

# Dev Kit

This manual contains general operating instructions, precautionary measures, maintenance instructions, and information for use of the CGX Dev Kit.

Please read this manual carefully and familiarize yourself with the controls and accessories before using the product.

## Note

- This is an investigational device designed for research and development efforts.
- It is not an FDA-approved medical device.
- There are no known side effects from the use of this product.

## Description

The Dev Kit is a portable development-oriented, dry EEG system. The kit includes an 8-channel amplifier and individual leads terminating in snap connectors. Also included are Drypad and Flex sensors, and a fabric headband for aid in sensor placement.

Wireless technology allows the subject to move about while real-time data is collected and displayed.

EEG channels are sampled at a time resolution of 500Hz and converted to digital data at 24 bits of resolution.

The Dev Kit provides research-grade signal quality and is ideally suited for general-purpose EEG and ERP research in laboratory and field environments.

**The Dev Kit is intended to be used to acquire the electroencephalogram (EEG) and transmit it wirelessly to a computer.**

**This Device Is Intended For Research Only.**

**It Is Not Intended For The Following Uses:**

- monitoring of patients in a clinical environment
- use in medical diagnosis
- on subjects undergoing surgery
- use in sterile environments
- use with sleeping subjects

**Do Not Use This Product In These Situations:**

- near high-frequency surgical equipment
- if exposed to ionizing radiation
- in oxygen-rich environments (concentration > 25% at 1 atm)
- in wet environments
- in the presence of flammable anesthetics or gases

**Precautions For The Practitioner**

- Do not drop, sit on, or step on the amplifier or sensors.
- Check if your subject has a sensitive dermatological condition causing sensor intolerance.
- Avoid cross-subject contamination. Do not use with subjects having open wounds or scalp infections.
- The Dev Kit headset is not a diagnostic tool. Any medical diagnosis related to the EEG should be derived by a certified physician.

**Subject Considerations**

- This device is intended for human use only.
- Subject should have a healthy scalp.
- Do not use with infants or neonates.
- Test subjects may or may not have hair.
- All sensors must be able to contact the subject's scalp.
- The entire headset may come into contact with the subject's skin.

**Follow These Advisories To Keep Your Dev Kit In Good Working Order**

- Do not immerse the amplifier, sensors, or leads in liquid.
- Do not expose the system to direct sunlight or heat source, moisture, vibration, mechanical shock, excessive dust, or humidity.
- Do not open, modify or disassemble the amplifier — this will void the warranty.
- Do not use if the amplifier or any accessories are damaged.
- Do not use when amplifier or leads are wet.
- Do not use caustic or abrasive cleaners on the system or sensors.

**Always Use Supplied Accessories**

Using accessories other than those supplied with your Dev Kit system may result in damage or diminished efficacy of the system.

The Dev Kit uses an internal Lithium-ion rechargeable battery.

**Avoid Cross-Subject Contamination**

Clean the device and clean or replace sensors after use following the cleaning instructions to avoid cross-subject contamination.

### Dev Kit Overview

EEG is the measurement — through the use of sensors and amplifiers — of scalp surface electrical potentials arising from activity in the cortex.

The Dev Kit is flexible and adaptable to a wide variety of custom EEG experiments. The eight sensor leads can be placed anywhere around the head, and the fabric headband keeps sensors in place around the circumference of the head.

The Dev Kit meets the mechanical, electrical, and sensor needs required to make an effective dry EEG system.

Conventional wet systems rely on electrolytic gels to penetrate hair, contact the skin, and provide a conductive path. The gel serves as a buffer filling in gaps between the sensor and skin.

No conductive gel is used in a dry system. The benefits are obvious: faster set-up, and no after-use clean-up required.

Dry systems are subject to several challenges. First, the sensor must directly touch the scalp or skin, even through thick hair. Second, the sensor must remain securely in place to minimize artifacts and noise. Finally, the electronics must tolerate impedances up to 200 times higher than wet systems — while rejecting noise and interference. A high-end dry solution — like the Dev Kit — balances sensors, mechanics and electronics achieving virtually the same signal quality as a traditional wet cap for most EEG applications.

# Device Overview

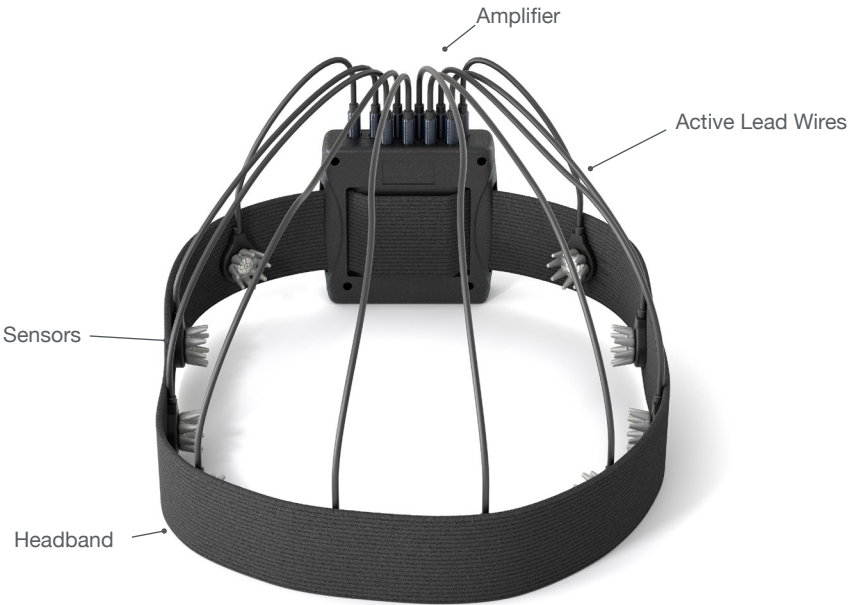
## The Package Contains The Following Items

Dev Kit Amplifier  
Bluetooth Dongle

1 Passive Ground Lead Wire  
9 Active Lead Wires  
10 Flex Sensors  
10 Drypad Sensors  
30 Skintact Sensors

Headband  
Wall Charger  
Carrying Case  
Manual

## Dev Kit with Headband



# Device Overview

## Amplifier



Wireless amplifier collects signals and transmits to Bluetooth Dongle.

## Bluetooth Dongle



High-speed receiver dongle plugs into your computer's USB port.

## Active Lead Wires



Active lead wire (3.5mm connector) for EEG channels.

## Passive Ground Lead Wire



Passive lead wire (touchproof connector) for Ground.

## Drypad Sensor



Drypad sensors make direct skin contact for ECG and EEG recordings.

## Flex Sensor



Flex sensors slide through hair for high-quality scalp contact.

## 1. Install The Software

**Note: CGX Acquisition software runs on Windows only.**

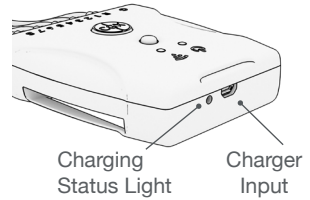
- Navigate to [CGXSystems.com](http://CGXSystems.com)
- Select **Software** from the top navigation menu.
- Select **Download** under **CGX Acquisition Software**
- Choose the latest version link under “Downloading and Installing the Software.”
- Extract the zipped file to your desktop.
- Run CGX Setup and follow the instructions.
- If you see a security warning, select **More Info** and **Run Anyway**
- The software will create a shortcut on your desktop.

Download the latest software from [CGXSystems.com](http://CGXSystems.com)

Downloads



### Charging

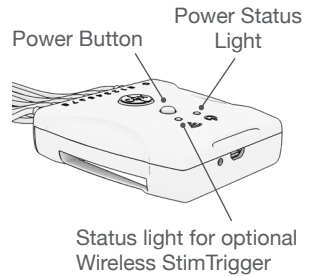


## 2. Charge the Internal Battery

Allow your Dev Kit to fully charge before each use. The device has a charging indicator light:

- The charging status light is red when the battery is charging.
- The charging status light is green when the battery is fully charged.

### Amplifier



## 3. Check Power Status and Trigger Status Lights On Top Of Amplifier

Power Light	Status
Off	Device Off
Green	Device On
Yellow	Low Battery
Red	Critically Low Battery (charge immediately)

### Trigger

The Trigger Status Light is for use with the optional CGX Wireless StimTrigger, and indicates when the headset is receiving trigger signals from the StimTrigger unit.

Trigger Light	Status
Off	Trigger Out Of Range
Blue	Trigger In Range

4. Insert Bluetooth Dongle

Plug the dongle into your computer and Windows should automatically install the correct drivers. Verify driver installation by checking the Device Manager for problems, marked by a yellow exclamation mark.

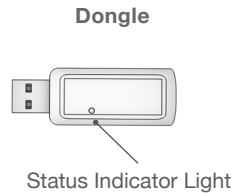
- The dongle is specific to each headset.
- For best performance, ensure a clear line of sight between the dongle and the front of the headset

*If Windows did not successfully install the driver for the dongle, refer to the FTDI driver installation manual on our website.*

Each Dev Kit is permanently paired to a receiver dongle. The pair automatically discover and initiate a connection when both are powered on and within a 10m range.

The light on the dongle indicates its current state:

Dongle Light	Status
Green	Power On, Not Paired
Purple	Searching For Device
Blue	Device Found
Flashing Blue	Data Transmitting



5. Start The Acquisition Software

Once you've established a connection, data should begin to stream.

Double click on the CGX Acquisition software icon. You should see **CGX Dev Kit** under **Discovered Devices**.

*If you do not see the name CGX Dev Kit, remove and re-insert the dongle and restart the software.*

1. First, click the device name in this window to select the Dev Kit
2. Then click **Connect**.

You should now see the device configuration window.

*If you do not, double check to make sure the Dev Kit is powered on.*

Click **Start Device**.

You will now see data streaming into the display. Click the **Channels** tab on the top right-hand side of the program. This will bring you to the impedance check. You are now ready to use the device.

### 6. Select Sensors

#### **Drypad Sensors**

Use Drypad sensors in positions where the subject has no hair (forehead and bald areas).



Drypad Sensor for direct skin contact

#### **Flex Sensors**

Use Flex sensors to penetrate hair. On most subjects, these are all the positions except Fp1, Fp2, F7 and F8.



Flex Sensor for hair

#### **Skintact Sensors**

Use Skintact sensors for direct skin contact.

### 7. Typical 8-Channel Montage Using The Headband

This is a typical circumferential montage, with Reference at the mastoid, and Ground set where convenient.

1. Insert the headband through the mounting slots on the amplifier.
2. Plug the passive touchproof ground connector into the **G** Ground port.
3. Plug an active 3.5mm lead into the **R** Reference port.
4. Attach Skintact sensors to the Reference and Ground leads. Ensure good contact between these sensors and the skin.

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*Note: Reference and Ground contacts are essential to the functioning of the device.*

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5. Connect as many leads as desired to the Dev Kit and attach the sensor of your choosing to the end of each lead.
6. Place the sensors around the head using the headband to secure the leads in place.

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#### **Attach Sensor To Lead**



It may require extra pressure to insert a sensor due to variability in surface coating. Try that sensor in an alternate pod location in case of a particularly tight fit.



### 8. Optimize Sensor Contact

After properly positioning the sensors on the subject, obtain direct contact on all sensors before recording.

Bring up the impedance check in the CGX Data Acquisition software under the Channels tab. The impedance check presents a color-coded map of the sensors on the device, corresponding to contact level:

Red	Impedance out of range ( $>5,000$ k $\Omega$ default)
Light Green	Impedance at top end of range ( $2,500$ - $5,000$ k $\Omega$ default)
Dark Green	Impedance at bottom end of range ( $<2,500$ k $\Omega$ default)

The range of impedances with dry sensors may be higher than what you are accustomed to when working with conventional wet sensor amplifiers. CGX devices utilize a combination of advanced electronics, shielding, and mechanics to obtain EEG signals even when contact is poor, and can tolerate sensor impedance up to  $5,000$  k $\Omega$ .

### 9. Adjust Sensors, If Required, To Improve Impedance Measurements

Check for acceptable impedance measurements on each channel.

To ensure good impedance measurements:

- Lift the sensor slightly to move hair aside.
- Lower the sensor back in place, keeping the sensor aligned to the subject's head.
- Lightly press down, holding for 5 seconds, then gently release the sensor.

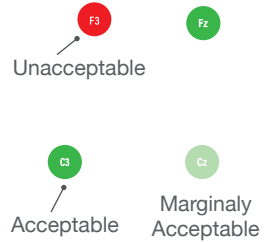
### 10. Record An EEG

After you have acceptable impedance levels, click **Record** under the Device tab to begin your recording. To end the recording, under the same tab, click **Stop Recording**.

### 11. End The Session

Close out the current file in the software if one is active and exit the program. Press the power button once to turn off the device.

#### Impedance Map Under The Channels Tab



Ground must be applied for impedance check to operate.

#### Position Of The Subject During EEG

Use the Dev Kit headset for subjects in an upright position. Do not let the subject lie or sleep on the sensors. It may damage the system.

## Cleaning And Maintenance

To avoid cross-subject contamination, follow the cleaning instructions to clean sensors, amplifier, and headband after each use.

This device is not intended to be sterilized in an autoclave.

### Cleaning Sensors

- Use hand sanitizer or 70% isopropyl-based alcohol wipes to clean Drypad and Flex sensors according to cleaning agent instructions.
- Do not use 90% or 99% alcohol. These solutions will damage the sensors.
- Check sensors regularly. Sensor functionality is important to maintaining signal quality. Replace sensors if signal quality degrades.
- Contact CGX for replacement sensors.

### Cleaning The Leads and Amplifier

- Use 70% isopropyl-based alcohol wipes to clean the leads and amplifier.
- Do not use 90% or 99% alcohol. These solutions will damage the system.

### Storage

- Transport system in the case.
- Store in a temperature and humidity controlled room.

### Do Not Let The Amplifier Come Into Contact With Liquid

Immediately turn off the system out and let the amplifier dry completely before resuming use.

### Disposal Instructions

To protect the environment, always follow local law, rules, and policies regarding electronic and battery disposal. You may also return the device to CGX for proper disposal.

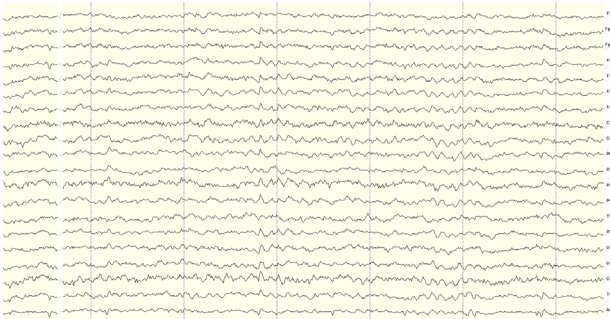
## Obtaining Clean EEG Data

The most important aspect of EEG recording is that output data is only as good as the recording input. While algorithms exist to remove artifacts, poorly recorded data cannot be fixed in post processing.

Recording good EEG data requires preparation of the participant for optimal sensor contact:

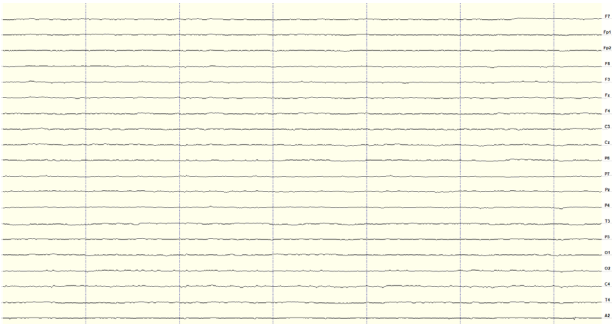
1. Participants should have their hair recently washed and fully dried before recording. Wet hair, hair gel, conditioners, and hair spray may cause interference and degrade signal quality.
2. Clean each sensor location on the head with a cotton swab soaked with alcohol.
3. In the event of difficulty establishing good contact, apply a small amount of water between the sensor and scalp to create an electrical bridge.
4. It is important for subjects to reduce tension in the head, neck, and shoulders during readings.

### Typical Clean Data Recording



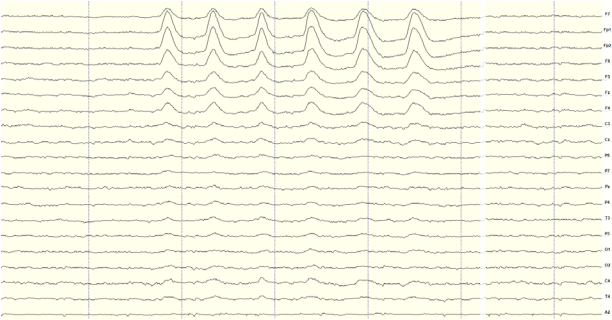
This is a representation of a clean data recording.

Clean Data At Default Scale



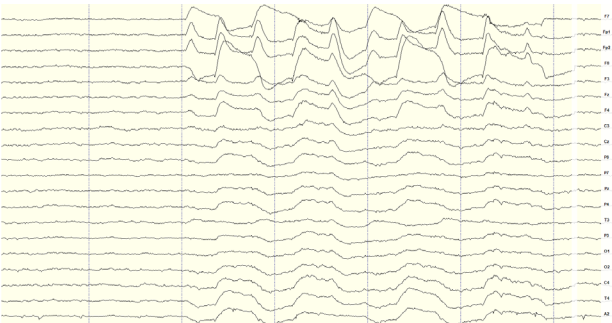
Traces are thin and deviate minimally from the axis.

Blinks



Eye blinks will generate muscle artifacts in the frontopolar locations (Fp1 and Fp2) and less so in frontal sensors (F3/F4, F7/F8), overshadowing brain activity in EEG recordings.

Eye Movement



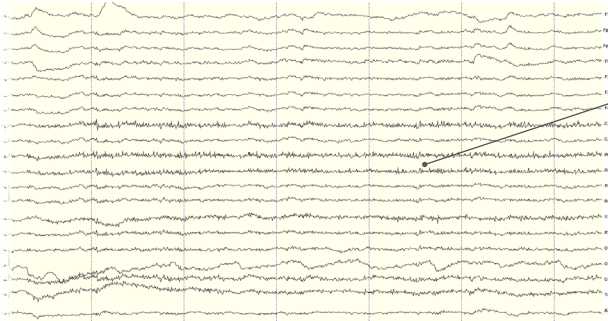
Moving the eyes will generate muscle artifact in the forehead and front of the head. A high concentration of neurons in the eyes generate strong electromagnetic fields, so eye movement causes disruptions in the EEG recording.

### Muscle Artifact: Jaw Clench



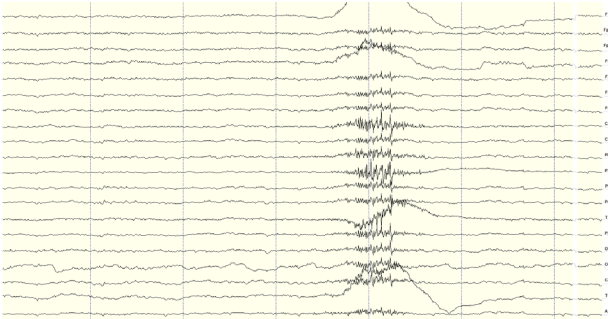
Jaw clenching may affect most or all channels, especially if clenching hard. Light jaw clenching or tightness can be observed in F7/F8, T3/T4. Take note of any temporomandibular joint disorders: these can cause artifact without typical clenching.

### Muscle Artifact: Tongue Movement



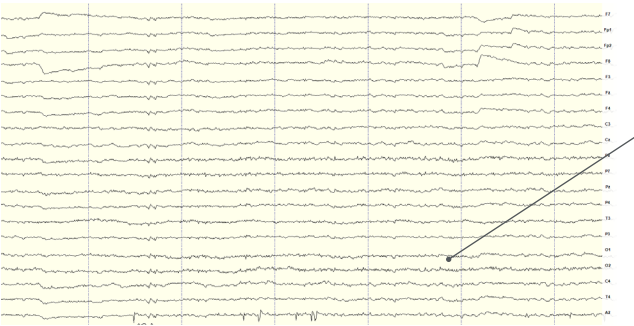
The tongue is a large polarized muscle, with the tongue's tip negative with respect to the base of the tongue. When the tongue moves around the mouth, it generates a moving field causing recording disruptions. Disruptions may be seen down the midline (Fz, Cz, Pz). Tongue movement during talking can be seen on many channels.

### Muscle Artifact: Swallowing



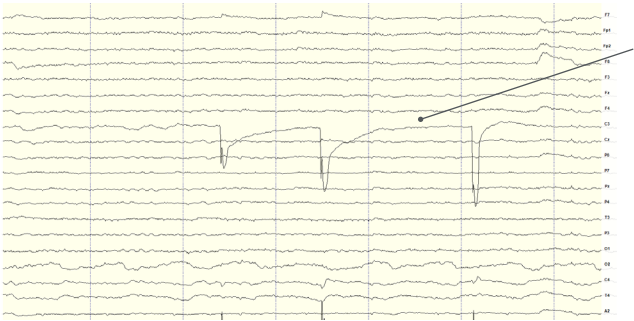
Swallowing invokes movement of several muscles in the mouth, including the tongue, causing disruption of many channels. Ignore swallowing if infrequent, but frequent swallowing may limit usable data.

**Muscle Artifact: Neck Tension**



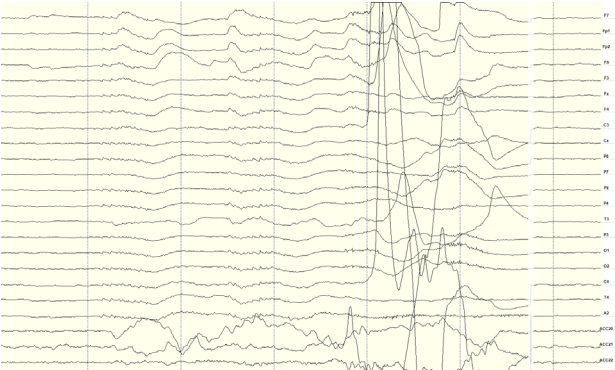
Neck tension may affect channels on the back of the head, predominantly O1/O2, but also in parietal sensors (Pz/P3/P4, P7/P8). Subjects should be comfortably seated, with appropriate bracing at the back and neck. Avoid slouching.

**Headset Or Electrode Disruptions: Sensor Pops**



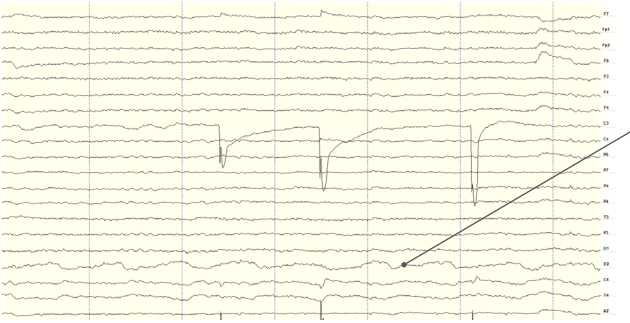
Brief disruptions in contact between sensor and scalp may cause “sensor pops” on recordings. Occasional pops can usually be ignored in processing, but if the problem persists, check the contact between the sensor and scalp. Wipe popping locations with a small amount of alcohol on the sensor.

**Headset Or Electrode Disruptions: Head Movement**



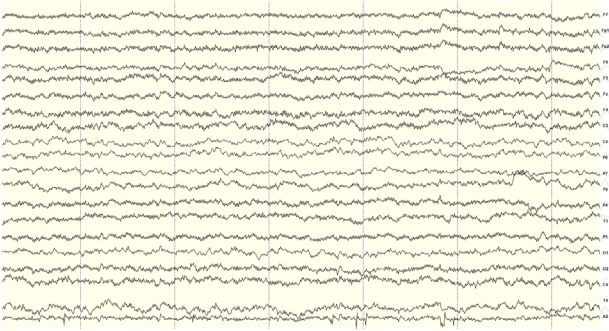
Excess or quick movement of the head may disrupt connection between sensors and scalp causing data artifacts as shown.

### Pulse Artifact



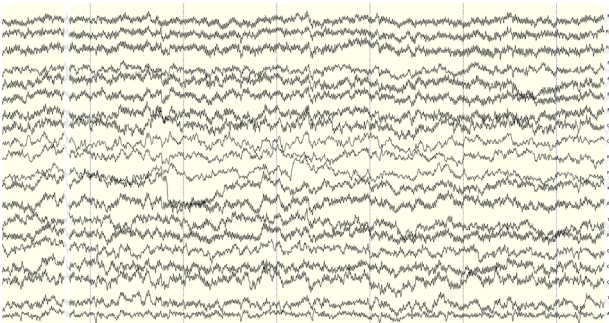
EEG sensors are sensitive enough to detect small electrical signals on the cortex. Occasionally, sensors may lie directly atop a blood vessel. When this occurs, sensors may detect the subject's pulse. Slightly move the sensors to reduce pulse artifacts.

### Mild Power Line Artifact



Power lines operate between 50 and 60 Hz. Unsecure power sources may leak electromagnetic frequencies. Because EEG records frequencies from 1hz to about 40hz, power line noise may negatively impact recordings on all channels. This is especially the case when connection between sensor and scalp is poor.

### Strong Power Line Artifact



To avoid power line artifacts, have subjects sitting at least 3 feet from power cords, plugged-in devices, and lighting or overhead fluorescent lights. The Dev Kit shields the sensors from environmental noise, but issues can still occur with poor skin contact.

Improper Setup: No Connected Reference

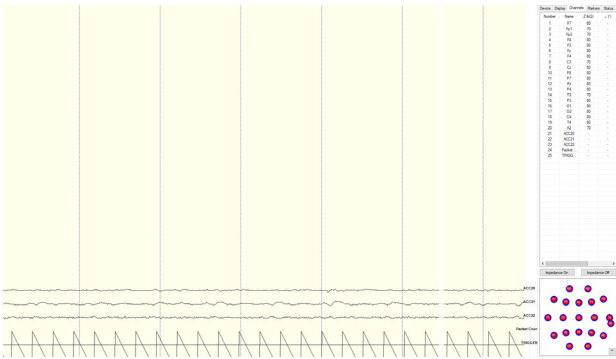


fig. 1

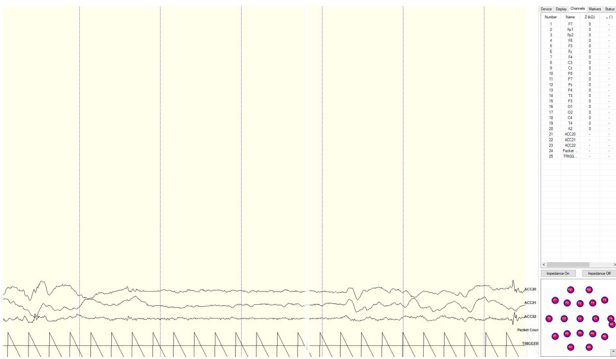


fig. 2

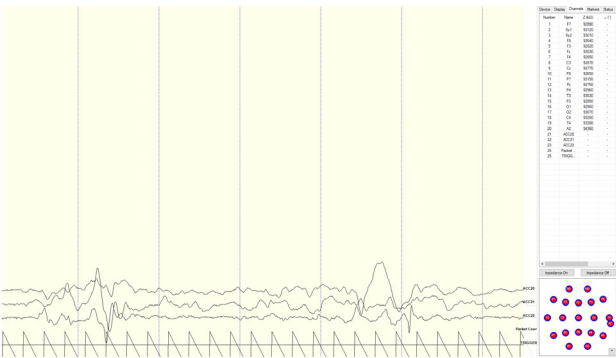


fig. 3

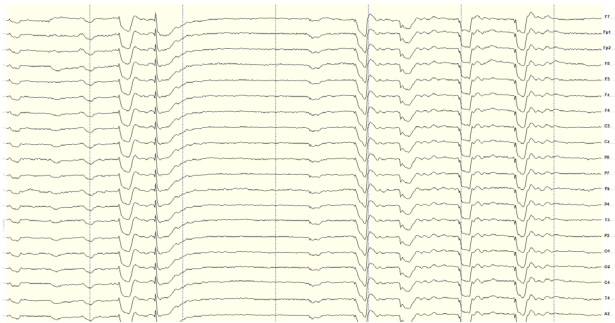
There are a multitude of recording errors when the A1 reference earclip is not connected to the subject.

The most common are:

- Impedances match or nearly match at a low value but do not appear on the display or in the impedance head map. (fig. 1)
- No traces appear and impedance values are zero. (fig. 2)
- No traces appear and impedance values are high. (fig. 3)

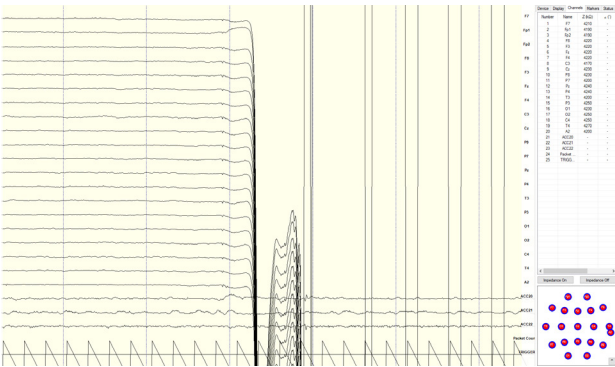


Improper Setup: Reference Contact



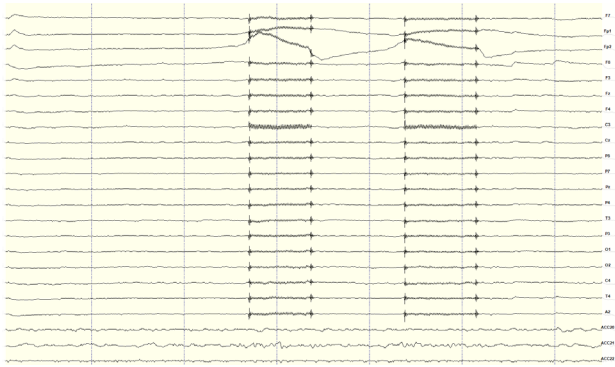
When the reference channel is touched or jostled, all channels will be affected. Avoid disrupting the Reference position during use.

Improper Setup: Reference Disruption



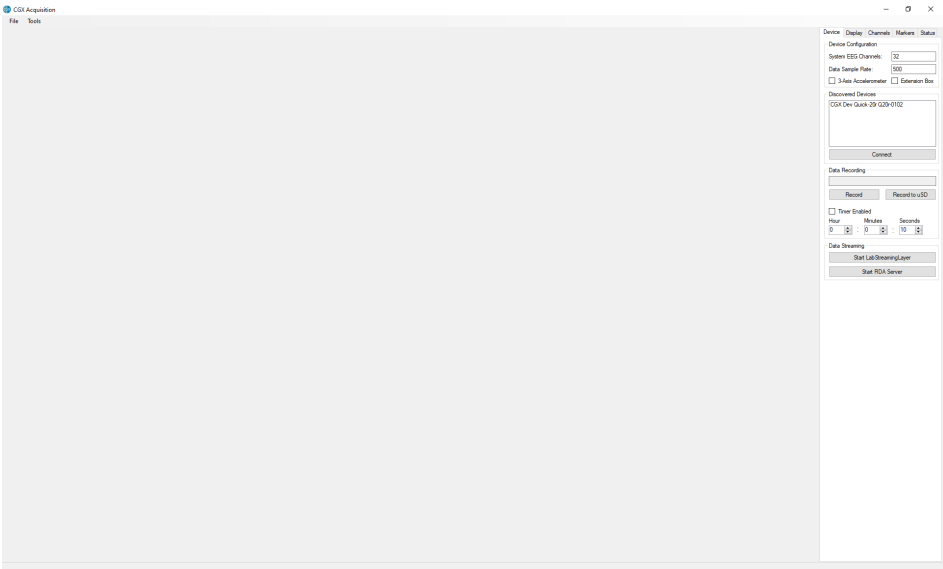
When the reference is disconnected, all channels will disconnect as well.

Improper Setup: Ground Disruption



If the ground has poor contact, all channels will be impacted. Avoid disrupting the connection of the Ground lead during use.

# Device Tab



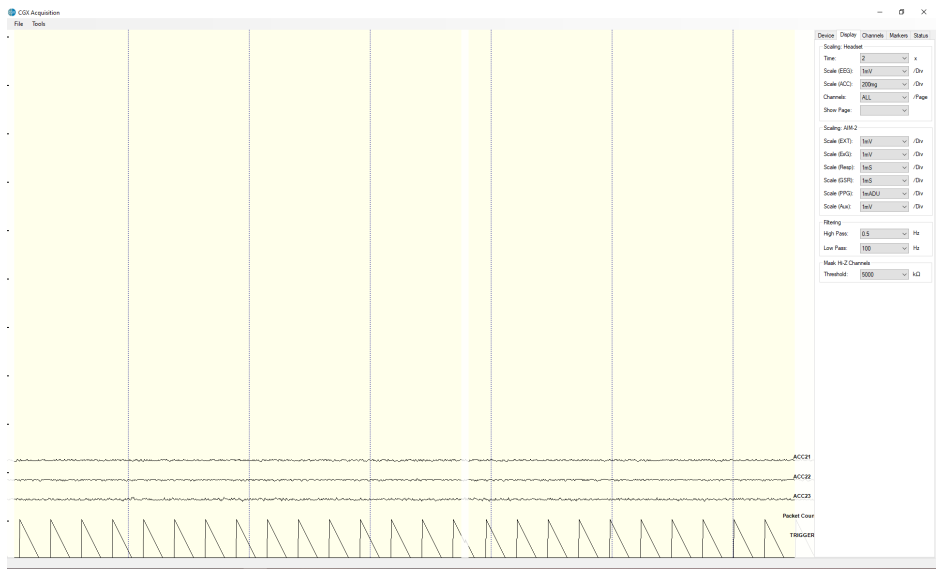
## Device Configuration

- **Discovered Devices** Connected dongles will be listed here. Select the device name of your system and hit **Connect**.
- The software automatically connects to your device to retrieve stored settings.
- The **Device Configuration** window is only for your information; changing the settings will not change the configuration of the device. If you need to change device configuration, contact support at CGX.

## Data Recording

- **Record** Click to open a file dialog. Select the desired location, file name, and file type. (CSV files have a time stamp built in). Recording begins when you press **OK**.
- **To Stop Recording** hit the button again. Elapsed time is shown in the box above the button.
- **Start LabStreamingLayer** Hit the **Start LabStreamingLayer** button.
- **Start RDA Server** To use the BCI2000 software with the Data Acquisition Software, click on this button. Then, connect to the application in BCI2000.
- **Timer** The timer allows you to limit file recording to a specific length.

# Display Tab



## Scaling: Headset

- **Time** sets the x axis time window. By default, it is set to 2 seconds.
- **Scale (EEG)** sets the y axis vertical gain for the EEG channels on the head.
- **Scale (ACC)** sets the y axis vertical gain for the accelerometer channels.
- **Channels** sets the maximum number of channels displayed per screen. To flip through the pages of channels, use the option below.
- **Show Page** switches between different pages of channels.

The display tab controls scaling and other viewing parameters for the signals.

## Scaling: AIM-2 (Optional)

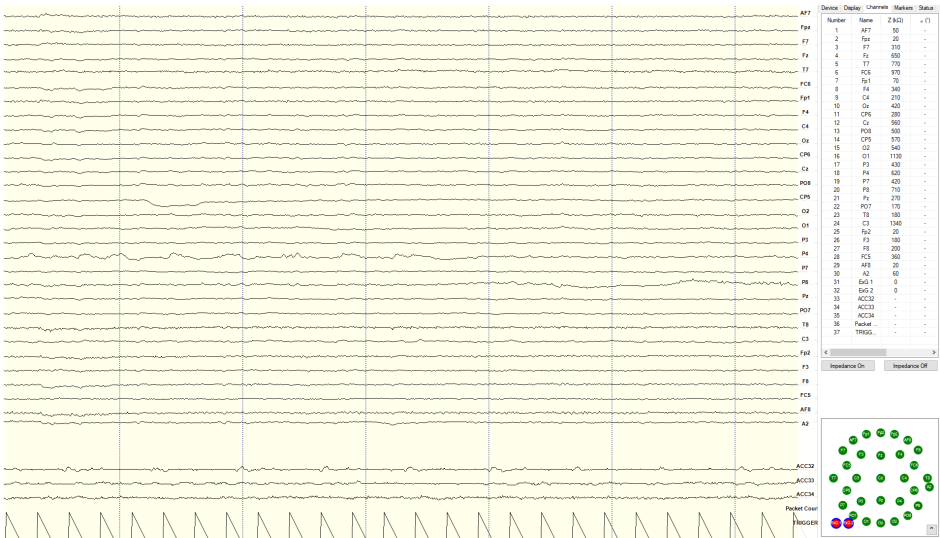
### Filtering

- **High Pass** sets the floor (removes offsets and slow signals) corner frequency for the display.
- **Low pass** sets a ceiling (removes high frequency signals and noise) corner frequency for the display.
- Note: filtering is for display only. Data files are saved raw and unfiltered to preserve the maximum amount of information.

## Mask Hi-Z Channels

**Threshold** hides channels with sensor impedances above the specified threshold from the display.

Channels Tab



The bottom half is a graphical map of sensor contact quality. Red circles indicate poor contact, whereas light green circles indicate acceptable contact. Dark green circles indicate ideal contact.

The threshold for this contact quality is, by default:

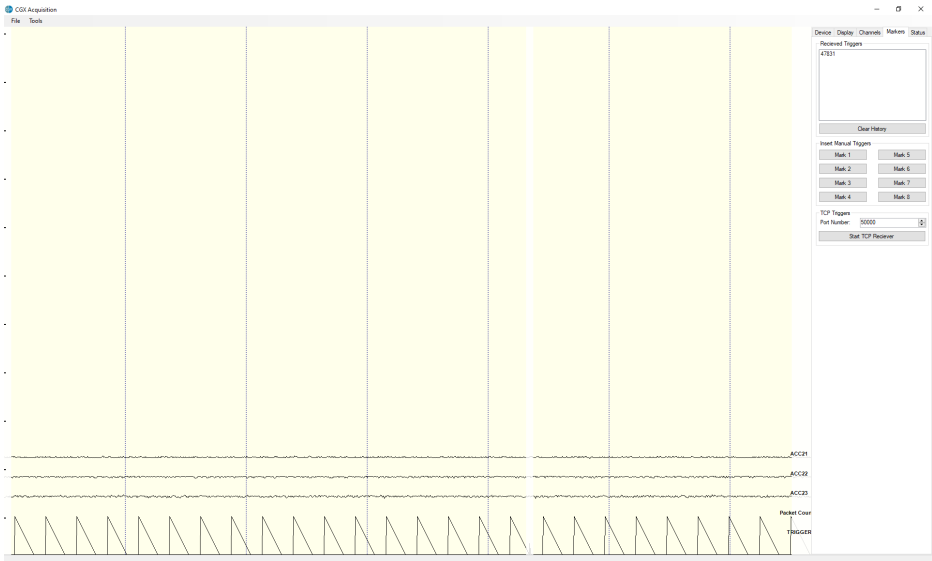
- Red** Above 5000 kΩ
- Light Green** Between 2500-5000 kΩ
- Dark Green** Below 2500 kΩ

This threshold can be changed with the Mask Hi-Z menu on the display tab.

- Red** 100% or greater of Hi-Z threshold
- Light Green** Between 50%-100% of Hi-Z threshold
- Dark Green** Below 50% of Hi-Z threshold

The top half of the Channels tab contains a table displaying information about each channel in the system including its number, name, contact impedance ( $Z$  (kΩ)) and sensor offset (Off (mV)). The offset is calculated relative to the reference channel.

# Markers Tab



## Received Triggers

- The box shows all of the received triggers chronologically.
- If no trigger is in range, value received will be 47831 (in hex: 0xBAD7).
- **Clear History** This button will clear all of the triggers in the box. It will not delete triggers from the recording itself.

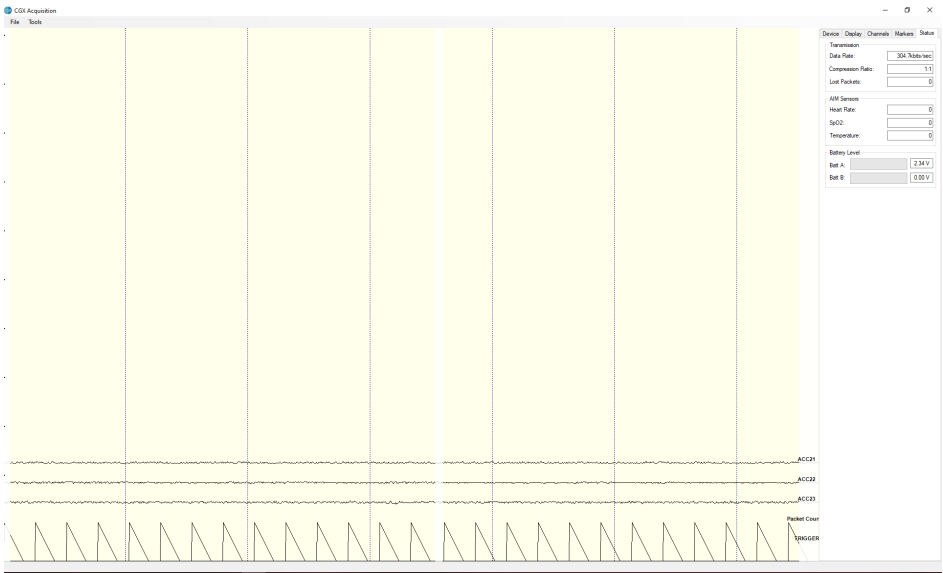
## Insert Manual Triggers

- You have the option to select any one of eight trigger codes to insert into the recording. These will be inserted in the same way as a normal trigger sent from our Wireless StimTrigger. However, we recommend only using the trigger for precision event marking, and to use these software triggers for general annotation.

## TCP Triggers

- **Port Number** Allows you to choose which port to receive triggers.
- **Start TCP Receiver** Starts the receiving service.
- Do not use for precision event marking.
- For general annotation only.

# Status Tab



## Transmission

- **Data Rate** Allows you to see the bandwidth being used for the data being sent.
- **Compression Ratio** Shows you the ratio at which data is being compressed and sent to the computer.
- **Lost Packets** Shows the amount of information dropped in communications between the headset and the computer, increasing as the headset moves away from the computer.
- **AIM Sensors** (not applicable)
- **Battery Level** Battery status is displayed at the bottom of this tab. The Dev Kit only uses Batt: A.

# Specifications

<b>A/D Resolution</b>	24-bit simultaneous sampling analog-to-digital converters.
<b>Sampling Rate</b>	500 samples per second.
<b>Bandwidth</b>	0-131 Hz with true DC coupling.
<b>Storage</b>	Store in provided carrying case in temperature and humidity controlled environments.
<b>Accelerometer</b>	3-axis accelerometer measures head motion.
<b>Range</b>	10 meters.
<b>Noise</b>	<1.0 $\mu$ V RMS from 1-50 Hz, shorted inputs.
<b>Sensor Life</b>	Drypad: 200 uses Flex: 200 uses Skintact: Single use
<b>Wireless Type</b>	Bluetooth Low Energy.
<b>API</b>	Full access to raw data via real-time streaming API.

<b>Impedance Check</b>	Continuous impedance check with real-time monitoring of all channels simultaneous with EEG.
<b>Data Export</b>	Export data to EDF, BDF, or CSV.
<b>Compatible With</b>	CGX Wireless Stimtrigger.
<b>Battery Type</b>	Internal Li-Ion Battery
<b>Battery Life</b>	8 hour battery life.
<b>Use With</b>	NeuroType, LabStreaming Layer, EEGLAB, BCILAB, MATLAB, BCI2000, OpenVIBE, NeuroGuide.
<b>Applied Part</b>	BF
<b>Weight</b>	80g
<b>Dimensions</b>	2.5 x 9 x 8 cm



### Dev Kit Headset

3 year warranty on manufacturing defects. 90 day warranty on accessories and disposable parts. Warranty is void if the device has been opened or tampered with.

### Returns

All units returned to CGX for repair and assessment must have an RA number issued by CGX.

CGX will pay outbound shipping costs only.

Ship all returns with an RA number to:

### CGX

**Attn: Service**

**8445 Camino Santa Fe, #213**

**San Diego, CA 92121**



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