Contact Quality

If a sensor is not in green, please check that it is making a good contact with the scalp and the sensor is wet. If the subject has thick hair, try to work the sensor under the hair and add additional fluid. Bad positioning and dry sensors are the two most common reasons for poor contact quality. Other reasons could be that the sensor housing isn't locked in place or the felt pad has been recently replaced which might not be pushed far enough into the sensor housing.

If a sensor is persistently not making a good contact, you can test its functionality by tapping on the sensor and observe if anything appears in the EEG data steam. You can also

try measuring your ECG by touching both references with one hand and the sensor with the other. You should be able to clearly see the QRS and T-wave.

If all of the channels are showing the same level of poor quality, the likely cause is the reference sensors are dry or the reference sensors are not making a good contact to the scalp. Before adjusting any of the recording electrodes, it is recommended that you have a good contact (green) for the reference sensors.

If the felt sensors are moistened for the first time, the sensors take time to absorb the fluid. The best solution is to apply a small amount onto each sensor and then top up each sensor so that they are wet.

For users with thick hair, skin contact can be improved by working the sensors through the hair to make a better contact onto the scalp.

Saline Solution
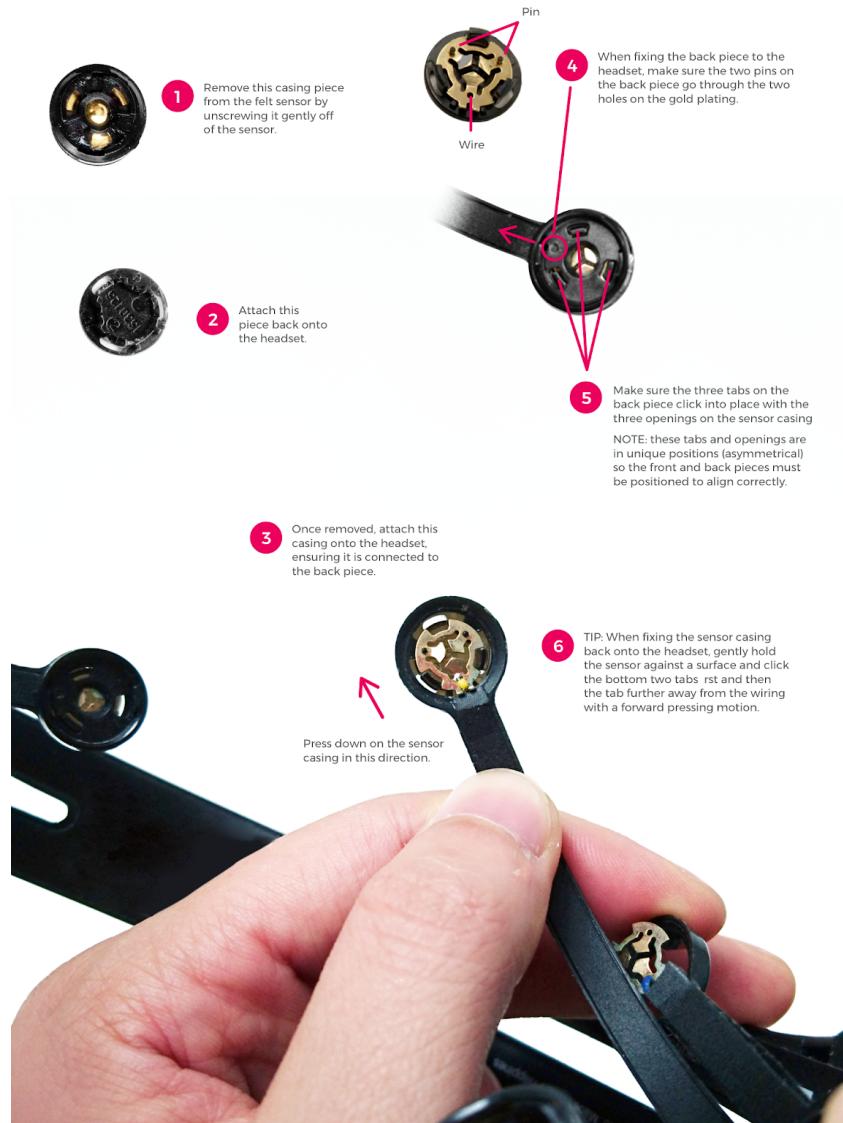
Each headset is packed with a small bottle of multipurpose contact lens solution. When this is exhausted, you can purchase from your local drug store or pharmacy. We recommend the use of contact lens solution if possible; but please do not use contact cleaning or sterilizing solutions. Multi-purpose solution contains non-allergenic anti-microbial agents which helps to keep your sensors fresh and prevent transfer of microbes between users.

A saline solution between 0.7% - 4% w-w sodium chloride can also be used, but we recommend adding a small quantity (< 4% by volume) of a household disinfectant such as 70% iso-propyl alcohol.

To reduce the rate of evaporation, add a couple of glycerin drops.

Reattaching Sensor Frame

Occasionally, the electrode assembly that the sensor locks into comes apart as shown in the following image.

1 Remove this casing piece from the felt sensor by unscrewing it gently off of the sensor.

2 Attach this piece back onto the headset.

3 Once removed, attach this casing onto the headset, ensuring it is connected to the back piece.

Pin

Wire

4 When fixing the back piece to the headset, make sure the two pins on the back piece go through the two holes on the gold plating.

5 Make sure the three tabs on the back piece click into place with the three openings on the sensor casing

NOTE: these tabs and openings are in unique positions (asymmetrical) so the front and back pieces must be positioned to align correctly.

6 TIP: When fixing the sensor casing back onto the headset, gently hold the sensor against a surface and click the bottom two tabs rst and then the tab further away from the wiring with a forward pressing motion.

Press down on the sensor casing in this direction.

Storage

When the EPOC+ is not in use, it is best to remove all the sensors or at least the felt pads and place them in the provided hydrator pack. The pack should be kept open to dry out. Wet sensor assemblies left in the headset will corrode over time and you don't want this corrosion to take place because it will damage the headset. The corrosion is caused by the saline solution reacting with the coating that we use to improve the signal quality.

We recommend that you soak the felts well to ensure good contact quality. You can place the felts in the hydrator pack but leave the sensors fitted to the frame.

We provide replacement sensor packs and felts on our accessories page of the online store.

Electrode Assembly

Broken Sensor Lock

Occasionally, due to wear and tear, the quarter turn locking mechanism holds the sensor onto the headset breaks. This makes it impossible for the sensors to stay in place but it is possible to repair. Please contact online support for assistance.

Software

EMOTIV Applications

EMOTIV offers several software solutions to use with your headset that you can choose based on your needs. To view our full featured software applications, please visit the PRODUCTS/SOFTWARE section of our website.

If you are interested in developing your own applications for your EPOC+ headset, you can view the SDK licensing options and support here. You can also access and download Cortex, our SDK service application that allows you to connect your device with our headset for third party applications.