ActiveTwo System

Operating Guidelines

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Please forward suggestions for improvement of this manual to the address above.

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I. Intended use of the system

A. Applications

The BioSemi ActiveTwo measurement system is designed to measure potential differences on the human or animal body surface. The system is successfully used to record signals originating from the brain (electroencephalography, EEG), the heart (electrocardiography, ECG), and the muscles (electromyography, EMG) for research purposes. The ActiveTwo system can be adapted to these different applications by using different versions of the (active) electrodes. Besides body surface potentials, the ActiveTwo system can acquire signals from a wide range of additional sensors, in order to measure variables like body temperature, muscle force, etc.

B. Research use only – not a medical device

The ActiveTwo is designed, and intended to be used as an instrument for scientific research only. The electrophysiological data acquired with the ActiveTwo is meant to be used within the framework of scientific research. The system is not intended for medical applications. The system is not approved or allowed to be used for diagnosis or treatment of disease, and the measured data shall not be used as a basis for any medical decision. The system is not certified as a Medical Device as defined in EU directive 93/42/EEC, Article 1, Sec 2 (a) (European Union), or as defined in the Federal Food Drug & Cosmetic (FD&C) Act, Chapter II, Sec 201 (h) (USA). Because the ActiveTwo is designed as an instrument for research, it offers a flexibility that cannot be offered in a system designed for patient treatment. For example, the hardware configuration and the open-source software *(Most updated version 7.05 06//05/2014)* are highly configurable to adapt the system to various demands of different research applications. This flexibility, however, also allows the user to choose configurations and/or software modifications that lead to corrupted data being measured. This is the mains reason that the system shall not be used for diagnosis or treatment of patients. Moreover, the system is meant to be used only by skilled professionals.

II. Educational resources available to ActiveTwo users

A. This booklet

This booklet was first developed in February of 2006 for use in a training course provided by Cortech Solutions in Wilmington, NC USA. We expect to update it periodically.

B. ActiveTwo User Guide

BioSemi has done an excellent job of documenting the ActiveTwo hardware in the ActiveTwo User Guide. This document is always included with the ActiView software media shipped with new systems, and we maintain a current copy in the downloads section of our website.

C. On-site installation and training

Take advantage of the opportunity to have an experienced technician visit after a new ActiveTwo purchase to help install the system/software and train you and your colleagues in its operation and maintenance. Under certain circumstances, an on-site visit might also be coordinated for a system that has been in the field and/or operating for some period of time. Contact us about this option if you are interested.

D. Web site of Cortech Solutions (US/Canada representative)

Visit www.cortechsolutions.com, especially the *Support* section.

E. Web site of BioSemi (manufacturer of ActiveTwo)

Visit www.biosemi.com, especially the *FAQ* (frequently-asked questions) section.

III. Cautions: What **NOT** to do.

A. Do not attempt to use the system before familiarizing yourself with the documentation.

Most operator errors that result in damage to the system can be avoided by ensuring that operators are properly trained and familiar with the system documentation, especially this section and the sections covering Electrode Handling and Battery Maintenance, before use.

B. Do not connect any AC powered device to the A/D box.

Connecting an AC powered signal source to the A/D box will decrease the signal to noise ratio of other signals measured by the A/D box and it can pose a safety risk. An optional auxiliary Analog Input Box is available for this purpose.

C. Do not allow active electrode tips to come into contact with any other metal.

Contact between dissimilar metals can result in corrosion and reduction in electrode performance (e.g. increased noise).

D. Do not store a fully-depleted battery.

When a battery enters shutdown mode (red Shutdown LED on front panel of battery comes on during system operation and power to system is lost), it is in its most fragile state. It is imperative to place the batter on the charger immediately to prevent further loss of charge that could result in permanent damage to the battery.

E. Do not use soap to clean gel / paste from the electrodes.

Wash electrodes immediately after use with warm water to remove gel / paste residue. Soap can accelerate the loss of Chloride from the electrode pellets, and its use on a routine basis should be avoided.

F. Do not soak electrodes in any liquid for more than 10 minutes at a time.

Prolonged soaking of the electrodes allows liquid to penetrate the ceramic electrode pellet, softening it, and making it more vulnerable to breakage. Soaking the electrodes in liquid for a prolonged period of time also results in corrosion, or loss of electrode material.

G. Do not attempt to plug connectors into system in the wrong orientation.

Attempting to force connectors into the system in the wrong orientation can damage input connectors on the A/D box, necessitating costly and time-consuming repairs. To prevent this, observe the red line on the left side of the electrode cable and make sure that it is on the left side of the AD box when you can see the front panel. Also, make sure that you

can see the serial number on the side of the electrode cable connector and that you can read the text model number label on the top of the electrode connector. Finally, get into the habit of looking at the pins inside the electrode cable connector before plugging the connector in. If there are any bent pins, you will be able to see them easily because the symmetry and linear arrangement of the pins inside the connector ensure that any bent pins pop-out visually.

H. Do not use alligator clips or other metal conductors to connect signal inputs to the active electrodes.

Connecting alligator clips or other metal conductors to the active electrodes will result in corrosion and it will most likely result in permanent damage to the active electrodes. Use the one- and two-bucket methods described in the Troubleshooting section to short inputs or to conduct signals to the system inputs.

IV. Components and accessories of the system

Starting at the participant and working in the logical direction of the host PC.

A. Consumable supplies

1. Electrolytes for use with active electrodes

a) SignaGel (by Parker Laboratories, Inc.)

SignalGel is the recommended electrolyte for most applications. As a polymer, it remains conductive for hours. The product has been designed, manufactured and packaged under the strictest conditions, resulting in consistent quality and safety as well as a long shelf life.

b) Others you might consider using

(1) Redux Paste or Creme (Parker Laboratories, Inc.

(2) Electro-Gel (Electro-Cap International, Inc.)

(3) Ten20 (Weaver and Company)

(4) Elefix (Nihon Kohden America)

c) Electrolytes to avoid

(1) Abralyt (Easy-Cap GmbH)

Contains unnecessary pumice.

(2) QuikGel (Compumedics Ltd)

Accelerates electrode corrosion.

2. Syringe to inject gel into head-cap electrode holders

a) MonoJect syringe with integrated, curved plastic tip

This one-piece plastic syringe/needle is less-threatening to participants with a fear of needles than a standard Luer-Lok syringe with metal blunt needle. Cost per participant is comparable.

b) 10 cc Luer-Lok syringe

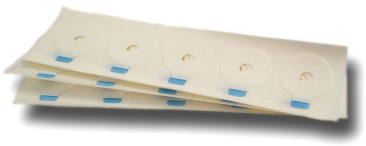
Use with 15 or 16 gauge blunt-tipped needle

3. Double-sided adhesive electrode discs for use with flat-type active electrodes

a) 12 mm od x 4 mm id, 100 ea discs

These small adhesive discs are best used when space is limited, but the small adhesive area means they do not stick as well as the larger 19x4 mm rings.

b) 19 mm od x 4 mm id, 100 ea discs



These discs are best used with the flat-type active electrodes. They have a large surface area for

robust adhesion. The inner diameter is approximately the same size as the electrode contact on the flat-type electrodes. The outer diameter will extend well beyond the outer boundary of the electrode housing, but this provides improved adhesion to the skin.

Avoid using alcohol to prep the skin before use because this will strengthen the bond of the adhesive. Also note that the longer these discs are in contact with the skin, the more robust the bond. With alcohol prep and prolonged contact, it is conceivable that injury could result upon removal.

4. Other consumable items you might find useful

a) Deionized water

Used with table salt for balancing electrodes and for testing / troubleshooting. Tap water will suffice for washing and occasional testing, but deionized water is best for routine electrode balancing. We do not provide deionized water in the accessory kit, so this is something you will need to source locally.

b) NaCl (non-iodized table salt)

Mixed with water for electrode balancing and for testing / troubleshooting. NaCl in solution ensures that there is ample free Chloride in the water so that the ionic charge at each electrode will balance over time. After 3-5 minutes of soaking a set of active electrodes in salt water, offsets should begin to balance and move toward zero. Don't expect the offsets to reach zero. It is most important that the offsets are less than +-40 mV across all electrodes. Any electrodes that do not yield to soaking in salt water may indicate a contaminated electrode pellet. In this case, inspect the electrode contact for discoloration. Contacts should be a dingy gray / brown color, and contamination may be associated with a white or orange powder build-up. In this case, you may find it necessary to use a very fine grain sandpaper or a soft toothbrush to lightly abrade the electrode contact to remove the build-up and then soak again.

If the electrode contacts are shiny Silver, this indicates the Chloride at the tip of the electrode has been stripped by some means. In this case, soaking in salt water will not solve the problem, and you may observe that the shiny Silver electrodes are noisier than others with the normal coloration. This is the expected failure mode for sintered Ag/AgCl electrodes, but if it happens sooner than applications into the life of the electrodes, then it may be the result of improper handling. Most often this happens when electrodes are washed with soap, soaked in water without NaCl on a

regular basis, or when harsh chemicals are used for cleaning or disinfection.

c) Medical tape

Use 3M Micropore paper tap to hold electrodes or leads in place or to bundle leads together. Avoid cloth (Durapore) or transparent (Transpore) tape, as these tapes leave residues on the cables and on clothing. Adhesive residue on cables will attract dirt and eventually will become black and unsightly.

d) Hydrogen peroxide 5% disinfectant solution

A 5% Hydrogen Peroxide disinfectant solution is available from Cortech Solutions.

- EPA-registered for use on soft surfaces.
- Simply spray on and let air dry per label instructions
- Kill bacteria on soft surfaces - like electrodes and head caps - in just 30 seconds
- Speed: The fastest non-bleach disinfecting times available (based on 30-second bacteria and virus contact times for disinfecting on Federal master labels of leading Healthcare wipes as of 10/2011. Use as directed on hard, nonporous surfaces.)
- Excellent product aesthetics: Designed without chemical fumes or odors for patient and staff comfort.
- Efficacy: Fast kill times on 43 microorganisms, including those that cause more than 75% of all HAIs.

We recommend disinfecting any surfaces that come into contact with the participant or the electrode gel, including the head-cap, chin/neck strap, electrodes and the first few inches of the electrode cables after each use. Disinfection should be done AFTER washing and towel or air-drying the equipment so that residual water from washing does not dilute the disinfectant.

Note that we do not recommended Metricide by Metrex for use with ActiveTwo. This product accelerates loss of Chloride from electrodes, drying/cracking of lead-wire insulation and bleaching of electrode/head-cap labels and requires a vent hood, which is rarely available in an electronhysiology lab.

B. Comfortable, flexible head caps for the ActiveTwo system

The ActiveTwo head cap was developed in cooperation with Dr. Peter Praamstra at the Behavioral Brain Sciences Center, University of Birmingham, United Kingdom. The head cap consists of an elastic cap with plastic electrode holders. The cap itself does not contain electrodes - only plastic electrode holders that receive the pin-type active electrodes. The caps have ear-slits for easy access to the ears. Head-caps are provided with an elastic / velcro chin strap for fixing the cap in place, but body harnesses with criss-cross chest straps are also available. The fabric template of the standard caps is suitable for positioning electrodes at traditional 10/20 positions.

1. Sizes and layouts

Caps are available in a wide range of sizes and with a variety of electrode position layouts. The age/gender norms and maximum number of electrode sites for various sizes of caps are outlined below.

Size	**Color**	**Head Circ.**	**Max # Sites**	**Std. Layout**	**Males**	**Females**
Infa 6	Red	22-26 cm	32	10/20	premature infants	premature infants
Infa 5	Blue	26-30 cm	32	10/20	premature infants	premature infants
Infa 4	Yellow	30-34 cm	32	10/20	premature infants	premature infants
Infa 3	Brown	34-38 cm	64	10/20	0-1 mo.	0-1.5 mo.
Infa 2/3	Pink/Brown	36-40 cm	64	10/20	0-2 mo.	.5-3 mo.
Infa 2	Pink	38-42 cm	64	10/20	1-3.5 mo.	1.5-5.5 mo.
Infa 1/2	Lt. Blue/Pink	40-44 cm	64	10/20	2-6.5 mo.	3-9 mo.
Infa 1	Light Blue	42-46 cm	64	10/20	3.5-10.5 mo.	5.5-15.5 mo.
X-small/ Infa 1	Green/Lt. Blue	44-48 cm	64	10/20	6.5-19 mo.	9-28 mo.
X-small	Green	46-50 cm	128	10/20 or ABC	10.5->36 mo.	15.5->36 mo.
Small/X-small	Yellow/ green	48-52 cm	128	10/20 or ABC	19->36 mo.	28->36 mo.
Small	Yellow	50-54 cm	256	10/20 or ABC	toddlers/ children	toddlers/ children

Medium/ Small	Red/Yellow	52-56 cm	256	10/20 or ABC	children/ teens/YA	children /teens/YA
Medium	Red	54-58 cm	256	10/20 or ABC	teens/adults	teens/adults
Lage/me dium	blue/red	56-60 cm	256	10/20 or ABC	teens/adults	teens/adults
Large	Blue	58-62 cm	256	10/20 or ABC	large teens/adults	large teens/adults
X-large	Brown	62-66 cm	256	10/20 or ABC	very large adults	very large adults

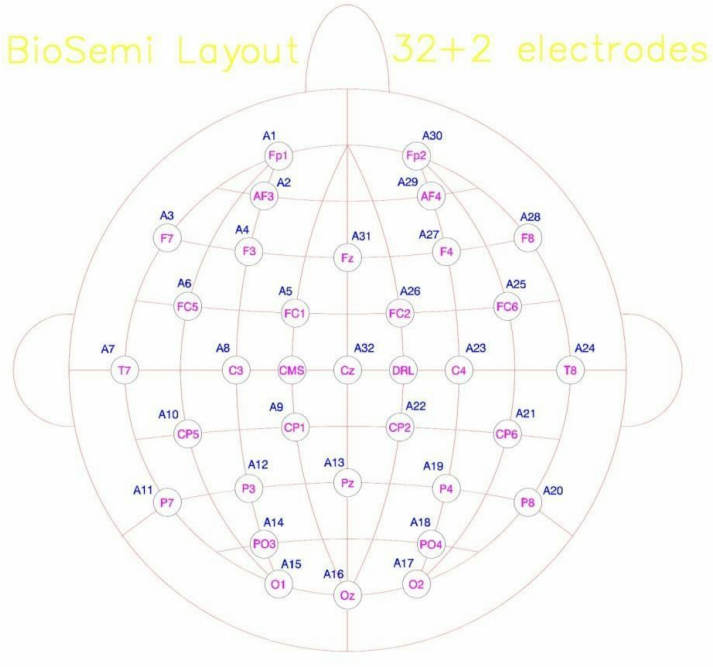
Standard cap layouts for 16, 32 and 64 channels are based on the International 10/20 System.

Layouts for 128 channel caps are available in an expanded 1020 system based on Oostenveld and Praamstra, The five percent electrode system for high-resolution EEG and ERP measurements. Clinical Neurophysiology 112 (2001) 713-719 (see black circles and open circles, excluding dots, depicted in figure 2 on p 4).

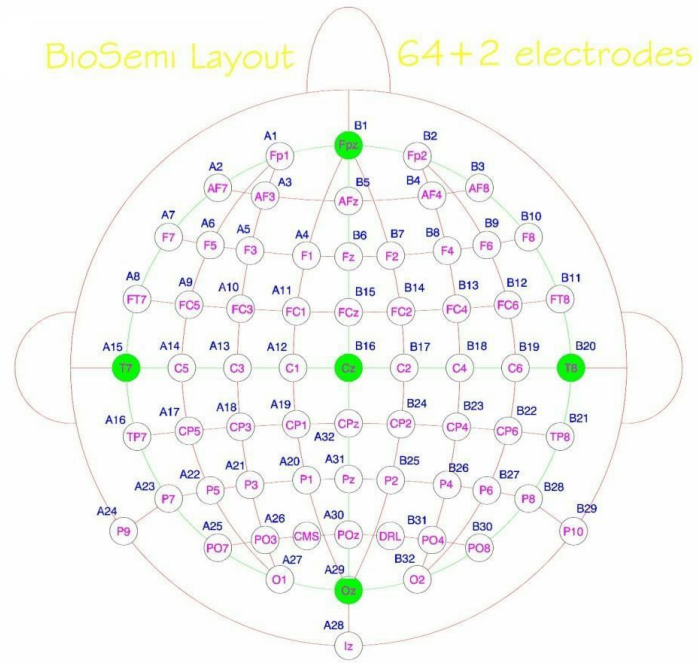
Caps with 128 channels are also available in layouts formulated similarly to the 160 and 256 channel caps, with electrode positions that are radially equidistant from CZ. The electrode position coordinates of standard ActiveTwo head caps are available from the Downloads page at www.cortechsolutions.com.

The images below provide a top view of the 32, 64, 128, 160 and 256 channel standard head cap layouts.

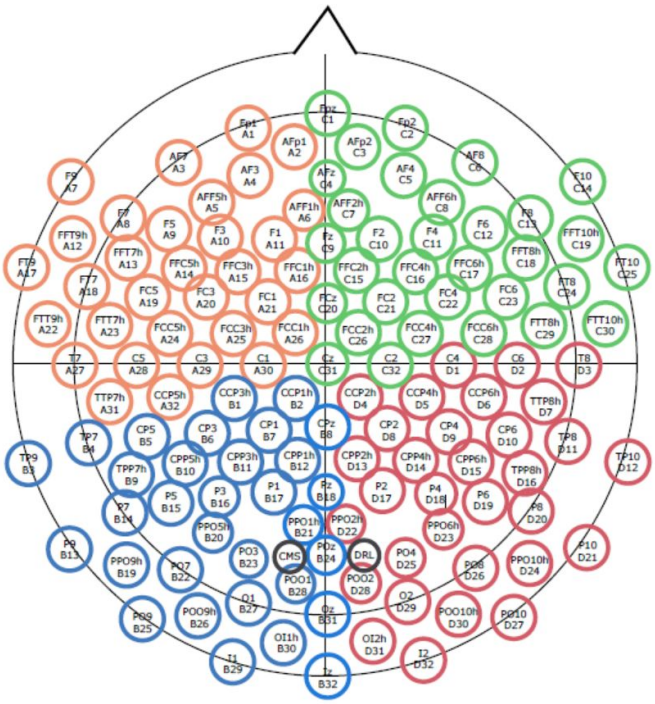
a) 32 channel layout



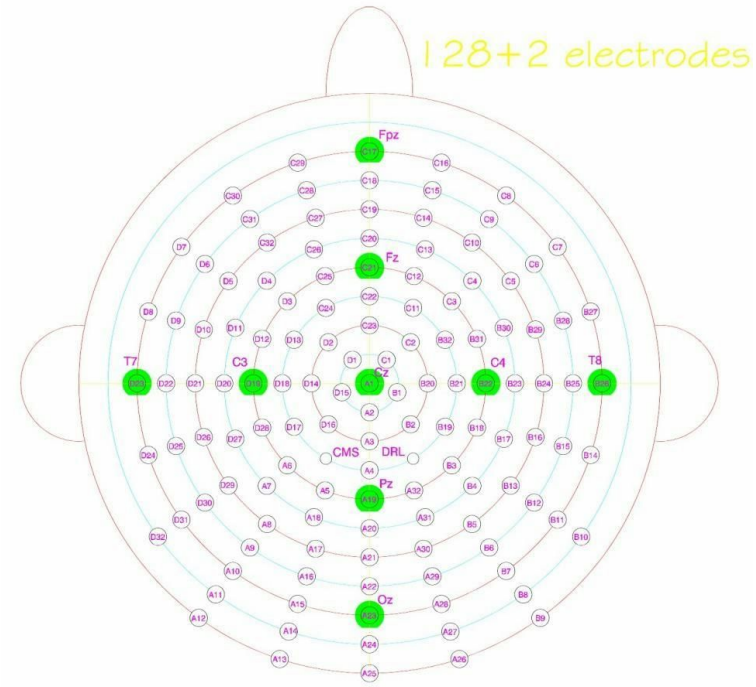
b) 64 channel layout



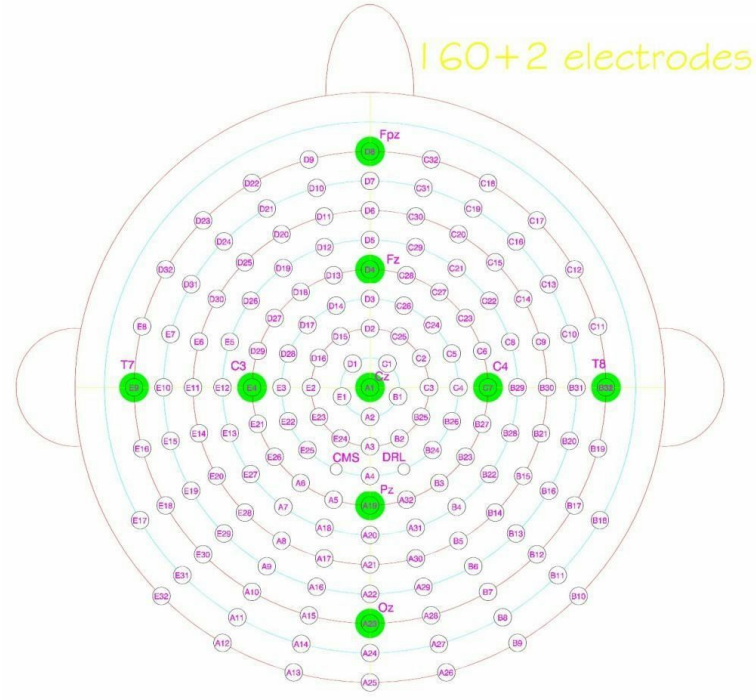
c) 128 channel layout - expanded 1020



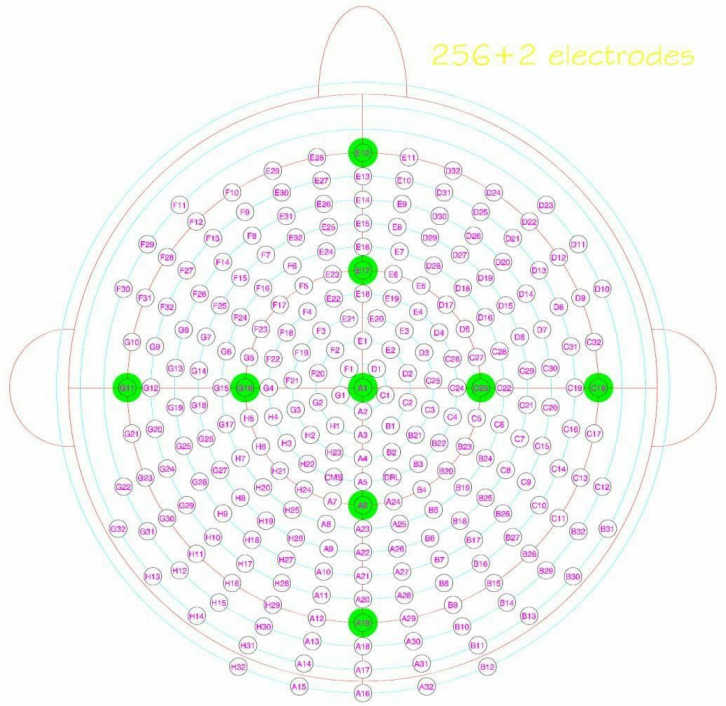
d) 128 channel layout - equiradial



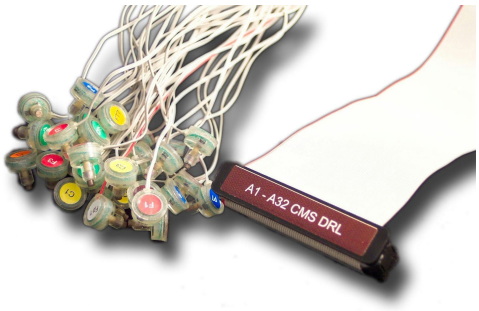
e) 160 channel layout - equiradial



f) 256 channel layout - equiradial



C. Active electrodes



1. Pin-type electrodes on ribbon cable

a) Typical application: EEG

These electrodes are designed to be used with the ActiveTwo electrode holders, especially with a head cap, for measuring EEG. Standard electrode sets contain 32 active electrodes, and are labeled according to either the standard 10-20/10-5 positions or alphanumeric A1-32, B1-32 …H1-32.

b) Custom applications: ECG, EMG, etc.

It is possible to mount the plastic electrode holders in a different fabric garment to permit measurement of other signals. For example, a tight-fitting shirt with electrode holders and pin-type active electrodes could be used to measure ECG from an array of electrodes on the torso. Other garments could be designed for positioning electrode holders over muscles of interest for measurement of surface EMG.

c) Latest design improvements

The latest iteration of the pin-type active electrode design includes:

(1) Sintered Ag/AgCl pellet material improved

A new, harder electrode pellet resists moisture and stands up to abuse better. Epoxy joint at cable entry to prevent separation.

(2) Strain relief on top of connector to further resist separation at cable entry

(3) Improved protection against electrostatic discharge

(4) Label (e.g. A1-32) positioned on top of connector

(5) Serial number on side of D connector

The serial number aids our record keeping and tracking of manufacturing issues according to manufacture date/batch. Please do not remove it.

2. Flat-type electrodes with individual leads/connectors

a) Standard applications: EOG, ECG, EMG and EEG reference

The flat-type active electrodes were designed specifically for use on bare skin for measuring EOG, ECG, EMG or EEG at mastoids, earlobes, nose, nape of the neck, etc. In these applications, you should use the double-sided adhesive electrode rings to adhere the electrodes to the skin. Peel the adhesive electrode ring off of its paper backing, apply the ring to the plastic electrode housing taking care to position the opening in the ring around the electrode pellet (note that the pellet is closer to the electrode ring than you might expect, and it is not directly opposite the electrode label). After sticking the ring to the electrode and before removing the protective paper cover, apply a small amount of conductive electrolyte gel to the electrode pellet. Then, remove the paper backing from the adhesive ring. Following this procedure should help remove any excess gel that might otherwise prevent the adhesive from sticking to the skin. Some cleaning of the skin with an alcohol prep pad may be required in case of excessive makeup, sweat or dry skin.

b) Other applications: EEG

To record EEG from the scalp, you can use the flat-type active electrodes with an adhesive electrode paste such as Ten20 paste or Elefix. Alternatively, you can use collodion (glue) to apply the electrodes to a participant's scalp for sleep studies or other long-term monitoring applications, but it is important to use only non-acetone remover. Take care to use the same electrolyte paste for the CMS/DRL, EEG/ECG/EMG measurement and reference electrodes.

c) Latest design improvement

Flat-type active electrodes now have a stronger wire to address problems with leads breaking at the junction with the active electrode. This new wire can be distinguished from the old wire by the fact that the new wire has a light gray color and no printing on the insulation jacket, whereas the old wire had a dark gray color and printing on the jacket.

D. A/D box

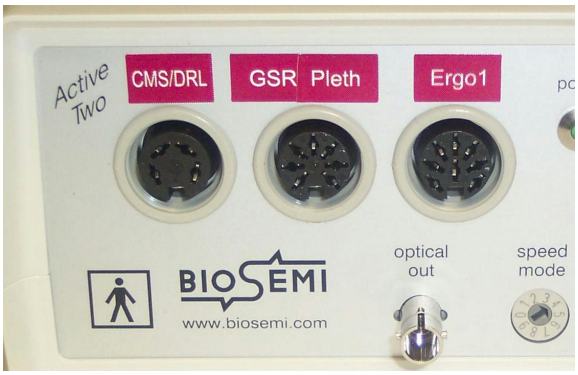
1. ActiveTwo User Manual

See the latest version of the ActiveTwo User Manual for detailed specifications and

operating instructions for the A/D box.

2. New features of the Mark II A/D box

The new Mark II (MK2) A/D box has the capacity for 280 channels total. The Mark II design also includes the capability to be daisy chained with other A/D boxes in a master-slave relationship (slave boxes must have *Optical In* port on front panel which is added as an extra cost option). In certain circumstances (e.g. daisy chaining), the Mark II boxes can provide greater numbers of channels at bandwidth settings previously supported. To determine whether your A/D box is model Mk1 or Mk2, see the 'About ActiView' tab-page in the ActiView software. The model will be identified in this tab after the software has communicated with the system (press Start or Start File) at least once after opening the ActiView application.



3. Front panel

a) Aux connectors

(1) Left-most (Aux1) now carries CMS/DRL (common)

(2) Aux 2 and Aux 3 typically carry 1 – 2 non-biopotential sensor signals

Note that if the labels above these connectors are Aux 2 and Aux 3 and not not a red and white label indicating a particular type of sensor electronics is installed, then these connectors are blank placeholders (no electronics are installed).

(a) Sensor options (see *Optional Non-EEG Sensors* below for more details)

(i) Skin conductance

(ii) Respiration

(iii) Temperature

(iv) Pulse / plethysmograph

(v) Microphone

(vi) Photocell

(vii) Other sensor options

(a) *Accelerometer*

(b) *Load cell*

(c) *Custom*

(b) Safety and signal-quality precaution

Aux inputs are on the patient-connected side of the device, so avoid connecting AC-powered signal sources to these inputs. Doing so could result in an unsafe situation and/or reduction of signal quality on other channels.

b) LED indicators

(1) Power (green)

On (lit) indicates power is reaching the A/D box from the battery. Off may indicate the battery is in shutdown state (fully depleted), the cable is damaged or the fuse on the battery is blown.

(2) CM in range (blue)

On (lit) indicates CMS/DRL electrodes are adequately connected to subject and no fault conditions (over/under-current) are detected. Off indicates EITHER that the CMS/DRL electrodes are not properly connected and gelled OR that there is some other electrode cable fault. Any single broken wire or bent pin on an electrode connector can cause a minor fault that causes the CM in range LED to go off. See the troubleshooting section for instructions on how to identify which electrode or electrodes may be involved.

(3) Low-battery (red)

On indicates low-battery state, activated when 20% of battery capacity is reached. Off indicates EITHER that the battery has more than 20% charge remaining OR that the battery is off or disconnected from the AD box.

c) Speed-mode dial

This dial sets the overall sample-rate and bandwidth of system. The final sample-rate to file is a function of both the speed-mode and the decimation-ratio set in the ActiView software. See the ActiveTwo User Guide for more details on setting the speed mode.

Before setting the speed mode, first determine whether your A/D box is model Mk1 or Mk2, see the 'About ActiView' tab-page in the ActiView software. The model will be identified in this tab after the software has communicated with the system (press Start or Start File) at least once after opening the ActiView application. The rotary switch can be used to select 8 different speedmodes for the A/D box (speed-mode 9 is reserved for use as Analog Input Box). Use a small screwdriver to rotate the switch to the preferred number according to the table below. After changing the speed-mode, switch the A/D box off and on again to reset the ADCs. Changing the speed-mode while having the power connected is not harmful to the electronic circuitry, but the synchronization between channels may be lost.

The firmware of MkII AD boxes can be upgraded to support 'high speed' speedmodes (10-13). Note: within 'normal' firmware, speedmode positions 0,1,2,3 are used for Daisy chaining; with the 'high-speed' firmware, speedmode positions 0,1,2,3 are for the high-speed speedmodes.

A/D box model MK1

A/D Box Switch	Sample rate	Pin channels	EX channels	Sensor channels
0	2048 (2kHz)	256	0	0
1	4096 (4 kHz)	128	0	0
2	8192 (8 kHz)	64	0	0
3	16384 (16 kHz)	32	0	0
4	2048 (2 kHz)	232	8	7
5	4096 (4 kHz)	104	8	7

6	8192 (8 kHz)	40	8	7
7	16384 (16 kHz)	8	8	7
8 (AIB mode: couple with AD box speedmode 4)	2048 (2kHz)	AIB mode	AIB mode	AIB mode
9	Reserved	Reserved	Reserved	Reserved

A/D Box Model MK2

A/D Box Switch	Sample Rate	Pin channels	EX channels	Sensor channels
0 *	2048 (2 kHz)	128	8	7
1 *	2048 (2 kHz)	128	8	7
2 *	2048 (2 kHz)	128	8	7
3 *	2048 (2 kHz)	128	8	7
4	2048 (2kHz)	256	8	7
5	4096 (4 kHz)	128	8	7
6	8192 (8 kHz)	64	8	7
7	16384 (16 kHz)	32	8	7
8 (AIB mode: couple with AD box speedmode 4)	2048 (2 kHz)	32	8	7
9 (ABR mode)	16384 (16 kHz)	5		

*In speed mode 0-3, the A/D boxes work as up to 4 optical fiber ‘daisy chained’ boxes, each with a maximum of 128+8 channels + sensors @ 2 kHz, speedmode switch=box number. Daisy chain possibilities are not standard included in the base system price.

A/D Box Model MK2HS 'High Speed'(no AIB mode, no Daisy-chain, not compatible with MK1 or MK2)

A/D Box Swich	Actiview display mode	Sample Rate	Pin channels	EX channels	Sensor channels
0	10	4096 (4kHz)	256	8	7
1	11	8192 (8kHz)	128	8	7
2	12	8192 (8kHz)	256	8	7
3	13	16384 (16kHz)	128	8	7

Note: When an auxiliary analog input box (AIB) is connected, the A/D box should always be on SpeedMode 4.

The acquisition software adjusts automatically to the selected speed-mode (check the indicator in the "about ActiView" tab page). You should close and restart the ActiView software after changing the A/D box speedmode, to prevent selectors from remaining disabled in the new speed-mode.

d) DC input (battery connector)

Note that the cable is attached to the battery, rather than the A/D box or AC charger supply. The A/D box is not intended to be operated from AC power.

e) Optical output

Fiber optic signal cable from A/D box to optical receiver

f) Optical input – optional

Mark II A/D boxes optionally can have two (2) fiber-optic connectors on the front panel, one input and one output. The input is active only when operating the system in slave mode as part of a daisy-chain of multiple A/D boxes (speed modes 1-3).

4. Top panel

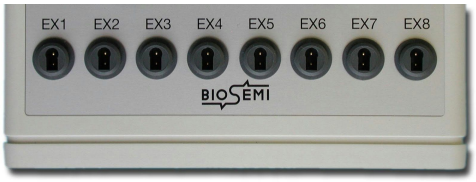
a) 68-pin D connectors labeled A1-32 to H1-32

(1) Each connector carries 32 monopolar signals from a single ribbon cable

(2) A1-32 represents inputs 1-32, B1-32 inputs 33-64, and so on

(3) Standard configuration expects active electrodes; not suitable for passive electrodes (custom configuration possible)

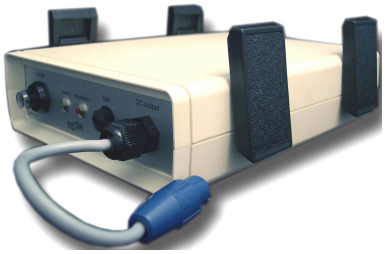
b) Key-shaped two-contact connectors labeled EX1-EX8



(1) Each connector carries one monopolar signal

(2) Standard configuration expects active electrodes; not suitable for passive electrodes (active adapter for passive electrodes available)

E. Battery unit



1. Overview

a) Two standard batteries supplied with each base system

b) Standard battery is high-capacity, rechargeable, lead-acid type with no memory effect

c) Standard battery capacity: approximately 15 hours with 72 channels, 10 hours with 136 channels and 5 hours with 280 channels

d) Useful life defined as over 1000 charge/recharge cycles

e) Fully-depleted standard battery with full capacity will take approximately 3.5 hours to charge

f) Reduced charge time reflects diminished capacity

2. Advice and cautions

a) Use only supplied charger

b) It is not possible to overcharge the standard charger. A battery can be left on the charger indefinitely as long as the charger remains energized. If the charger is not powered but it is connected to the battery, it is an open circuit and it will drain the battery relatively quickly and eventually ruin it.

c) If capacity is significantly diminished (charge time less than 3 hours), cycle battery fully 3-5 times by charging/discharging/charging until capacity (charge time) increases to normal.

d) Never store a fully-depleted battery; store only fully charged

e) Battery will maintain a charge for 4-6 weeks while stored at normal operating temperature. Recharge stored batteries frequently to avoid deep discharge.

f) If power at source is lost while battery is connected to charger, the charger forms a partially open circuit that will slowly drain the battery. Leaving a battery in this situation too long can cause permanent damage. If you doubt the reliability of your power source, disconnect charged batteries from the charger as soon as the greed LED comes on.

g) Connect battery to charger after using approximately 75% of capacity.

h) See meter in ActiView for current battery state or place on charger when Low Battery LED comes on.

i) When to recharge

Once a battery reaches 20% remaining usable charge (low battery state), it should be recharged.

j) Battery meter

See meter in ActiView for current battery state or place on charger when Low Battery LED comes on.

F. Battery charger and AC adapter

Sophisticated charging unit with intelligence to maintain optimal battery performance and maximize useful life coupled with a unique 9V, 3A AC/DC converter.

MK1 charger

MK2 charger

1. Mk2 Charger Front Panel

a) Green LED: ready

Indicates power or charged. If no battery is connected=power, if battery is connected=fully charged

b) Yellow LED: charge

Continuously on indicates normal charging; blinking is the recovery charge mode.

c) Red LED: error

Continuously on = battery short circuit
2 blink = charger overheated, charging aborted
3 blink = charger timeout charging aborted; replace battery
5 blink = battery does not accept charge (too high internal resistance), replace battery

2. Mk1 Charger Front Panel

a) Red "Charging" LED

On indicates battery charge is 0-90%, so full charge is being delivered. Labeled "Full-Charge" on older models.

b) Yellow "90% Charged" LED

On indicates battery charge is 90% or greater. Labeled "Trickle Charge" on older models.

c) Green "Full" LED

On indicates battery is fully-charged. Labeled "Ready" on older models.

d) Charge output connector

Socket for connecting cable from battery unit. Note that the charger has no cable and cannot be connected to the battery while the battery is connected to the A/D box during operation.

3. Charger rear panel (Mk1 & Mk2)

a) DC power input connector

Connect power from AC/DC converter

b) Fuse

Replaceable 5 AMP slow-blow fuse

4. Connections (Mk1 & Mk2)

a) Connect AC adapter to charger

b) Plug AC adapter into AC socket

c) Connect battery unit to charger

G. Fiber-optic cable

1. Advantages

a) Perfect electrical isolation

Eliminates current leakage problems between host computer and patient-connected device, yielding better signal quality and ensuring safer operation.

b) Eliminates interference pickup

Fiber cable between front-end and host PC can run next to other power and signal cables without picking-up interference.

c) Longer cable runs

Cable runs up to 50 meters are possible without signal loss. Standard cables are 3 meters in length.

2. Description

a) Unidirectional fiber-optic communication lead from optical output connector on front panel of A/D box to optical receiver / USB 2.0 interface

b) Standard multimode (62.5/125), simplex, ST-ST cable

3. Cautions

Note that this cable is made of glass fiber and is somewhat delicate, although it is not very expensive to replace in case of a problem. Take care to:

a) Avoid running-over the cable with rolling chair wheels

b) Avoid closing the cable in doors

c) Avoid setting heavy objects on the cable

d) Avoid positioning connections so that ends of cable are subject to shear stress

H. Optical receiver / USB 2.0 interface

Receives digital data via unidirectional fiber-optic cable from the A/D box

1. Advantages

a) Portability

Makes ActiveTwo completely portable when used with a notebook computer

b) Flexibility

Programmable logic allows easy changing of number of channels and sample rate

c) Electrical isolation

Trigger inputs remain galvanically isolated from A/D box, electrodes and patient

d) No unwieldy AC supply required

Easy power supply from PC via USB 2.0 port

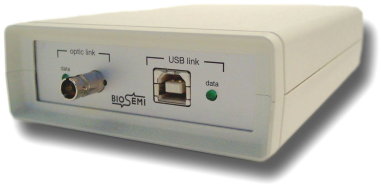
e) Simplifies troubleshooting

LED indicators for data input and output

f) Easy installation

When performed properly, installation of he driver takes only a few minutes

2. Front-panel (optical receiver / USB interface)



a) Fiber-optic input connector

b) Data input LED (left of fiber-optic connector)

On indicates power is being received from host PC via USB interface and data are being received from A/D box.

c) USB 2.0 output connector

d) Data output LED (right of USB connector)

On indicates that data are being requested by application via driver on host PC. This LED will not come on unless data are being requested by host for display or storage.

3. Rear panel (optical receiver / USB interface)

The rear panel contains the system's 37-pin digital I/O connector

a) 16-bit trigger input port

Pins 1-16 of this port represent bits 0-15 of the 16-bit trigger input port.

b) Digital output port

Pins 17-31 of this port represent bits 0-14 of the digital output port (accessible to developers and for custom applications only – not presently utilized by the standard ActiView software).

c) System clock signal output

The system's clock signal is carried out to pin 32 of the 37-pin digital I/O connector.

d) Ground on pin 37

Pin 37 carries the system ground. Connect to ground of trigger port of stimulus computer or ground of other devices connected to trigger port. Use caution when considering connecting this ground to a device that the subject will come in contact with (e.g. a button box), as this can compromise system safety and reduce signal-to-noise ratio of physiological measurements.

I. Optional non-EEG sensors

A variety of sensors other than the active electrodes are available for use with ActiveTwo. In general, a "sensor" consists of a transducer with some specialized electronics and one or two dedicated amplifier/converter channels installed in the A/D box. Sensor inputs are on the middle and right-most circular DIN connector on the front panel of the A/D box. If there are any sensors installed in the A/D box, labels above the circular connectors on the front panel of the A/D box will indicate what type of sensor electronics are installed at the connectors. If labels above the connectors read "Aux2" and/or "Aux3", no sensor electronics are installed on the associated connector.

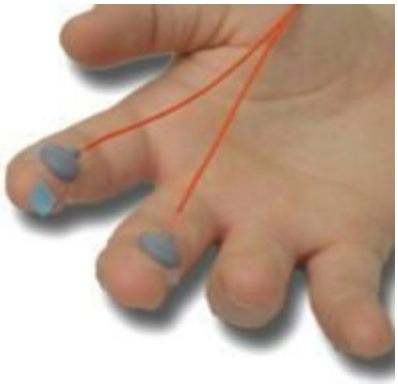
1. Respiration

A Sleepsense respiration belt is provided with a cable wired for use with one of the three available circular DIN connectors on the ActiveTwo front panel. Strong reliable signals are produced, because the respiration belt uses the ActiveTwo system's power supply. An additional LabVIEW module is delivered with the system when a respiration belt is ordered. Note: if an older version (ADC 16 or

less) is being used, it is necessary to upgrade the motherboard to the newer version to support this new model respiration belt. Older Nihon Kohden respiration belts are no longer supported and must be replaced with the new type.

SleepSense 1387-kit for ActiveTwo

2. Skin conductance (SC)



With this ActiveTwo accessory, the conductance of the skin can be measured. The SC option consists of two passive electrodes to induce an oscillatory signal exactly synchronized with the system's sample-rate. The skin conductance option is wired to one of three available circular DIN connectors on the ActiveTwo front panel. Because the skin conductance accessory uses "lock-in detection", the stimulus-current can be as low as 1uA. The low-current and synchronized oscillator ensure that the biopotential measurements (EEG, EMG or ECG) are not corrupted by the skin conductance oscillator signal.

In models produced before mid-2005, these couplers were configured to measure skin resistance or galvanic skin response (GSR). ActiView software version 5.35 or later automatically identifies whether the ActiveTwo system has a 16 Hz or 512 Hz coupler . To check which model you have, setup the ActiveTwo system and start the ActiView software to view incoming data for a few seconds. Then, select the "Auxiliary Sensors" tab, and check the "GSR units" indicator in the left sidebar:

- “unit = Ohm” means a 512 Hz GSR coupler is installed (see section a below)
- “unit = nanoSiemens” means a 16 Hz skin conductance coupler is installed (see section b below)

The version of coupler installed can also be checked by identifying the "physical dimension" of the “GSR” channel in the header of the BDF file (field 13 of the header, see http://www.biosemi.com/faq/file_format.htm).

The GSR signal itself is the result of processing in ActiView, and only reflects (slow) impedance/conductance variations. The original excitation frequency is not present in the signal. In other words: FTT or any other analysis of the GSR signal stored in the BDF file will not reveal the underlying 16 or 512 Hz excitation signals.

The GSR signals to file are not filtered (bandwidth is the anti-aliasing filter frequency as displayed in the right sidebar). However, the frequency of the excitation frequency imposes a limit in the maximal frequency of the variations in impedance/conductance that can be measured. With the 16 Hz GSR, a full wave of the excitation signal is necessary to calculate a conductance value. This means that a new GSR value can only appear every half-wave, or every 31.25 ms. At a 2048 Hz sample rate, the BDF file will contain 64 identical samples for each single GSR value). In other words, the effective sample rate of the GSR is 32 Hz, and consequently GSR variations faster than 16 Hz are ignored (Nyquist theorem). Incidentally, this is the reason for the choice of 16 Hz as the best compromise between the previous 512 Hz value and the typically used 10 Hz value. A lower frequency makes the response to GSR changes too slow, and a higher value results in responses that involve both resistive and capacitive components rather than the more pure measure of skin resistance/conductance.

See the appropriate heading below for further information about the type of unit you are using.

a) 512 Hz GSR coupler

The 512 GSR circuit in ActiveTwo uses 1 Amp constant current, 512 Hz square wave signal that is synchronized with the ActiveTwo system’s sample rate. Although these are different from the parameters often used in GSR measurement, this design is intended to make the GSR coupler optimally compatible with the apparatus for EEG measurement. Typical GSR AC excitation frequencies overlap with the frequency range recorded in EEG, thus making it difficult to measure EEG at the same time without corrupting the signal. DC excitation can affect the EEG baseline, producing electrode offsets that make it similarly difficult to measure EEG simultaneously.

The LSB value (resolution) is 1 . With the 24-bit ADC, the GSR signal has an input range of 0 to +262 k. Because ActiveTwo uses a higher excitation frequency than most stand-alone devices, it measures smaller absolute skin resistance values. Also, the response on subject's arousal is an INCREASE

in skin resistance, instead of the DECREASE of skin resistance seen with DC and low frequency (up to approx. 10 Hz) excitation. However, the response is very reliable: we measure a typical resting skin resistance of approx. 5 k, with responses of (+) 50-100 , and a quick return to the baseline value after when the subject relaxes again.

Since many analysis programs do not have a mechanism to handle units other than uV, it is useful to know that GSR data points are scaled such that when the GSR units are displayed in V, 1 V is equal to 1 . To convert to Siemens, take the reciprocal of the value (S = 1 / R). Note that you cannot simply take the reciprocal of a resistance CHANGE, because S2-S1 is not equal to 1/(R2-R1). So, every point should be converted from to Siemens separately, before calculating changes in Siemens.

ActiveTwo's GSR measurement works with a DC coupled amp (same as for the EEG channels), so there is no high-pass time constant to worry about. Any high-pass filtering would be performed in software off-line. A low-pass filter of 3-10 Hz is usually applied off-line to reduce interference. ActiView displays the GSR with a 3 Hz low-pass, but the data to file are full bandwidth (no filters are applied).

Note that the GSR sensor only works in speed modes that allow recording of sensor channels (i.e. 4, 5, 6, 7 and 8). Remember that if you change the speed mode, you will need to turn off the power at the battery unit and turn it on again to let the internal firmware adjust itself to the new speed mode.

Also, your ActiView CFG file must enable the use of sensors. Since most systems are sold without GSR measurement capability, the default configuration files that come with new versions of software contain a code that disables the sensors *(Most updated version 7.05 06/05/2014)*. To edit the CFG file, open it in Windows Notepad, and go to the section entitled [FreeChoice]. Look for the code:

AuxFree=0%

If you find this, change it to:

AuxFree=1%

Remember that, if you do not explicitly select a CFG file, the DEFAULT.CFG file in the same directory as the .EXE is used. Once you open the ActiView program and the CFG file you want to use is active, click over to the sensors page to be sure that the GSR sensor is selected for

display. When you click Start File, be sure to enable saving of sensor signals by selecting the option to “Save displayed sensors”.

Note that the CMS and DRL electrodes must be attached to the subject and connected to the system, and the blue “CM in range” light must be on for GSR measurement to work properly. Also, the green "GSR in range" lights should be on when GSR electrodes make adequately low impedance contacts with the subject. Note that the green GSR lights always remain off if the blue CM light is off. GSR can only be measured with the blue CM light and the green GSR lights glowing.

Finally, if the GSR signal looks flat after you have made all of the other settings, it may be that you need to increase the scale of the GSR signal on the display. There is a scale tool at the left side of the Sensors display page.

b) 16 Hz SC coupler

The 16 Hz SC circuit in ActiveTwo uses 1 A constant current, 16 Hz square wave signal that is synchronized with the ActiveTwo system’s sample rate. The 16 Hz design is intended to make the SC coupler consistent with traditional SC methodology. Although the 16 Hz excitation frequency might be expected to interfere with simultaneous EEG measurements in ActiveTwo, testing has confirmed that there is minimal influence from the 16 Hz excitation frequency on the EEG signal.

The LSB value (resolution) with the 16 Hz SC frequency is 1 nanoSiemens. With the 24-bit ADC, The SC signal has an input range of 574 nanoSiemens (1.7 MOhm) to 262,000 nanoSiemens (3.8 kOhm). With the 16 Hz SC coupler in ActiveTwo, the response on subject's arousal is an INCREASE in skin conductance (DECREASE in skin resistance), instead of the INCREASE of skin resistance seen with the 512 Hz GSR.

Since many analysis programs do not have a mechanism to handle units other than uV, it is useful to know that SC data points are scaled such that when SC units are displayed in uV, 1 uV is equal to 1 nanoSiemens. To convert to Ohms, take the reciprocal of the Siemens value (R = 1 / S). For example: 10,000 nanoSiemens is 100 kOhm. Note that you cannot simply take the reciprocal of a conductance CHANGE, because R2-R1 is not equal to 1/(S2-S1). So, every point should be converted from Siemens to separately, before calculating changes in .

ActiveTwo’s SC measurement works with a DC coupled amp (same as for the EEG channels), so there is no high-pass time constant to worry about. Any high-pass filtering would be performed in software off-line. A

low-pass filter of 3-10 Hz is usually applied off-line to reduce interference. ActiView displays the SC signal with a 3 Hz low-pass, but the data to file are full bandwidth (no filters are applied) .

Note that the SC sensor only works in speed modes that allow recording of sensor channels (i.e. 4, 5, 6, 7 and 8). Remember that if you change the speed mode, you will need to turn off the power at the battery unit and turn it on again to let the internal firmware adjust itself to the new speed mode.

Also, your ActiView CFG file must enable the use of sensors. Since most systems are sold without SC measurement capability, the default configuration files that come with new versions of software contain a code that disables the sensors. To edit the CFG file, open it in Windows Notepad, and go to the section entitled [FreeChoice]. Look for the code:

AuxFree=0%

If you find this, change it to:

AuxFree=1%

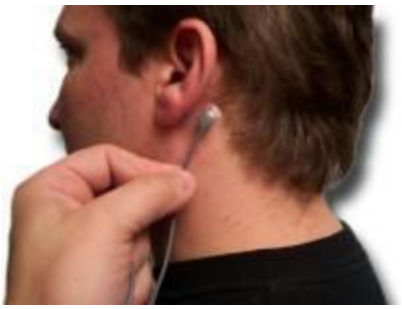
Also, since the change from the 512 Hz GSR to 16 Hz SC, the default channel labels for the SC couplers (two couplers per A/D box are possible) in the ActiView software CFG files have not been modified from GSR1 and GSR2 to SC1 and SC2. You may wish to make this change in your CFG files for clarity. Look for the entries “Aux1=GSR1” and “Aux2=GSR2” and change the labels to the right of the = sign to “SC1” and “SC2” or “SCR1” and “SCR2”.

Remember that if you do not explicitly select a CFG file the DEFAULT.CFG file in the same directory as the .EXE is used. Once you open the ActiView program and the CFG file you want to use is active, click over to the sensors page to be sure that the SC1 and/or SC2 sensors are selected for display. When you click Start File, be sure to enable saving of sensor signals by selecting the option to “Save displayed sensors”.

Note that the CMS and DRL electrodes must be attached to the subject and connected to the system, and the blue “CM in range” light must be on for GSR measurement to work properly. Also, the green "GSR in range" lights should be on when GSR electrodes make adequately low impedance contacts with the subject. Note that the green GSR lights always remain off if the blue CM light is off. GSR can only be measured with the blue CM light and the green GSR lights glowing.

Finally, if the GSR signal looks flat after you have made all of the other settings, it may be that you need to increase the scale of the GSR signal on the display. There is a scale tool at the left side of the Sensors display page.

3. Temperature



With this high precision temperature sensor from HP (Agilent 21078A), skin temperatures can be measured. The temperature sensor directly plugs into one of the three available circular DIN connectors on the front panel of the ActiveTwo A/D Interface Box. An additional LabVIEW module is delivered with the system when a temperature sensor is ordered.

4. Pulse / plethysmograph

This Plethysmograph sensor from ADI instruments (MLT1020) uses an infrared photoelectric sensor to detect changes in tissue blood volume. The Plethysmograph sensor directly plugs into the front of the ActiveTwo. An additional LabVIEW module is delivered with the system when a Plethysmograph sensor is ordered. This sensor can be ordered with a finger clip (/F option), with a Velcro strap (/p option) or with an ear clip (see picture, /E option).

5. Jazz vigilance monitor

The Jazz vigilance monitor system was developed by a Polish academic research group, led by Prof. Ober. A special 'synchronic' version is offered for interfacing directly with the ActiveTwo. The synchronic Jazz system consists of 3 building blocks: 1) the head mounted eye monitor, 2) transmitter with twin fiber-optic connection (data out, sync in), and 3) receiver with twin fiber-optic connection and RS232 output. Note that there is no head position/orientation monitoring capability, so Jazz cannot be used to derive 'point-of-regard' from eye-position, as would typically be possible with an eye-tracking system, unless the subject's head is immobilized. The sample-rate of Jazz is synchronized with the ActiveTwo sample rate via a sync connection between ActiveTwo receiver and Jazz receiver. The Jazz data interfaces to the ActiveTwo host PC via the RS-232 port. The ActiView acquisition software combines the ActiveTwo data (via USB2 port) and Jazz data (via RS-232 port).

6. Active strain gage

BioSemi can equip your force transducer with a miniature (15x30mm) precision strain gage amplifier. This makes your strain gage active. The output signal is processed by the ActiveTwo A/D box just like any other active sensor. The advantages are that all influences of the connection cable are completely eliminated, there is no cable interference and there is no temperature drift. The Active strain gage contains a low-noise, low-power, zero-drift, chopper-stabilized differential amplifier. The power supply is from the ActiveTwo A/D box (16mA total bridge current). The modification to the Active strain gage can be performed for quarter, half and full bridge strain gage configurations. The supplied LabVIEW module automatically zeros the bridge and amplifier offset on startup. No further hardware trimming is necessary. The photo shows a precision force measurement for finger pressure, the amplifier is sealed in resin on the left side of the ergometer. Note that this sensor type needs an Ergo input (2 channels configured for differential measurement).

7. Microphone

A microphone can be used to record audio stimuli and responses. A highly effective built-in spherical filter minimizes wind and breath 'pop' noise. Note that this sensor type needs an Ergo input (2 channels configured for differential measurement).

8. Dual response switch

Response switches for direct connection to the AUX (front) connectors on the A/D box. The setup with the response switches connected directly to the A/D box ensures accurate timing of the response moments (pulse is mixed directly with the incoming EEG signals) as well as optimal isolation of the subject (no grounded equipment near the subject). Using the USB trigger port with a response box also provides good timing, but has the disadvantage of bringing the safety grounds near the subject. The BioSemi Response switches connected to the A/D box will make sure your response timing is accurate and your subject isolation remains optimal. Note that this sensor type needs an Ergo input (2 channels configured for differential measurement).

J. ActiView software

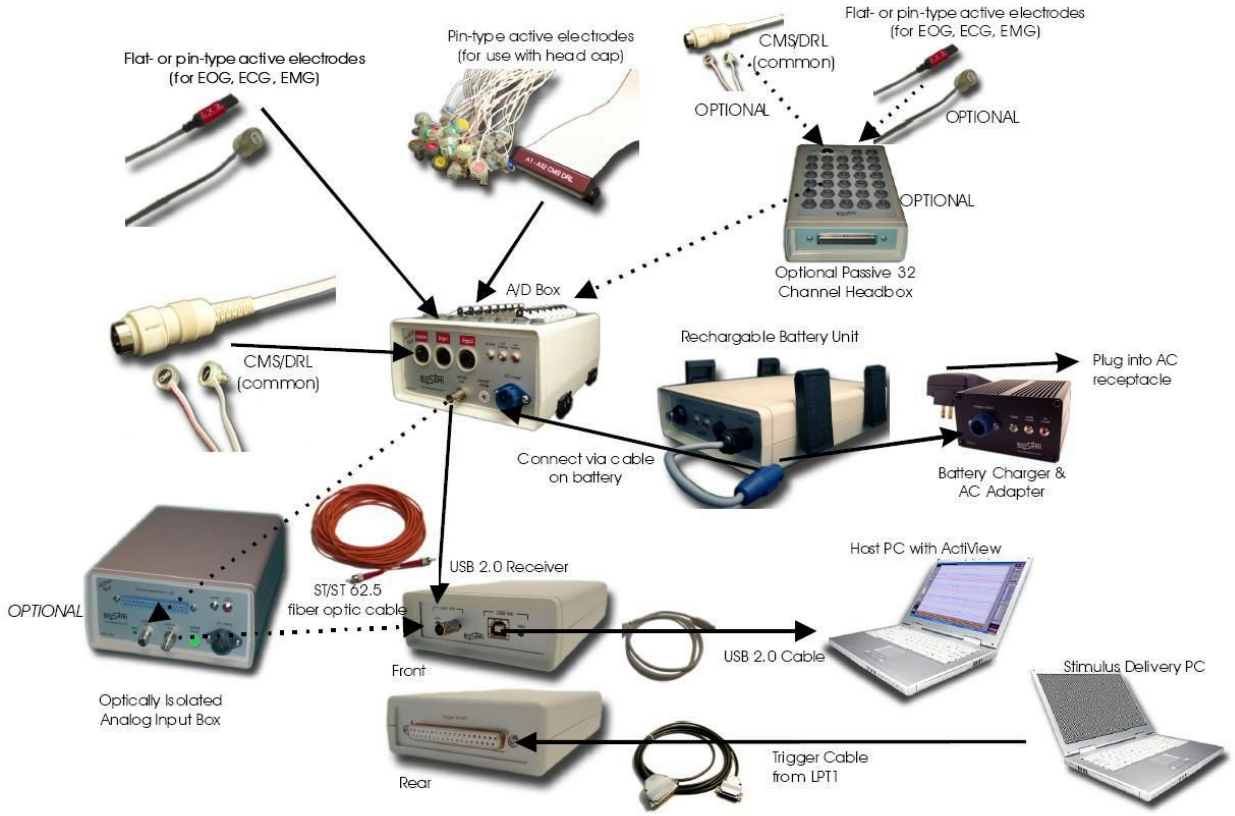
ActiveTwo is provided with a free, open-source data acquisition software program called ActiView . ActiView is optimized for use with ActiveTwo, and it provides mechanisms for visualizing and storing signals from all of the system's available sensors, including specialized sensors like the Jazz Synchronic Vigilance Monitor. The source code is provided so that 1) users have access at the most basic level to understand how their data are being treated, and 2) developers can easily modify the standard application to add specific functionality they need. ActiView has been developed using National Instruments LabVIEW, so the source code is provided in the form of LabVIEW llb files, and developers must have access to LabVIEW to view and modify the source code. See the sections on *ActiView Software Installation* and *Operating the ActiView Software* for detailed instructions on using the software.

V. ActiveTwo hardware setup

A. Connect the ActiveTwo components

The diagram below shows how to connect the basic components of the ActiveTwo system. Note that there are a wide variety of other sensors that can be used with

ActiveTwo, and those are not depicted here. In general, other sensors would be connected to the Aux 2 or 3 inputs.



B. Ensure that electrodes and sensors have been applied properly to participant

See the section above on applying electrodes to ensure that the electrodes and sensors are properly connected to the subject.

C. Plug the electrodes and sensors into the A/D box

Plug electrodes and sensors in at their designated locations. See above section for details.

D. Verify the speed mode

Check the *Speed Mode* dial on front panel of A/D box to be sure that it is set according to the requirements of the current study. Refer to the ActiveTwo User Manual for detailed specifications and instructions.

E. Turn on power

Depress the power switch on the battery unit connected to the A/D box.

F. Verify that the CM in Range light comes on

If *CM in Range* does not come on, then verify that you followed the steps described under *Applying Electrodes*. Failing that, see the section on *Troubleshooting*.

G. Start the ActiView software (or other data acquisition software)

See the section on *Operating the ActiView Software* for details.

VI. ActiView software installation

A. Computer requirements

Ensure that your host PC meets the following requirements:

1. Windows XP SP2 32-bit, Windows 7 32-bit or Windows 7 64-bit. (Windows 8 has not been fully tested, but worked in limited tests.)

2. USB 2.0 interface

If you wonder whether your computer has a USB 2.0 interface, check Device Manager for an "Enhanced USB Host" entry. This is "code" for USB 2.0.

3. Adequate display resolution

The resolutions below are specifically supported, but other display modes providing at least 1024 horizontal lines will work fine. Display modes with fewer than 1024 lines present a problem, because ActiView does not dynamically resize to the current display mode.

a) SXGA = 1280 x 1024 (LoRes)

b) WSXGA = 1440 x 900 (notebook)

c) UXGA = 1600 x 900 (laptop)

d) Variable (scroll-bars permit use on any display)

4. Windows user rights

You must have local administrative rights to install ActiView, but the USB driver will install properly even if the current user does not have administrative rights. Note that if your network administrator forces software installed by local users to be located in a specific folder with access rights limited to one user or group (e.g. on a network drive), the access to the ActiView application may be limited to the

current user or members of the same security group. Also note that the operator's computer/network account must have permissions to read and write in the folder in which the ActiView application is located. Consult with your network administrator to determine the correct user rights required for optimal installation and operation of ActiView.

B. Copy software from web or insert USB thumb drive

1. Use USB Thumb Drive

Insert the ActiView software thumb drive in the drive of the host computer, or …

2. Download latest software from BioSemi.com

Retrieve the desired version of ActiView software, associated version of the LabVIEW Runtime Engine and the USB interface driver from http://www.biosemi.com/download.htm.

Note: there are several versions available. Each operates at a fixed resolution as described above, and not every display resolution is supported. It is important to have a display with adequate resolution to support the full width and height of the ActiView software interface.

C. Windows XP Installation

1. USB Driver Installation

a) Disconnect fiber-optic cable

Driver installation will fail if fiber-optic cable is connected to USB interface and to A/D box with A/D box power on during the driver installation procedure.

b) Connect USB cable

Connect the USB cable to the front panel USB connection on the optical receiver / USB 2.0 interface.

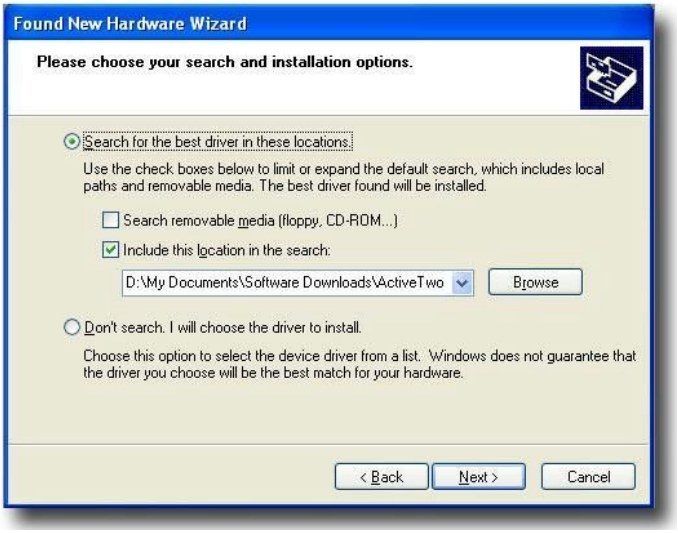
c) "Windows Update" question – IMPORTANT!

Windows will detect the USB device and it may bring up a dialog box asking whether it can search Windows update to find a suitable driver. IMPORTANT: ANSWER 'NO' TO THIS QUESTION!

d) Next, Windows will ask whether it can find the best driver automatically.

(1) Select the option to "Install from a list or specific location", and click Next to proceed.

(a) Select "Include this location in the search", and type the path to the folder where you placed the driver or use the Browse option to locate the folder.



(b) Click Next to proceed.

e) Success = MS WinUSB2

If Windows finds and installs the correct driver, you will see the name "MS WinUSB2 Driver for Biosemi ActiveTwo".

2. LabVIEW Runtime Engine Installation

ActiView 7.03 and later require LabVIEW Runtime Engine (LVRTE) version 8.6.1. Note that other versions of ActiView may require different versions of LVRTE. See the table at http://www.biosemi.com/download_actiview.htm for a list of ActiView versions and the version of LVRTE required for each (a link to download each is also provided).

a. Locate LabView Runtime Engine Installer

Open Windows Explorer. If you are installing from the CD, then browse to the BioSemi CD, and find the folder containing the LVRTE self-installer (e.g. LVRTE861STD.exe). If you downloaded ActiView and LVRTE from the BioSemi web site, then browse to the folder in which you placed the installer.

b. Double-click LVRunTimeEng.exe

The LVRTE installation will begin.

c. Click through the installation using all default settings

3. Copy the ActiView application to a local folder

4. Create a new folder under the root of the drive where most applications are installed

Create a folder for the selected version of ActiView:

"<*DriveLetter*>:\Biosemi\ActiView\<VersionNumber >\"

where "<*DriveLetter*>" is the letter of the drive that contains your existing Program Files folder and <VersionNumber > is the version number of the ActiView software. You can have multiple versions of ActiView installed on the PC at once. Be sure not to place the ActiView software in a location where you cannot be sure that ALL users will have both read and write privileges. Users will need read and write privileges in folder in which the ActiView software is located as well as all subfolders.

5. If you downloaded ActiView

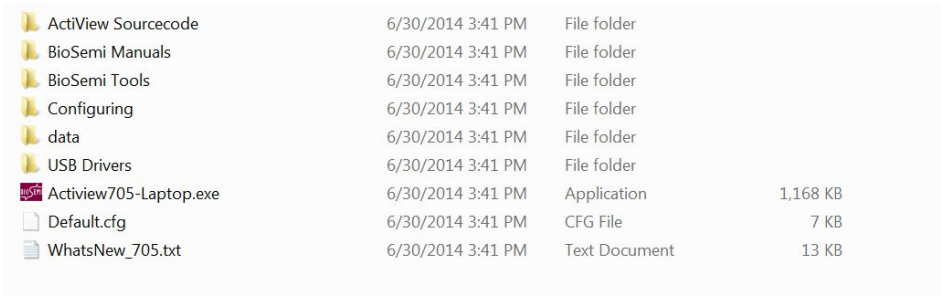
If you downloaded the ActiView application, it will be contained in a ZIP archive file from which you will need to extract the application and associated files. Place the extracted files in the folder you created in step (1) above.

6. If you are installing from the USB Thumb Drive

If you are installing ActiView from a BioSemi USB Thumb Drive, then select a version of ActiView that will be compatible with the highest-resolution display mode that your computer can comfortably display. Place all of the files associated with the chosen version of ActiView in the folder you created in step (1) above.

7. Be sure to preserve all files in the folder and subfolders

The ActiView folder should contain at least one executable application (ActiView*.exe), a file called Default.cfg and a whatsnew*.txt file as well as several folders.



The folder "Data" and its contents must remain as a subfolder. Exact names for the .EXE, .INI and .LLB files will differ depending upon which version of ActiView you chose in the step above.

Note that the .CFG files may be recognized as another type of file due to file name extension application association. Be sure that you use ONLY Notepad or another pure text editor to read and modify the CFG files. These are text files and they will be corrupted by Wordpad, WORD and other word processing applications.

Note also that CFG files with channel label schemes matching the standard head caps are located in the folder named "Configuring". You can load the one that matches your head cap layout and save it as Default.CFG to ensure that the correct labels are used. Note that there are specific rules about what must be contained in the file, and it is easy to accidentally remove necessary text elements when editing the CFG file, so it is a good idea to copy or load/save in a different location so that you have the original distributed CFG files for future reference in case editing a CFG file by hand leads to a corrupt CFG file that cannot be read by ActiView.

8. Create a Windows shortcut to ActiView

Right-click on the file with the .EXE extension in the ActiView folder and select *Create Shortcut*. Rename and move the shortcut file to your Desktop (<*DriveLetter*>:\Documents and Settings\<*YourUserNameHere*>) or to the shared desktop (<*DriveLetter*>:\Documents and Settings\All Users) to make it convenient for other users to find and access the shortcut.

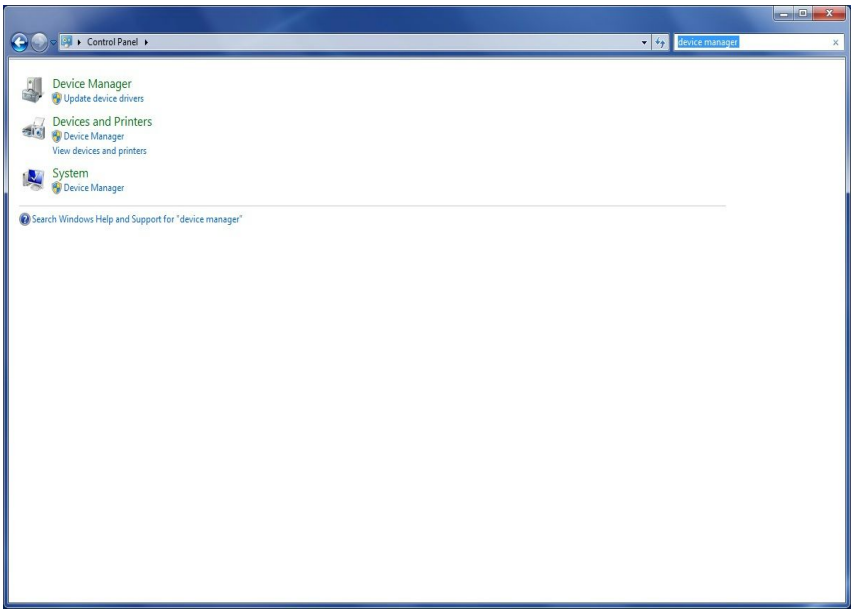
D. Windows 7 Installation

For initial install, the USB provided with your driver can be used.

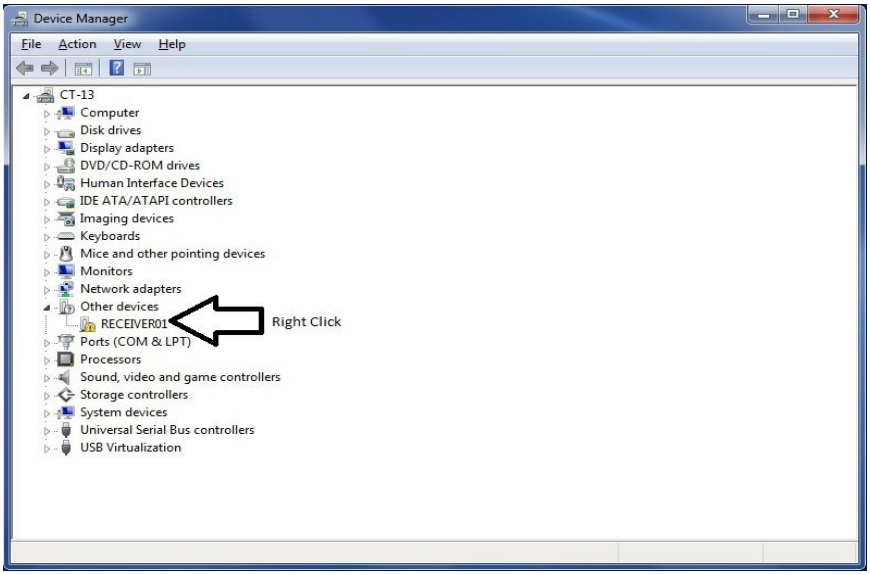
Part 1: Driver Install

1. First, **save the ActiView files** to a location where all users can access the files. It is recommended to create a new folder for these files.

2. Open the Control Panel and go to the **Device Manager** and click **"Update device drivers"**

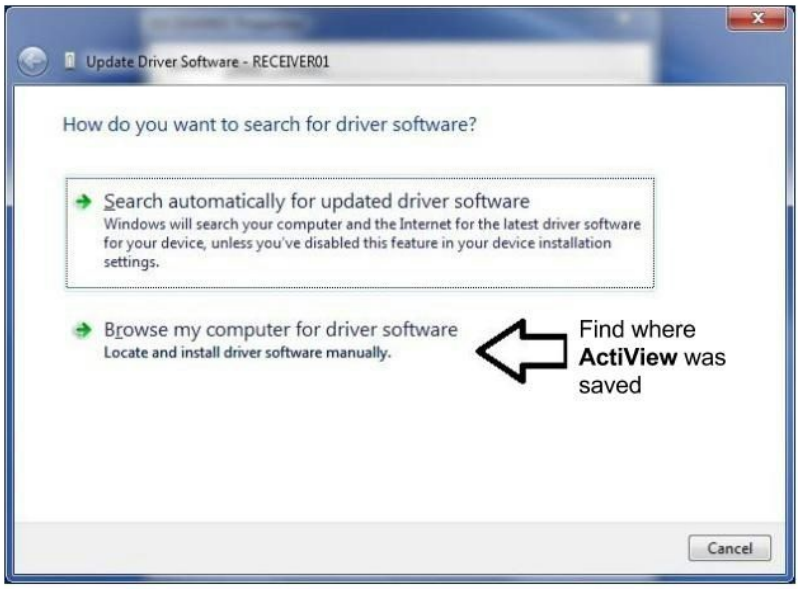


2. Right click **RECEIVER01** and then click on **Properties**

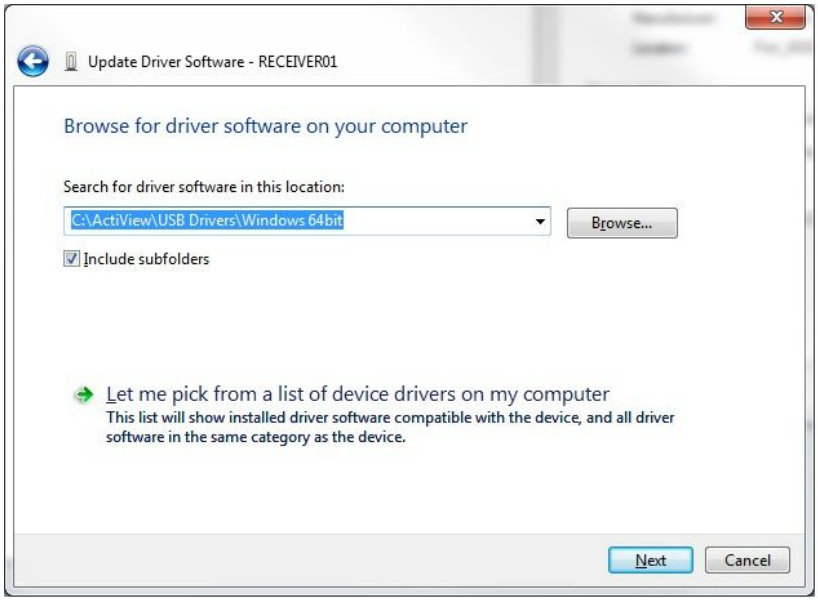


3. Click **Update Driver** *You may have to use administrator permission

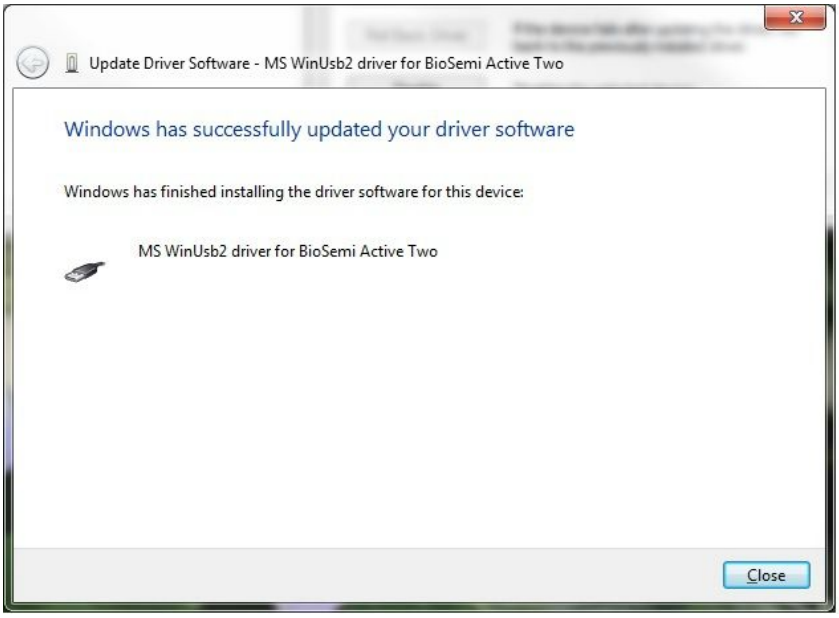
4. Find where **ActiView** was saved and then click **Finished**.



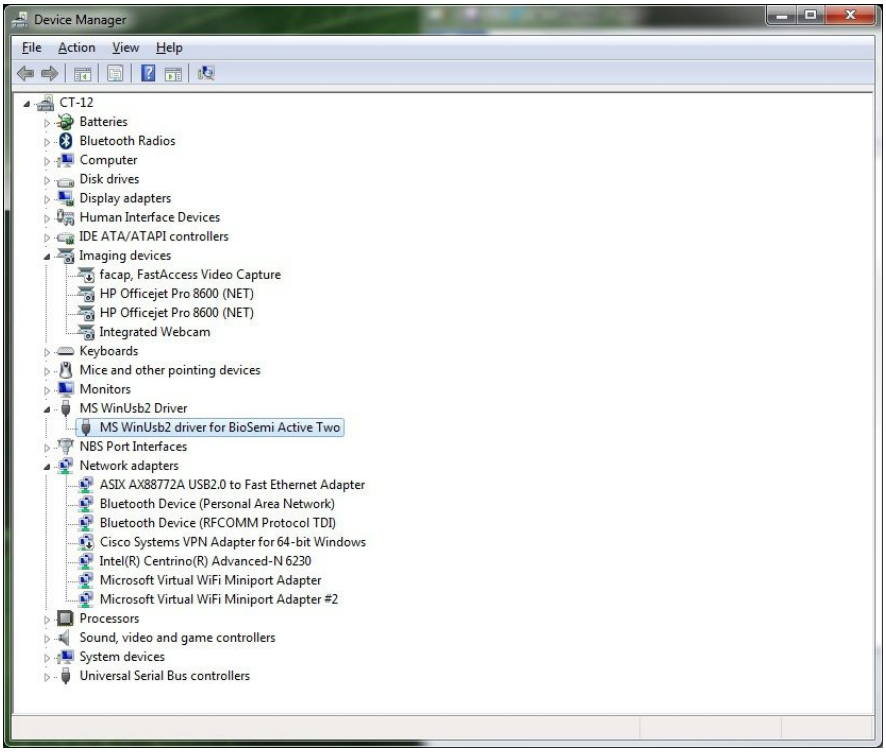
5. For this installation, ActiView was saved under:
C:\ActiView\USB Drivers\Windows64bit. Check the computer's operating system before selecting final folder.



6. After the driver has been successfully installed, a screen will appear as a notification of the new update.

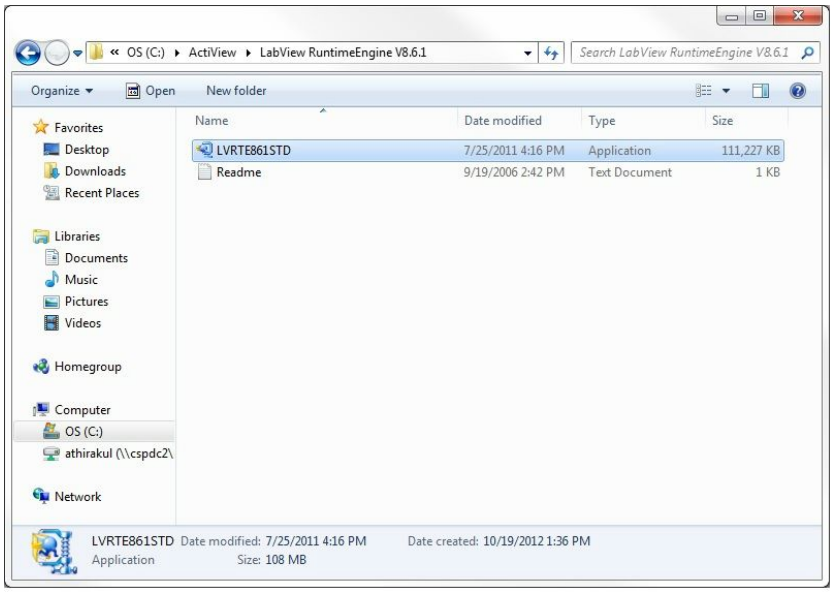


7. This new updated can also be seen in the Device Manager: instead of RECEIVER01, “MS WinUsb2 driver for BioSemi Active Two” appears

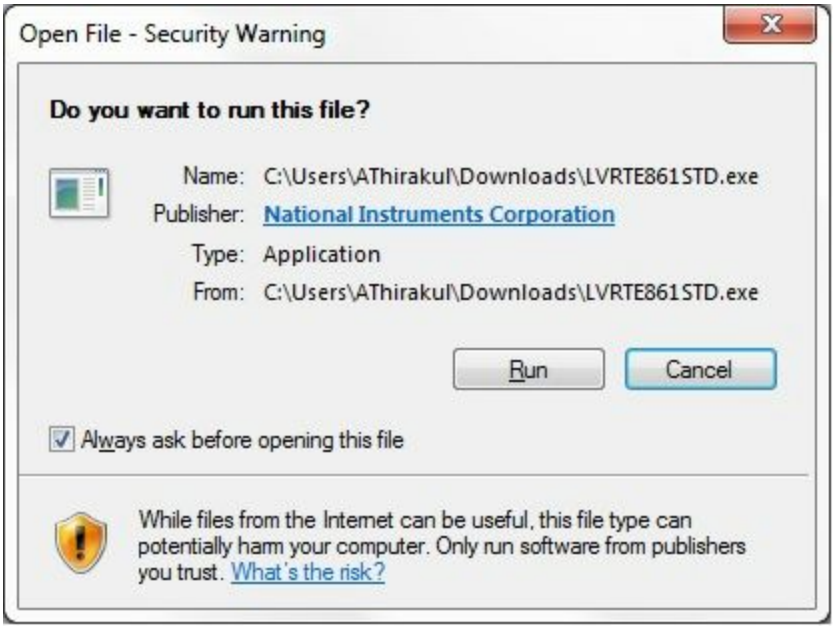


Part 2: Run-Time Engine Installer

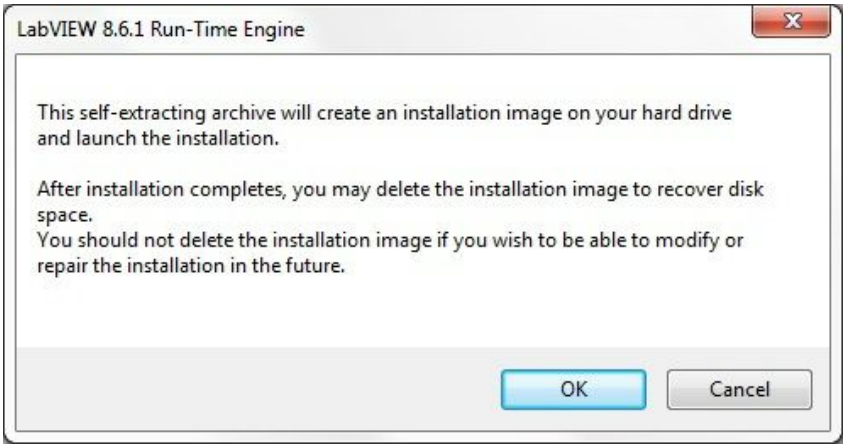
1. This can be found on the USB or downloaded from the BIOSEMI site for the most recent updates. Start from where the ActiView folder was saved, and click on the folder where you saved the LabView Runtime Engine. Open the folder and click on the self-installer (e.g. LVRTE861STD.exe).



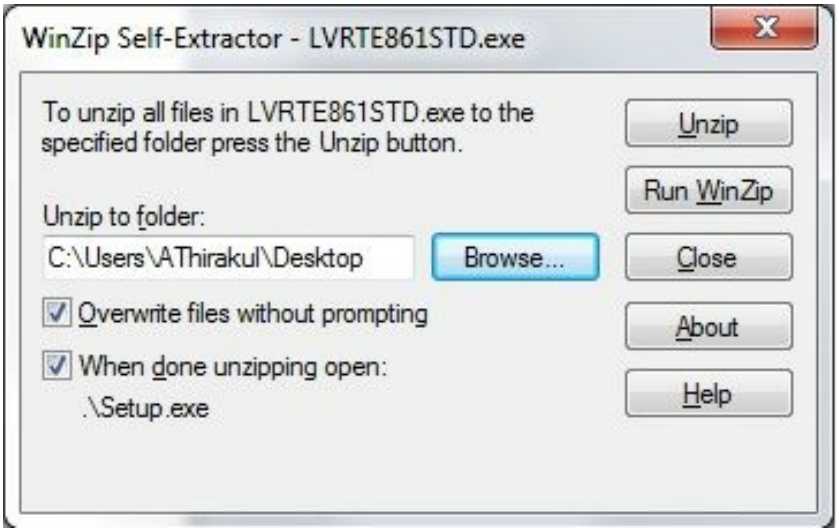
When the warning dialog below appears, click Run.



2. Click OK

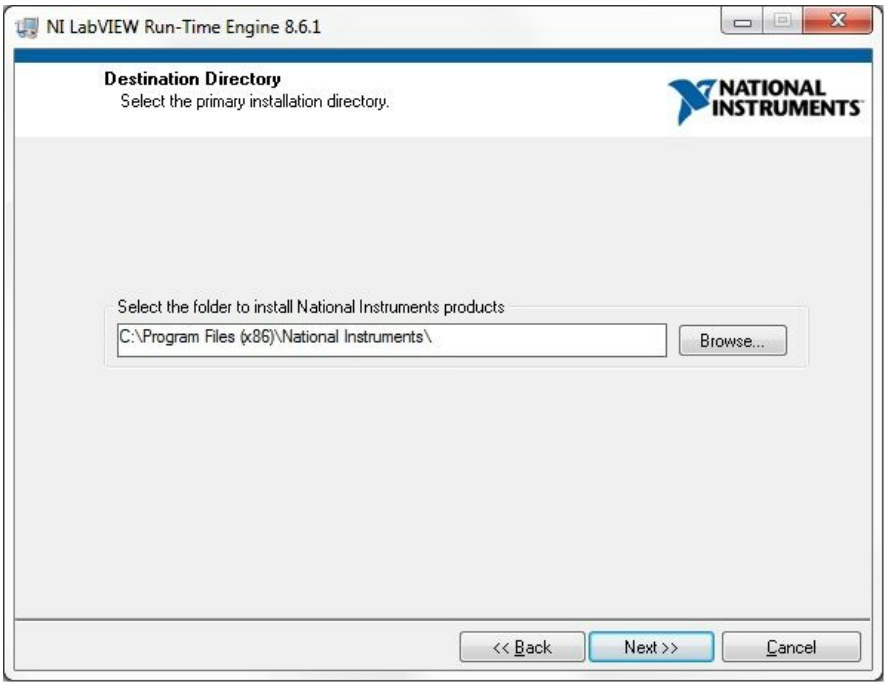


3. Choose the folder to upzip to and click the “Unzip” button in the top right corner

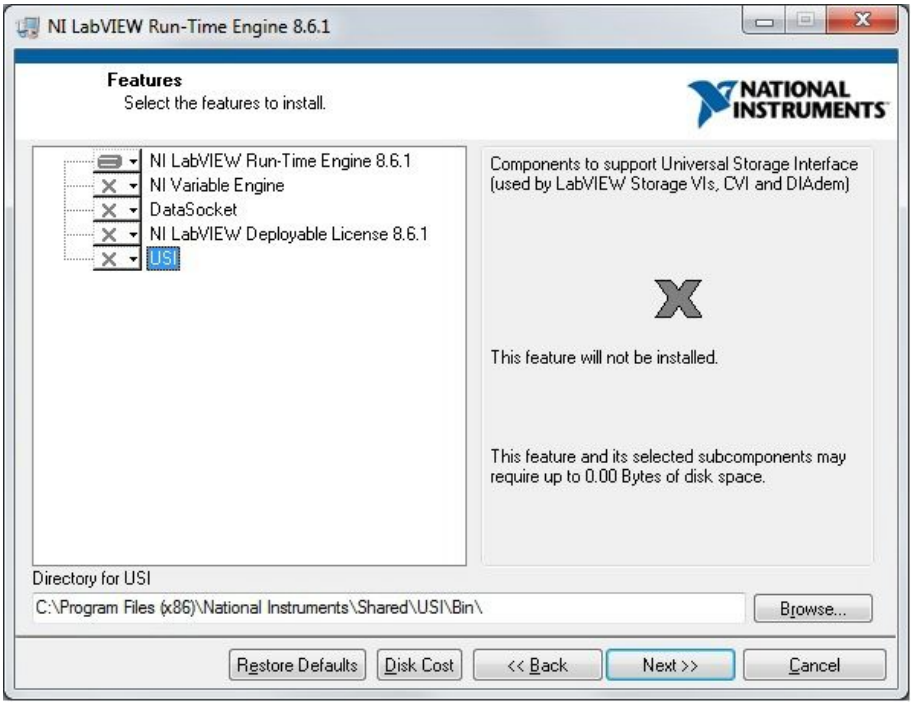


4. Click “Next”

5. Click “Next”



6. Enable only **"NI LabVIEW Run-Time Engine 8.6.1"** and click "**Next**"



7. Install is finished. The computer will need to restart.

Part 3: Copy software to desktop or create a shortcut that is easily accessible.

E. Lab Streaming Layer (LSL)

LSL is free software distributed by UCSD / SCCN. Please refer to the LSL Wiki for help with this software. We provide these brief instructions for your reference only.

1. LSL Distribution

a. The core transport library (liblsl) and its language interfaces (C, C++, Python, Java, C#, MATLAB). The library is general-purpose and cross platform (Win/Linux/MacOS, 32/64) and forms the heart of the project

b. A suite of tools built on top of the library, including a recording program, online viewers, importers, and apps that make data from a range of acquisition hardware available on the lab network (for example audio, EEG, or motion capture).

2. Streaming Layer API

a. **Stream outlets**: for making time series data streams available on the lab network. The data is pushed sample by sample or chunk by chunk into the outlet, and can consist of single or multiple channel data, regular or irregular sampling rate, with uniform value types (integers, floats, doubles, strings). Streams can have arbitrary XML meta-data (akin to a file header). By creating an outlet the stream is made visible to a collection of computers (defined by the network settings/layout) where one can subscribe to it by creating an inlet.

b. **Resolve functions**: these allow to resolve streams that are present on the lab network according to content-based queries (for example, by name, content-type, or queries on the meta-data). The service discovery features do not depend on external services such as zeroconf and are meant to drastically simplify the data collection network setup.

c. **Stream inlets**: for receiving time series data from a connected outlet. Allows to retrieve samples from the provider (in-order, with reliable transmission, optical type conversion and optical failure recovery). Besides the sample, the meta-data can be obtained (as XML blob or alternative through a small built-in DOM interface)

d. **Built-in clock**: allows to time-stamp the transmitted samples so that they can be mutually synchronized

3. Coding Guides

a. The distribution includes a range of code examples in C, C++, Python, MATLAB, Java, and C# including some very simple sender and receiver programs, as well as some fairly extensive demo apps. See example code in C++ below:

b. Sending and receiving data in C++ click here

4. Acknowledgements:

The original version of this software was written at the Swartz Center for Computational Neuroscience, UCSD

VII. Applying electrodes and sensors to participant

A. Applying pin-type active electrodes

1. Familiarize yourself with basic skull surface anatomy

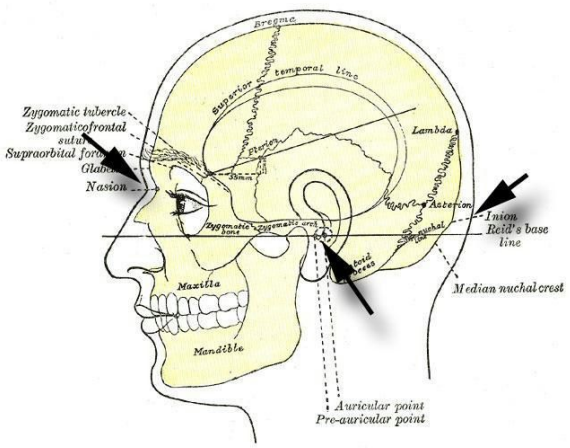
If you are not already familiar with the surface anatomy of the skull, familiarize yourself with the important landmarks used in EEG positioning. These are:

a) Nasion

b) Inion

c) Left preauricular point (LPA) and right preauricular point (RPA)

d) Vertex (intersection of lines between nasion/inion and left/right preauricular points), also know as Cz



Adapted from Gray's Anatomy
Philadelphia: Lea & Febiger, 1918
New York: Bartleby.com, 2000

2. Fit the head cap

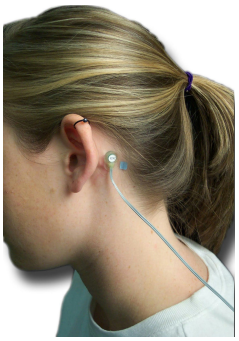
a) Measure head circumference to select proper cap size

Measure (in centimeters) the circumference of the subject's head just above the eyebrows and over the inion at the back of the head. Use this circumference measurement as a guide in choosing a head cap size. Fifteen cap sizes are available, but most users have access only to a few sizes. Cap sizes are intended to fit a four centimeter range of head circumferences, so the tightness of fit will vary depending on whether your participant falls near the upper or lower end of the range for a given cap.

b) Measure nasion-inion distance before applying head cap and divide this distance by two

Measure the distance from nasion to inion and divide by two to determine the proper location of the Vertex electrode (in 10/20 or 10/5 terminology, the Vertex is referred to as Cz). Remember this measurement.

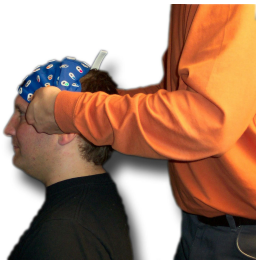
c) If participant has long hair, fix mastoid or earlobe electrodes before putting-on the head-cap

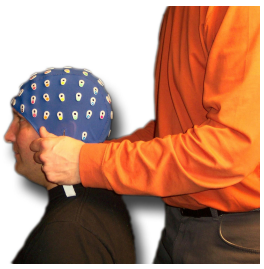


Hair long enough to cover the mastoids or earlobes will make it difficult to impossible to fix mastoid or earlobe electrodes after putting on the cap, so fix at least these flat-type electrodes before putting on the head cap. Note that it is also advisable for a subject with long hair to let their hair down and distribute it evenly around the back and sides of the head to minimize the barrier it can form preventing electrolyte gel from contacting the scalp. Follow the steps under *Apply flat-type active electrodes* below to apply these electrodes.

d) Put the cap on the participant's head

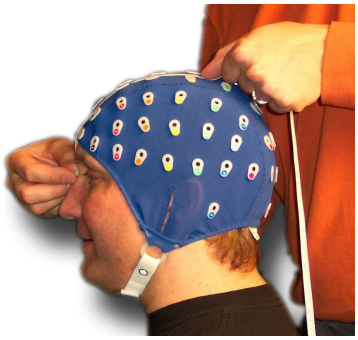
Standing behind the participant, 1) place the frontal electrode holders on the forehead (taking care not to let them slip over the participants eyes), and 2) stretch the cap back over the head. Finally 3) reach under the participant's chin and fix the chin strap. Some participants may find it helpful to place tissue or gauze under the chin strap for comfort and to avoid chafing.

1 

2 

3 

e) Measure nasion-to-inion distance and adjust cap position from front-to-back



After putting on the cap, measure to be sure that the vertex electrode is where it should be. With caps labeled according to the 10/20 or 10/5 system, the vertex electrode site will be labeled Cz, but in the

standard ActiveTwo 128, 160 and 256 channel head caps, the vertex will be labeled A1. Most often, the cap will be slightly too far back on the head at first.

f) Position vertex at half-way point between LPA and RPA

Open the ear-slit in the left side of the head cap and find LPA. Place the zero point of the measuring tape at LPA. Stretch the tape over the head as close to the vertex electrode as possible while trying to avoid placing the tape over electrode holders. Note that if one side of the tape goes over electrode holders and the other side of the tape goes next to electrode holders, the measurement of the half-way point will be inaccurate. Open the right ear-slit in the cap and find the measurement at RPA. Divide this distance by two to determine the correct position of the vertex from left-to-right.

g) Ensure cap is not rotated

Standing behind (or in front of) participant, visualize a line following the center hole in each of the midline electrode holders from vertex toward the front of the head. If this line does not line up with the nose, then rotate the cap to line up the midline electrodes with the nose.

h) Repeat the above steps

Repeat the steps above one last time to ensure vertex is at half-way point between nasion/inion and LPA/RPA and cap is not rotated.

3. Fill electrode holders with electrolyte gel

a) If using SignaGel…

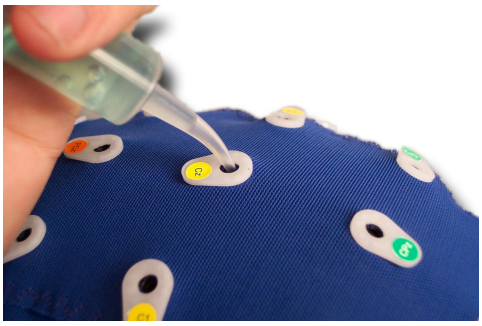
If using SignaGel, remove the plunger from a clean syringe, and inject approximately 10 ml of gel into the syringe. This is a suitable amount for about 64 channels. Use less gel if you have fewer channels. Replace the plunger.

b) If using another electrolyte that does not come in a tube…

If using another gel that does not come in a tube, decant 10-20 ml of gel into a disposable cup. This helps avoid contamination of the vessel containing the electrolyte. Remove the needle if you are using a Luer-Lok syringe. Then, place the tip of the syringe into the gel in the cup, and pull back on the plunger to pull approximately 10 ml gel into the syringe. This

is a suitable amount for about 64 channels. Use less gel if you have fewer channels. If you removed the needle from the syringe, replace the needle.

c) Inject gel into the first electrode holder



Place the tip of the needle or syringe (tip) into one of the electrode holders, being careful to touch the scalp and lift the syringe away from the head as you press the plunger. If you hold the tip at the scalp and do not pick up while pressing the plunger, the gel will spread across the scalp rather than forming a conductive column from the scalp to the top of the electrode holder. As your first site, choose a position where the hair seems to be fullest. IMPORTANT – do not abrade the scalp as is traditionally done with other EEG systems. This will only increase the risk of breaking the skin, which can result in infection.

d) Ask the participant whether they feel the gel at the scalp

If the participant does not feel the cold sensation of the gel at the scalp, the use the tip of the syringe to part the hair (touch the scalp with the tip and rock gently back-and-forth once or twice) and then inject a small amount of gel. Ask the participant again if they feel the gel. If so, then proceed to the next step. If not, then try another location where the hair is less full. Repeat this until the participant reports feeling the cold sensation of the gel on the scalp. Use this self-report technique any time you doubt whether the gel is making contact with the scalp.

(1) Important notes about electrode contact impedance

With ActiveTwo, the gel simply needs to make contact with the scalp and with the electrode (which will be placed in the electrode holder later) to measure excellent quality signals. The ActiveTwo system has very high input impedance, so it is very tolerant of high and variable impedance contacts at the skin. For the most part, skin impedance levels (and differences in skin impedance) are not important factors in signal quality measured with ActiveTwo. There are two main exceptions to consider:

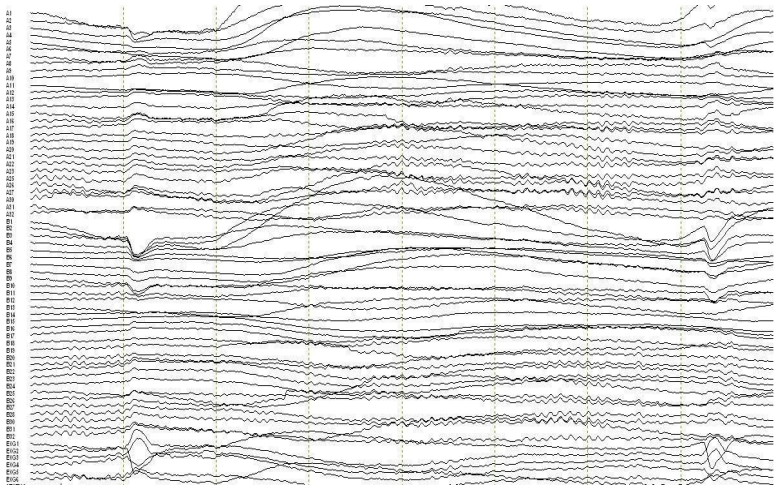
(a) Very high impedance contacts

There is a relatively narrow range (very unlikely, and occurs very infrequently) of possible skin impedance levels at which ActiveTwo will exhibit higher input noise (e.g. 60 Hz common mode interference) or instability (e.g.

low-frequency drift), so it is sometimes necessary to touch-up contacts at one or two sites to address noisy signals.

(b) Skin potentials

Be aware that no bio-amplifier system, including ActiveTwo, can distinguish between local variations in skin potential and local variations in very low frequency potentials resulting from brain activity. Below is a sample of the low-frequency artifact associated with skin potentials and sweat to assist in recognizing this phenomenon:



We recommend designing your experiment and your experimental procedure to minimize the possibility that skin potentials will corrupt your EEG measurements. Here are some suggestions for minimizing skin potentials:

(i) Design your lab space with adequate ventilation.

Surprisingly enough, people often go to great lengths to build a shielded room with special electrically-quiet lighting, but they forget about ventilation and temperature control. Have your lab space designed with more ventilation and range of temperature control than you would expect to need, especially if you have an electrically shielded room and/or are using low-voltage halogen lighting.

(ii) Use a fan to move air through the room.

If you do not have control over heating and cooling systems, then use a simple electric fan to increase

air flow around the participant. Keep the fan as far as is practical from the subject, and make sure that you follow the recommendations below for twisting the CMS/DRL electrode leads around the leads of the active electrodes to minimize pickup of magnetic noise associated with the fan's electric motor. For a small 6 inch electric fan, a distance of four feet from the participant is adequate to eliminate interference pickup, assuming the CMS/DRL cable is wrapped around the rest of the active electrode cables about five times along the length of the run from the participant to the AD box.

(iii) Ask your participants to layer their clothing.

Suggest that participants wear a short-sleeve shirt with a sweat shirt or sweater so that they can remove a layer if they get too warm. Warm participants will produce spontaneous skin potentials that will require high-pass filtering to remove.

(iv) Use an electrolyte gel with higher salt content.

SignaGel contains no Chloride. To minimize susceptibility to skin potential artifact, especially that associated with physical exertion by the subject during the recording session or an uncomfortably warm / humid environment, use an electrolyte gel containing Chloride. Do not use Abralyt or Quik-Gel as these products contain other undesirable ingredients. Parker Laboratories Redux Creme and Paste also have relatively high salt concentration.

e) Fill the remaining electrode holders with gel

This is the second most time-consuming step of applying an electrode head cap. It is important to use only enough gel in each site, and it is important to try to fill each holder, but practice this procedure to minimize the time it takes to fill all of the holders.

f) Insert the pin-type active electrodes into the head-cap

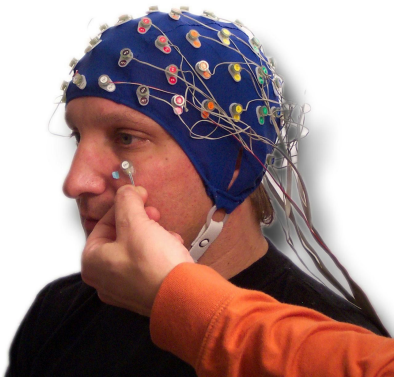
Drape a ribbon cable containing pin-type electrode holders around your neck and over your shoulders. Observe that pin 1 and channel 1 are on the side of the ribbon cable with the red line. Take a group of four or eight electrodes at one or the other end of the cable in one hand, being careful to control the others so that they do not hit the participant in the eye.

f) Drape ribbon cables over the participant's shoulder

After applying each pin-type active electrode set, drape the ribbon cable over the participant's shoulder so that you do not step on them as you move around.

g) Insert CMS and DRL electrodes

On newer systems, CMS and DRL are on a special lead with a circular DIN connector that fits in to the left-most circular jack on the front panel of the A/D box. On older systems, CMS and DRL are included as the last two electrodes on the A1-32 electrode set. Note that on new systems, the pins on the first D connector serving CMS and DRL are still connected, so if you plug in an A electrode set with CMS/DRL and a circular DIN connector with CMS/DRL, the safety circuit of ActiveTwo will be engaged, causing the *CM in Range* light to go out and making it impossible to record meaningful data. IMPORTANT: Be careful to avoid electrolyte bridges between CMS and/or DRL and active electrodes. An electrolyte bridge (short) between any active electrode and DRL will result in very high noise in the signal measured from the active electrode. An electrolyte bridge between any active electrode and CMS will result in a flat-line (no voltage can be measured between two shorted contacts).



B. Apply flat-type active electrodes

If you will use flat-type active electrodes to measure EOG, ECG, EMG or EEG reference (that you did not apply before putting on the head cap), then apply those at this time. Some cleaning of the skin with an alcohol prep

pad may be necessary in case of excessive makeup or sweat.

Note that it is possible to use only flat-type active electrodes (without a head-cap), but you must always have CMS and DRL connected to the subject. In this case, you will need to have a special flat-type CMS/DRL set that plugs into the front panel of the A/D box. If you are not using the head cap, you may wonder where the CMS and DRL electrodes should be positioned. The location of DRL is not particularly important – it just needs to be on the body. For convenience, position DRL within about 3 inches of CMS. The location of CMS is theoretically important, since it is effectively the *common*. If possible, position CMS near the middle of the electrode array. If the density of the electrode array does not permit this, then position CMS as close to the electrode array as possible. IMPORTANT: Be careful to avoid positioning CMS and DRL too close to other electrodes. An electrolyte bridge (short) between any active electrode and DRL will result in very high noise in the signal measured from the active electrode. An electrolyte bridge between any active electrode and CMS will result in a flat-line (no voltage can be measured between two shorted contacts).

1. Peel the adhesive electrode ring off of its paper backing

2. Apply the ring to the plastic electrode housing (flat electrode)

Take care to position the opening in the ring around the electrode pellet. Note that the pellet is closer to the electrode ring than you might expect, and it is NOT directly opposite the electrode label.

3. Apply gel to electrode contact

After sticking the ring to the electrode and before removing the protective paper cover, apply a small amount of conductive electrolyte gel to the electrode pellet.

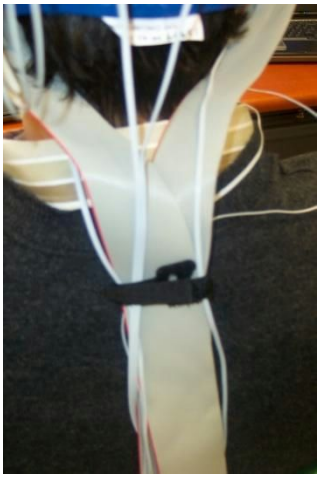
4. Then, remove the paper backing from the adhesive ring and attach to participant

Remove the paper backing and place the electrode where you want it. Note that when you position the electrode, you will be looking at the label side. Remember that the electrode contact is at about where the junction of the lead wire with the plastic housing, rather than directly under the label. Following the procedure outlined here should help remove any excess gel that might otherwise prevent the adhesive from sticking to the skin.

5. Drape leads over the participant's shoulder

After applying each flat-type active electrode, drape the lead over the participant's shoulder so that you do not step on them as you move around.

IMPORTANT: Wrap the CMS/DRL cable around the other electrode and sensor cables



Wrap CMS/DRL around the other cables 3-5 complete turns along the length of the cables between the participant and the A/D box before plugging it into the front of the A/D box to help minimize magnetic interference pickup. Use medical tape or Velcro cable ties to keep the cables close to one another. This is an important step to ensure you measure the absolute best quality data possible.

B. Connect the electrodes to the A/D box

Plug the electrodes that are attached to the participant into the A/D box.

1. Pin-type electrodes: ribbon cables with 68-pin D connectors

The ribbon cables with 68-pin D connectors are labeled A1-32, B1-32, etc. Plug these connectors into the A/D box first, taking care that the connector is oriented so that the label is legible to you if you are standing facing the front of the A/D box. (Note that ribbon cable sets are available with flat-type electrodes, although this configuration is typically only required for dense surface EMG measurements.)

IMPORTANT: Take care to plug connectors in the correct orientation to avoid costly damage to connectors on the cables or on the A/D box. Attempting to plug-in a D connector in the wrong orientation can result in a bent pin on a 68-pin D connector (electrode ribbon cable). Attempting to plug-in a damaged D connector can result in damage to the mating D connector on the top of the A/D box. Since all of the connectors on the top of the A/D box are mounted to a single input board, a single damaged input connector may require the entire input board to be replaced.

2. Flat-type electrodes: individual leads (two lead cable) with key-shaped connectors

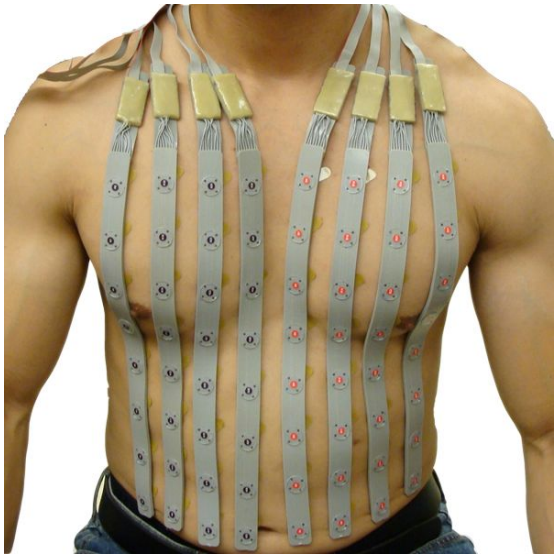
Individual leads with key-shaped connectors are intended to plug-in at EXG1-8 on the top panel of the A/D box. Note that the labels on the electrodes match labels on the connectors, so it is a good idea to be consistent in connecting these leads to the A/D box in such a way that the labels match. That said, the labels in the electrodes are somewhat arbitrary, and it is possible to plug in an electrode labeled EXG1 at the jack labeled EXG2 without any ill effects aside from the obvious potential confusion that could result. (Note that individual leads with key-shaped connectors are available with pin-type electrodes to supplement the

standard electrode array provided by the head cap + ribbon cable or as quick-insert leads to replace a faulty electrode from a 32 channel ribbon cable on an emergency basis.)

3. CMS/DRL set with circular DIN connector (Important: keep leads together!)

Insert the circular DIN connector at the front panel of the A/D box, taking care to position it in the correct orientation. If your CMS/DRL cable set is equipped with the plastic threaded ring, press-in and turn the plastic ring on the DIN connector until it is snug. Failure to tighten the threaded ring when it is present can result in intermittent cable faults (CM out of range). Do not over-tighten as it can break. If your CMS/DRL cable is not equipped with a plastic threaded ring, then note that the connector may feel a little loose when plugged in. Typically, this does not present a functional problem with connectivity.

D. Body Surface Potential Mapping



1. Supplies

2. 10ml syringe (box of 100) CS-SY-SYLL10
3. Electrolyte paste: CS-GP-GERXP
4. Flat electrodes on carbon strips
    a. Panel 4X8: Total of 32 electrodes on 1 connector
    b. Panel 4X12: Total of 48 electrodes on 1 connector
5. Adhesive electrode washers: 8mm id X 22mm od CS-AT-ARIV8X22
6. Tweezers
7. Pallets or holding tray
8. Waist Apron

2. Preparation

a. Configure a map of where to place each electrode strip on the torso
b. Lay panels flat on a non-metal surface (suitable trays as shown

are available from Cortech Solutions) with each electrode strip oriented in order and electrodes facing upward

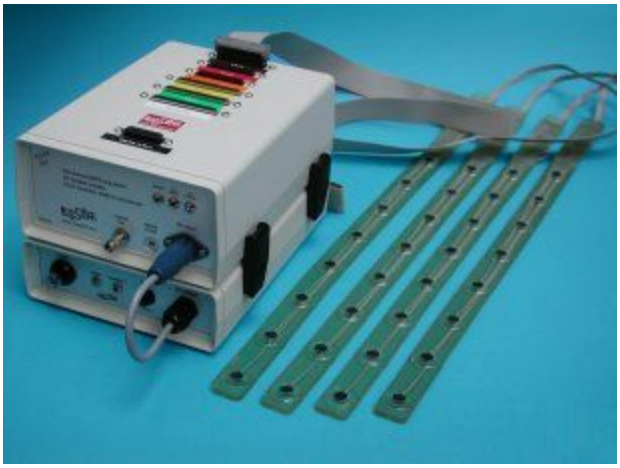
c. Place the adhesive electrode washers directly above each electrodes, careful not to cover the metal part and the blue tab perpendicular to the runner strip
d. Prepare CMS/DRL and LL/RA/LA with appropriate adhesive washers
e. Fill 2 syringes with the electrode paste and place a small amount above each electrode
f. Using the tweezers, gently remove the paper-backing from each adhesive.
g. Place Set A on a pallet and have ready as the first set of electrodes to be placed on the torso according to the map. Prepare Set B and place on a second pallet.

3. Application

a. Beginning with A1, place the first strip onto the torso, and continue onto A2, A3, and A4. Stagger the strips on the surface in order to cover more surface area
b. Orient the strips so that the wires are facing down and not being pulled by any tension
c. Gently press the strips to any curves of the body to make contact with the skin
d. Continue to add electrode sets to cover the torso according to the map
e. CMS should be placed in a central location on the chest, DRL can be placed anywhere
f. Avoid placing these directly onto muscle LL= lower leg, RA= right arm LA= left arm
g. To support all of the cables, place the cables in the pocket of the apron

4. Data Acquisition

a. Similar to the EEG, use the *Electrode Offset* tab to observe any noise. If any channels are +/-40, gently press on the electrode strip to make contact with the skin. If noise persists, add a small amount of gel and re-apply. *Tape can also be used to help the electrode strip stay in place
b. On the *Monopolar Display* tab, view all necessary channels (A32-D32) and check again for any noise or electrical interference
c. Label references EX1, EX2, and EX3
d. Click “Save File” and be sure to “Un-Pause” when file is created



5. Maintenance and Care

a. Use warm water to wash away the gel from electrodes
b. Towel dry and hang in a dark room to avoid sunlight
c. Perform the one-bucket test* periodically to check the quality of the electrodes. *For these electrodes, use a wide and rectangular bucket to fit the equipment

E. Apply any additional sensors

ActiveTwo supports a variety of other sensors for measuring physiological and non-physiological signals. A current list is maintained in the Accessories section under ActiveTwo on the Cortech Solutions web site (www.cortechsolutions.com). New sensor options are periodically added, so check the web site if you have not looked at it recently. If you need a sensor that was not provided with your system or that you do not find in the Accessories listing under ActiveTwo on our web site, please contact us.

1. Skin conductance (SC)

Measuring SC is more complicated than measuring signals with some of the other sensors available for use with ActiveTwo, so we have provided some specific procedural recommendations.

a) Preparation

(1) Start with clean electrodes

Tarnish on the electrodes may affect the baseline resistance reading, but it will not affect the ability of the system to measure changes in skin conductance.

(2) Wash your hands

Always wash your hands with soap and water before applying electrodes to someone else. If you have any breaks in the skin of

your hands, or any "weeping" rashes or lesions, wear examination gloves.

(3) Wash the participant's hands

Always have the participant wash his/her hands with soap and water and dry them thoroughly before applying electrodes. This helps to equate the degree of skin hydration across participants.

(4) If the subject has any breaks in the skin or weeping lesions on his/her hands near the recording sites, DO NOT RUN THAT SUBJECT.

b) SC electrode application

(1) Select an electrolyte to use as a conductive medium.

Skin conductance is best measured using an electrolyte formulated specifically for skin conductance measurements rather than the strongly hypertonic solutions generally used for EEG or ECG measurements. Keep the electrolyte container closed between uses. Do not use SignaGel or other electrolyte solutions with high salt concentrations for skin conductance. One option is to have a local compounding pharmacist make a batch of electrolyte paste according to one of the recipes found in:

> Lykken, D.T., & Venables, P.H. (1971). Direct Measurement of Skin Conductance: A Proposal for Standardization. Psychophysiology, 8, 656- 672.

(2) Apply paste evenly to the surface of the electrode.

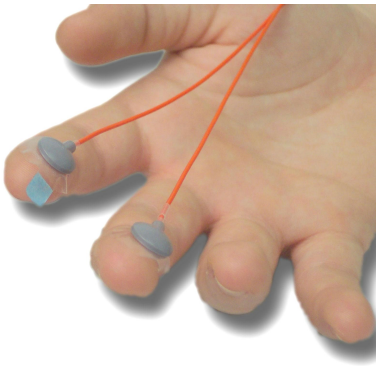
Avoid creating air bubbles in the paste. Fill the electrode well to the top to insure contact between the entire electrode surface and the skin. Overfilling will cause paste to spread out under the collar when the electrode is applied to the subject, resulting in variation in the electrode contact area and poor adhesion of the collar. If you overfill the electrode, use the side of a toothpick to grade off the excess paste.

(3) Select a location and affix electrodes

Press the electrode in place on the subject with the lead wire running in an appropriate direction. Be careful not to move the electrode after contact with the skin. Press firmly on the electrode to be sure that it adheres tightly to the skin. Use paper tape to hold the electrodes in place. The double-sided adhesive rings pictured

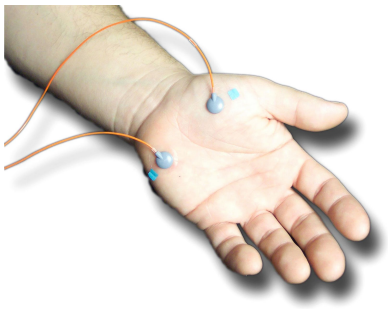
below are an option, but tape usually works best with paste electrolytes.

(a) ***Option 1 (standard placement)***



Affix the electrodes to the volar (palmer) surface of the distal phalanges (the fingerprint region) of the left hand. Run the leads down the fingers toward the palm, and wrap a loop of paper tape around the lead and medial phalange of each finger to relieve stress on the electrode. Further secure each electrode with a loop of paper tape around the fingertip.

(b) ***Option 2 (****alternative placement****)***



If the subject has cuts or callouses on his/her fingertips, or if he/she has slender fingers that make it difficult to secure electrodes to the fingertips, opt instead for the thenar and hypothenar eminences of the subject's left hand. Place the electrodes so that the leads travel toward the wrist and secure them at that point with a strip of paper tape.

(4) Connect electrodes to A/D box

Connect the SC electrode leads at the circular DIN connector marked GSR on the front panel of the A/D unit. If you are not also recording EEG, then position flat-type CMS and DRL electrodes on the back of the hand about 2 inches apart. Be sure that the *CM in Range* light comes one when the CMS and DRL electrodes are connected and the A/D box power is on. Skin on the arms and hands tends to be dryer than elsewhere on the body and may require some preparation (moistening with water or electrolyte gel) for adequate conductivity to be achieved. If *CM in Range* comes on, no further skin preparation for CMS/DRL or for the SC electrode sites should be necessary.

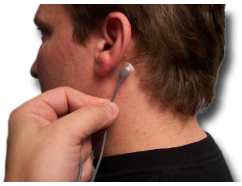
(5) Adaptation period

Reliable recording requires an adaptation period of at least 10 minutes (15-20 minutes is recommended for research in which within-session change in skin conductance level is an important variable). This period allows equilibration of hydration and sodium at the interface between the subject's skin and the electrode paste.

2. Respiration

The ActiveTwo respiration sensor is a Nihon Kohden TR-753T respiration belt. Two channels on the ActiveTwo are modified in order to provide a bipolar signal. Strong reliable signals are available because the respiration belt uses the power supply from the ActiveTwo system. The respiration belt directly plugs into the front of the ActiveTwo.

3. Temperature



With this high precision temperature sensor from HP (Agilent 21078A), skin temperatures can be measured. The temperature sensor directly plugs into the front of the ActiveTwo.

4. Plethysmograph

This Plethysmograph sensor from ADI instruments (MLT1020) uses an infrared photoelectric sensor to detect changes in tissue blood volume. The Plethysmograph sensor directly plugs into the front of the ActiveTwo. This sensor can be ordered with a finger clip, with a Velcro strap or with an ear clip.

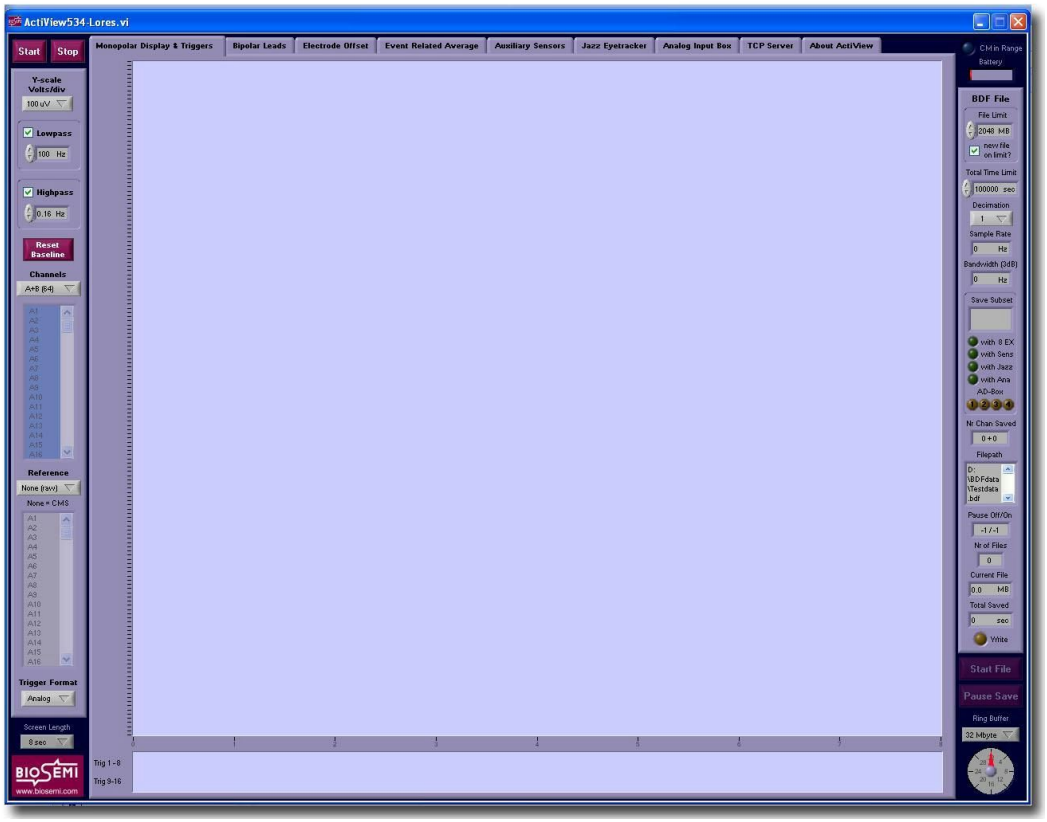
5. Other sensors

Sensors other than those above are generally provided with a connector designed to plug into a circular DIN jack labeled Ergo1 or Ergo 2 on the front panel of the A/D box. Regardless of whether these are physiological sensors, it is still necessary for the CMS and DRL electrodes to be connected to the participant and for the *CM in Range* light to be on (indicating the system has a stable common against which to measure electrical potential) for meaningful signals to be measured.

VIII. Operating the ActiView software

A. Start ActiView

Start ActiView by double-clicking the ActiView .EXE file or the shortcut you created pointing to the .EXE file. A window like the one below should appear.



B. Select a configuration (.CFG) file

Note that the file DEFAULT.CFG located in the current directory (the directory in which the ActiView executable (.EXE) file you are using is located) will be loaded automatically when ActiView is started.

1. If you want to ensure that a particular .CFG file is loaded on startup

Rename the old DEFAULT.CFG to OLD_DEFAULT.CFG, and save your desired configuration file as DEFAULT.CFG.

2. To force the operator to select a .CFG file on startup

Delete or rename DEFAULT.CFG and do not replace it. When ActiView goes to find DEFAULT.CFG, it will bring up a Windows File Open dialog box and ask

the operator to select a .CFG file. If you have a busy lab with multiple experiments being conducted with the same equipment, it is advisable to use this strategy to ensure that the operator chooses the right .CFG file.

3. To load a CFG file manually, follow these steps:

a) Select About ActiView

This tab can be found at the upper right side of the ActiView screen.

b) Select Load Config

This button can be found at the top of the left-hand panel. A Windows file dialog will appear showing the contents of the current directory. The current directory will be the directory in which the ActiView program (.EXE) exists.

c) Select a configuration (.CFG) file, and click *OK*

A selection of CFG files with appropriate channel labels for the standard 1020 head caps are stored in the folder *Configuring* under the folder in which the ActiView software has been placed. When the ActiView screen returns, the new settings will have been loaded, but their effect may not be seen until you return to the *Monopolar Display* tab (upper left) and click *Start* to start viewing the incoming data. Note in particular that the *Channel* labels will not update until after the *Start* button has been pressed. Other parameters such as *Sample Rate* and *Bandwidth*, which depend on the current setting of the Speed Mode dial on the front of the A/D box, will not be updated unless the program has communicated at least once with the A/D box (either before or after the .CFG was loaded).

C. Verify the equipment is properly connected

See *ActiveTwo hardware setup* for guidelines on connecting the equipment.

D. Turn on the A/D box power and verify the contacts at CMS and DRL

Once the equipment is connected, depress the power switch on the battery unit connected to the A/D box and follow the instructions under *Electrode Offset* below to verify that the CMS/DRL electrodes are properly connected to the subject and that there are no other problems that would prevent you from recording meaningful data.

E. Verify the Decimation Ratio and Screen Length settings

Decimation Ratio and Screen Length are the two main parameters you will need to verify before clicking *Start* below. These two parameters cannot be adjusted while data are being displayed.

F. Click on Start to display data

Start will display the incoming signals in the ActiView screen. Regardless of how good or bad the signals look in this view, we recommend that you visit the *Electrode Offset* tab (see below) to check the stability of the electrode contacts.

G. Electrode contact checking

Electrode contact checking involves several steps that should be undertaken in the order presented here. If you see problems at any stage, remove the active electrode at the offending site, insert the syringe tip and touch the scalp, gently rock the syringe back-and-forth 2-3 times to part the hair, apply more gel, but only if no gel is visible at this site or you think you may not have applied gel here during preparation. Be careful to avoid using too much gel, because this can result in electrolyte bridges between two active electrodes or between an active electrode and CMS or DRL. Repeat these steps until satisfactory signals are achieved from all active electrodes. If you find that certain channels do not respond to your efforts, see the section on *Troubleshooting* below for assistance.

1. Verify that the blue *CM in Range* LED comes on

CM in Range serves more than one purpose, but it must be ON to record meaningful data.

a) CM in Range: solid blue (on)

(1) CMS and DRL connected to participant and A/D box

CM in Range will not come on if the CMS and DRL electrodes are not connected to the participant, if there is not adequate gel to make contact with the participant's skin and if the CMS/DRL cable is not connected to the A/D box.

(2) No cable faults detected

CM in Range will not come on if any over-current or under-current state is detected at the CMS electrode. Such a situation can be caused by a faulty active electrode or a connector / cable serving any active electrode. An over current situation theoretically could be caused by current flowing via a leaky ground of another device the subject is in contact with, but you would have to be extremely unlucky to encounter this circumstance.

b) CM in Range: blinking blue (off)

A blinking blue CM in Range LED indicates EITHER that the CMS/DRL electrodes are not properly connected and gelled OR that there is some other electrode cable fault. Any single broken

wire or bent pin on an electrode connector can cause a minor fault that causes the CM in Range LED to go off. See the troubleshooting section for instructions on how to identify which electrode or electrodes may be involved.

2. Be sure offsets on all channels are less than +- 40 mV

Verify that offsets at each active electrode are between +/-40 mV at rest. The *Electrode Offset* tab is a running average of the voltage measured between CMS and each active electrode. This value is NOT convertible to impedance, and it should not be considered the functional equivalent of impedance.

Electrode offset reflects the half-cell potential of the electrode/gel/skin interface. Differences in offset are mainly attributable to the attachment of stray ions at electrode tips (oxidation) or the loss of ions from the tip (corrosion). If you take good care of the electrodes (following the Electrode Handling guidelines in the *ActiveTwo User Manual*), you should see only small variations in offset (+/-40 mV is considered the normal range), and these small offsets are easily tolerated by the system.

If all offsets are at the maximum level of 262 mV, then either CMS or DRL is not connected or there is a cable/connector fault (broken wire or bent pin) on one of the OTHER active electrodes. Offset values exceeding the input range of the A/D converter (+/-262 mV) across all channels, suggest that the CMS/DRL connection is not intact. Stable contacts at CMS and DRL are necessary for measuring low, stable offsets on other channels. If offsets at all channels are at +262 mV, then the *CM in Range* LED is probably off. It may be necessary to part the hair or add electrolyte gel to make a stable contact at CMS/DRL.

If some but not all electrode offsets exceed +-262 mV, then CMS/DRL is connected well, but some other active electrodes are not connected well. Offset values exceeding the input range of the A/D converter at fewer than the total number of channels suggest that the CMS/DRL connection IS intact, but contacts at certain measurement sites (active electrodes) ARE NOT intact. Remove the affected electrodes, part the hair with the syringe tip, add gel and recheck offsets.

3. Touch electrode cables near the head to be sure that offsets do not change visibly

Stable electrode offset is a necessary, but not sufficient, condition for measuring good quality physiological signals from active electrodes. Gently touching the electrode cables near the subject's head will allow you to see any unstable electrodes on this tab. Poorly connected electrodes will not oscillate visibly when the cables re touched near the head with an offset tab scale set to +-262 mV. It is also a good idea to ask the participant to move their head (nod "yes", shake "no") while viewing the offsets to ensure a good, stable connection.

4. Observe signals on the Monopolar Display tab to identify outliers

Once you have done what is necessary to create low, stable electrode offsets at all of the active electrodes, you should click over to the *Monopolar Display* tab to view the incoming signals. Here you are looking for any channels that have larger signal than the others, which would typically mean they have more low-frequency artifact (unstable baseline or drift) or more high-frequency noise (e.g. 60 Hz).

To maximize the information you get from the *Monopolar Display* tab during the process of electrode contact checking, we recommend the following settings:

a) Set *Channels* to include the range of inputs you are using.

If you are using 32 active electrodes on the first 68-pin connector for ribbon cables (labeled *A1-32*; normally used for pin-type active electrodes), then select *A* under the *Channels* selector. If you are using 128 active electrodes on four ribbon cables plugged in at the first four D connectors (A1-32 … D1-32), then select *ABCD* under the *Channels* selector.

b) Set *Reference* to *None (Raw)*

Selecting *None (Raw)* under *Reference* will show you the voltage reading at each active electrode with respect to CMS (effectively, the Common). Note that this view is consistent with the way signals are stored by ActiView – unreferenced. The unreferenced view is helpful in identifying noisy channels, and it eliminates the possibility that the digital reference subtraction will make a saturated (flat signal; voltage exceeding the input range of the A/D converter) channel look like it is in range and measuring a meaningful signal.

c) Turn off display filters (Low-Pass and High-Pass)

The High-Pass and Low-Pass filters should be off to maximize your ability to see unwanted low and high frequency interference. Use this unfiltered view to guide you in finding sources of interference and eliminating them before you start recording data. To turn the display filters off, click on the green with the green highlight in the center below each filter title to change its state to gray or off.

5. Intentionally introduce 60 Hz to find the worst contacts

When you are comfortable that the offsets are low and stable and there are no channels that are visibly worse than others in terms of low or high frequency artifact or noise, it is a good idea to stress the preparation a bit to see if you can reveal any other problems that exist.

To identify poor electrode contacts not revealed by the offset and outlier checks, turn on ActiView's low-frequency filter (set to 0.1 Hz), turn off the high frequency filter and set the reference to the average of the displayed channel. This will give you a view of the signal at each channel referenced to the mean of all displayed channels. Then, ask the participant to put their foot on a nearby power cord (intentionally bring a power cord nearby if you have already removed power cords from the area around their feet). Press Start at the top left side The worst electrode contacts will pop out with more 60 Hz interference than others.

6. If the offsets and signals all look fine, then proceed to Recording below

You may find that all of the electrode offsets and signals look perfectly fine at this point. If so, then you should proceed to *Recording Data* below.

H. Recording

1. Click *Start File*

Start File is at the lower right side of the Monopolar Display page, and it is available only while viewing data (see above).

2. Designate which groups of channels you want to save to the file

A dialog box will come up asking you to designate which channels ActiView should save.

a) Predefined channel groups

Use the drop-down menu to select a predefined group of channels or to choose to save the channels that currently are being displayed (Monopolar Displayed Channels).

b) Additional channels (EXG channels, sensors, AIB channels)

Use the selector buttons to indicate whether to save the eight EXG channels, the displayed sensors (use the list on the sensors tab to change which ones are displayed before starting the Save File process), AIB channels, etc.

3. Set a path and file name for saving data

If the path specified in the current CFG file exists, then a Windows file dialog will come up allowing you to choose a path and file name for the saved data. If the

path in the CFG file does not exist, then an error message will come up. Click out of the error message, and use the Windows file dialog to choose/create a folder in which to save the data file. After your session is finished, you may want to save the CFG file to ensure the newly selected path is active the next time this CFG file is used.

4. IMPORTANT: ActiView is still Paused!

Note that after all of the above steps, the software is still not saving data. ActiView comes up in *Paused* mode, and it is necessary to "un-pause" manually or using a reserved code from a remote computer connected to ActiveTwo via the trigger input port. Click on *Paused* to switch the software to the *Saving* mode. During the recording session, you can click *Pause Save* to interrupt data saving (while the display continues to update) and then click *Paused* to resume saving.

IX. Best practices for making good EEG measurements

A. Optimizing the laboratory environment

1. Ample room

Clear enough space in the lab for the ActiveTwo system, computer(s) and any necessary furniture. Allow at least 2-3 feet between ActiveTwo A/D box / participant and any source of electrical interference. Avoid resting the A/D box on a metal surface: wood or plastic surfaces are ideal.

As an aside – note that people often confuse some of the environmental requirements of our magnetic 3D digitizer products with those of ActiveTwo. Note that these are separate issues. In most cases, a full-equipped participant room is a uniquely bad place to measure electrode positions. If you will be using a Patriot of Fastrak magnetic digitizer to measure electrode positions, remember that metal objects (i.e. metal file cabinets, metal studs in walls, etc.) near the participant can impact the accuracy of position measurements. Mount the system's magnetic digitizer as close as possible to the participant's head, and then measure the distance between the transmitter and the opposite side of the head. Keep metal objects at least 3 times this distance from the transmitter and the participant's head. Note that despite the fact that Aluminum is a poor conductor of electricity it is a particularly poor choice for use in a tripod to mount the transmitter, as it has a strong influence on the magnetic field.

2. Separate rooms for participant and experimenter

An area with two adjoining rooms is preferred -- one sound attenuated room for the participant and a separate area for the experimenter. Sound attenuation and visual isolation will help your participant stay focused on the task at hand, and it will allow the experimenter some freedom to move around and perform necessary tasks without distracting the participant.

3. Shielded room

An electrically-shielded room often does not produce a noticeable improvement in the quality of EEG measured with ActiveTwo. Whether it will be helpful depends on the environment and what type of devices you decide to bring inside of the shielded room with the participant.

a) Faraday cage (RF shielding) – not required

A Faraday cage, which is intended to provide protection against unwanted electric fields, is generally not required with the ActiveTwo system. Note that Faraday cages are often used to shield against radio frequency (RF) interference, but RF is well above the frequency range of interest in EEG (and outside the measurement range of the equipment), so RF is not a

serious concern unless the source is extremely powerful (e.g. a radio station antenna just outside the building) or extremely close to the participant (i.e. a cell phone near the participant's head). A Faraday cage can be constructed from continuous conductive sheet metal (best protection against RF) or copper mesh surface (walls, ceilings, floors, windows and light fixtures covered) enclosing the participant room. A Faraday cage around the participant room can help minimize interference from electrical equipment (i.e. power supplies) outside the room, but this is often futile, since electrical devices such as monitors (with integrated power supplies) are being used inside the participant room anyway. Examples of sources of electrical interference that may be of concern if located too close to the participant or the ActiveTwo A/D box are switching power supplies for monitors or other equipment, computers and other AC powered electrical equipment

b) Mu metal enclosure (magnetic shielding) – required only in extreme cases

A magnetically shielded room is generally not required unless there are exceptionally strong sources of magnetic interference in the area. Most typical office and laboratory environments are suitable for operating ActiveTwo without magnetic shielding. It is only in extreme cases that magnetic shielding would be required for the operation of the equipment. Even in extreme cases, if one part of the building poses a magnetic challenge, a different room in the building will be just fine. Examples of sources of strong magnetic interference that may be of concern are MRI / NMR equipment in adjacent rooms and large electrical motors associated with elevators, trains or other heavy equipment in the immediate area around the lab space.

4. Lighting

Lighting in the participant room can be a source of electrical interference and heat, both of which can be problematic for EEG recording. Special attention should be paid to selecting light fixtures that provide adequate illumination while emitting minimal heat. In general, fluorescent lighting produces the greatest amount of electrical interference. AC incandescent lighting is better, but still somewhat electrically noisy. The best option for minimizing electrical interference in a lab environment is low-voltage DC lighting. DC lights normally use halogen bulbs, which generate more heat than incandescent bulbs, so be careful to select DC lighting that does not generate excessive heat or compensate for the extra heat by providing extra AC / ventilation. Modern LED lighting can provide adequate lighting and it does not produce electrical interference. This may be the best option as prices continue to decrease and availability improves.

5. Ventilation

Ventilation and temperature control are important variables in preparing the participant room. Be sure that you have adequate temperature control and plenty of ventilation in the participant room to make the environment comfortable for the participant. You will get better data from a comfortable participant. A small fan will allow adequate air flow if the room is too warm.

6. Furniture

In general, avoid furniture with metal frames or surfaces in favor of wood or plastic. Metal-framed tables are especially problematic. Metal-framed chairs are generally OK, as long as they are upholstered and have minimal exposed metal. Large metal cabinets in the participant room can also be problematic as they can serve as an antenna and cause 60 Hz noise to be displayed in the Monopolar Display tab.

a) Chair for participant

A comfortable low-back chair is recommended for studies in which the participant will sit upright viewing a display or listening to sounds. A comfortable procedure chair with localized neck support (e.g. a dentist's chair) has advantages for supine participant positioning over a standard upholstered recliner, since a standard recliner places support behind the head, placing pressure on the electrodes, rather than behind the neck away from the electrodes.

b) Desk or table for equipment in participant area

A wood or plastic table or computer stand is recommended for use inside the participant room. Avoid furniture with metal surfaces or metal frames in the participant area since metal can inductively couple interference from monitor power supplies and other powered devices in the participant room to the participant if the participant comes into contact with the metal surface or frame.

c) Small cart for supplies used in preparing the participant

A small wood or plastic wheeled cart may be useful for holding consumable supplies, and if the participant room is small it is sometimes helpful for this cart to have wheels so that it can be rolled in and out as needed.

d) Additional small table for equipment in participant area

A small wood or plastic table is needed to hold the EEG system's input box. The table should be small enough that it can sit beside or behind the participant.

B. Regular testing with the "one-bucket" and "two-bucket" methods

To ensure the best possible performance when you have a participant connected to the system, bench-test the system regularly without a participant to ensure everything is in working order.

1. The one-bucket test – shorted input test

a) Fill a glass or plastic bowl or bucket with tap water and add a teaspoon of table salt (NaCl).

b) Make sure that the ActiveTwo hardware is assembled correctly, the power to the system is on and the ActiView software is up and running.

c) Connect CMS/DRL to the A/D box and submerge the CMS and DRL electrodes in the water.

d) Connect only the offending electrode(s) to the system, and submerge it in the salt water.

e) Observe the blue CM in Range light on the front panel of the A/D box. If it goes out, then see the section *CM in Range does not come on* under *Troubleshooting* later in this booklet.

f) Set *Channels* (left panel of ActiView monopolar display tab) to display only the used channels, set the *Scale* (upper left corner) to 100 uV/div, set *Reference* (left panel, lower) to *None (Raw)*.

g) Observe the signal on all connected channels over the course of 5 minutes. If you see anything other than flat traces in this test, it may be helpful to save the data (save only the monopolar displayed channels) so that you can send them to your support contact for advice or assistance.

(1) If the signal starts out relatively flat and becomes noisy over time

This is a sign that the electrode pellet may have lost some of its Chloride. This is a sign that it is nearing the end of its useful life.

(2) If the signal starts out noisy but becomes quiet over the course of 3-5 minutes

This is most likely a sign that the electrodes started out dry and it took a few minutes for the moisture to penetrate the hard electrode material. 3-5 minutes of slightly noisy signals when starting out with dry electrodes is within the expected range of normal operation. To avoid this initial noisy period, try soaking your active electrodes in salt water for 5 minutes once a week or for 5 minutes before each recording session. IMPORTANT: Soaking active electrodes in any liquid for longer than 10 minutes at a time is inadvisable as moisture will penetrate the electrode pellets and accelerate corrosion (loss of electrode material), resulting in poor electrode performance.

2. The two-bucket test – testing inter-channel calibration

a) Fill two vessels with salt water

Fill two glass or plastic bowls or buckets with tap water and add a teaspoon of table salt (NaCl) to each.

b) Assemble ActiveTwo and turn on power

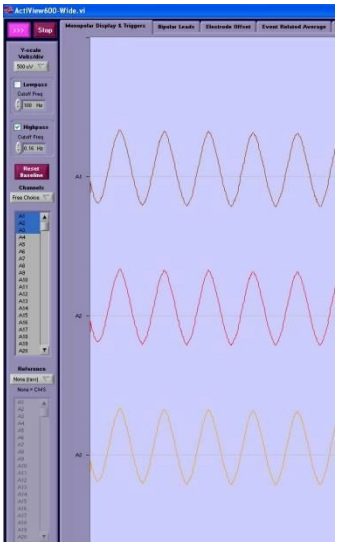
Make sure that the ActiveTwo hardware is assembled correctly, the power to the system is on and the ActiView software is up and running. Also, connect an attenuator to sine side of the signal generator. Set amplitude to MAX

c) Connect CMS/DRL to the A/D box and submerge the CMS and DRL electrodes in the water of one vessel.

d) Connect all of the active electrodes to the system, and submerge them in the salt water of the same vessel.

e) Perform the one-bucket test as described above.

f) Remove the active electrodes from the first vessel and submerge them in the second vessel (separate from CMS/DRL).



g) Set *Channels* (left panel of ActiView monopolar display tab) to display only the used channels, set the *Scale* (upper left corner) to 100 uV/div, set *Reference* (left panel, lower) to *None (Raw)*.

h) Use Ag/AgCl electrodes to conduct signal

Use Ag/AgCl electrodes to connect a signal generator to the test rig. Place the electrode carrying the signal generator Common (black) to the vessel containing CMS/DRL, and place the electrode containing the signal (red) to the vessel containing the active electrodes. IMPORTANT – do not use electrodes or other objects made of other metals to conduct signals into the salt water. Electrode corrosion or oxidation can result.

i) Observe/record signal

Observe the signal on the connected channels over the course of 1-2 minutes. To determine whether the system is measuring the same voltage across channels, save the data to a file and review it in your preferred analysis software tool.

C. Electrode and head-cap maintenance

1. Follow the current guidelines for electrode handling

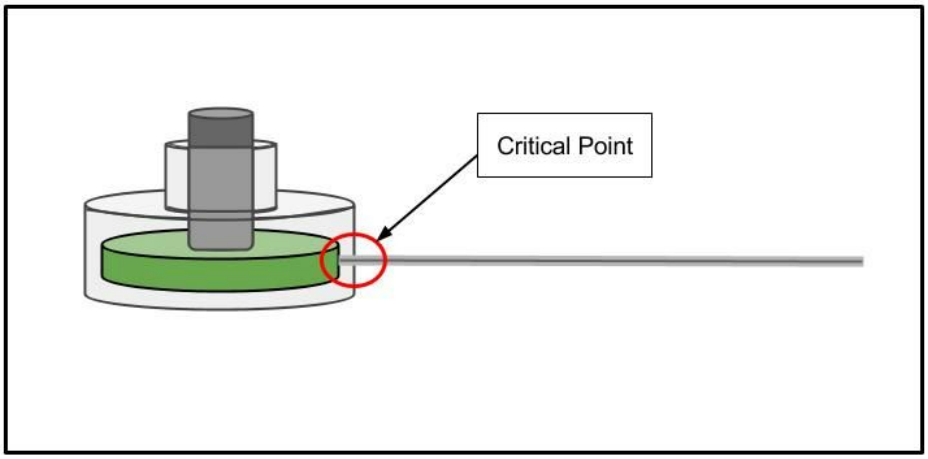
See the ActiveTwo User Manual for electrode handling guidelines. Here are some additional suggestions.

a) Use approved gel/paste.

Use SignaGel, Ten20 or Elefix for standard lab situations. Use Lectron III, Chloride 10 (Pharmaceutical Innovations) if your subjects are physically active, if temperature control in the lab is problematic, or if for any other reason you are having problems with skin potentials. We have found that this gel with higher Chloride content can help minimize drift caused by sweat and skin potentials. Avoid using unapproved gel/paste

products.

b) Handle electrode by plastic encasing, not by the wire which is more fragile. (See figure below)



c) Wash electrodes immediately after use.

d) Use warm tap water in a plastic basin for cleaning.

e) Avoid soap.

Avoid using detergents, as much as possible. Even mild detergent will eventually facilitate the corrosion of electrode pellets and loss of Chloride from the sintered electrode tips.

f) Avoid prolonged soaking.

Avoid soaking in water or other liquids, especially where other metal parts are present (e.g. electrodes, sink drains, etc).

g) Choose the mildest disinfectant that meets your needs.

Be aware that disinfectant products have a detrimental effect on the electrode contacts and the lead wire insulation. Options range from Hydrogen Peroxide (mild) to Isopropyl Alcohol to surface level disinfectants such as EcoTru and Envirocide to Metricide (harsh).

h) Air-dry the electrodes away from direct sunlight.

i) Store the electrodes away from direct sunlight in a non-metallic container separate from other metal parts.

j) Use very soft brush if necessary but only infrequently.

If you notice a build-up of gel or paste on the electrodes despite regular cleaning, brush lightly with a very soft toothbrush to clean the surface of the electrode. Do this only infrequently, as the electrode contacts are soft and brushing will remove material.

k) To balance offsets and minimize drift upon application, soak electrodes in salt water for 3-5 minutes before use.

Use one teaspoon of table salt to one liter of tap water. This is an especially useful procedure if you are planning to convert data to another file format with reduced precision (i.e. 16-bit or 12-bit) for analysis. Avoid soaking too long. This is an acceptable procedure to use routinely (before every run), but it can be helpful in maintaining low electrode offsets even if performed only after every third or fourth use of the electrodes.

2. Follow these guidelines for head-cap maintenance

a) Wash with mild soap (e.g. dish soap) and water.

b) Choose the mildest disinfectant that meets your needs.

Be aware that disinfectant products have a detrimental effect on the elastic fabric of the head cap. Options range from Hydrogen Peroxide (mild) to Isopropyl Alcohol to surface level disinfectants such as Control III and Envirocide (moderate) to Metricide (harsh).

c) Dry flat or on a cap stand.

Dry your head caps flat on a hard surface or on a head-shaped cap stand to avoid stretching.

d) Avoid heat.

Do not use heat to accelerate drying. A cool fan will accelerate drying considerably.

D. Participant intake procedures

1. Measure head at intake, and make sure you have a head-cap that fits snugly.

2. Instruct participants in advance to:

a) Minimize Nicotine and Caffeine use 2-3 hours before session to minimize muscle artifact.

b) Arrive early, especially if a long walk or stairs will be required to reach the lab.

c) Wash their hair the morning of the session and avoid using hair products such as leave-in conditioners, hair gels, waxes, oils, etc.

d) Layer their clothing so that they can control their own body temperature in case they arrive overheated or in case the lab space is too warm or too cold for them. The best types of clothing are button-up or zipper. Sweaters or shirts that require being pulled over the head is problematic.

E. Electrode application and signal-quality checking

1. Err on the side of too little gel rather than too much.

Too much gel can result in spreading and electrolyte bridges. This can lead to identical measurements at involved sites (average potential between two active electrodes), increased noise (i.e. short between active electrode and DRL results in reduction of CMRR) or complete loss of signal (i.e. short between active electrode and CMS results in no measured electrical potential at active electrode).

2. Use Electrode Offset tab in ActiView to check offsets

Verify that offsets are low (+-40 mV) and stable. Low, stable electrode offset is a necessary (but not sufficient) condition for measuring good quality signals in ActiveTwo. To address contact problems, remove the electrode at the site in question, use the syringe tip to part the hair by touching the tip to the scalp and gently rocking back-and-forth, inject a small amount of gel and replace the electrode.

a) Offsets > +-40 mV

Offsets exceeding +-40 mV that do not exceed the +-262 mV input range of the A/D converter indicate a potential problem of electrode corrosion or oxidation.

b) Offsets exceeding +-262 mV on all channels

Offsets exceeding +-262 mV on all channels with active electrodes connected indicate a problem with poor contact at CMS or DRL or a system fault (broken wire, faulty cable/connector junction, fault in active electrode electronics or fault in A/D box).

c) Offsets exceeding +-262 mV on less than the total number of used channels

Offsets exceeding +-262 mV on less than the total number of used channels indicate inadequate contacts at the active electrodes.

d) Unstable offsets

Have the participant move her head back and forth a few times to ensure that the contacts are stable even during rapid movements.

3. Check signal quality in monopolar and bipolar tabs using *Reference = None (Raw)*.

Ask the participant to sit quietly while you observe the EEG signal on the Monopolar and Bipolar pages. Set *Channels* to display all of the channels associated with electrodes you have connected to the system, set *Reference* to *None (raw)* to display the single-ended voltage measurement between CMS and each channel and turn off the high-pass and low-pass filters (de-select the green 'button' below each in the Monopolar Display page). Look for problems such as:

a) High 60 Hz interference

60 Hz is identifiable by the periodic envelope that results from the fact that the display does not have adequate horizontal resolution to display the high-frequency signal.

b) Low-frequency instability

Low-frequency instability can result from poor electrode contacts (inadequate contact between gel/skin/electrode), but it can also be caused by aged electrodes from which too much Chloride has been lost. Use the one-bucket test above to distinguish between the two.

F. Positioning of A/D box, cables and participant

1. Follow the furniture guidelines above.

Avoid metal tables, especially in the presence of other electrical equipment.

2. Position A/D box as close as practically possible to participant.

Although impractical, the electrical ideal is for the A/D box to be on the participant's lap. Keep the two as close together as possible.

3. Keep the active electrode leads close together along the length of the run from participant to A/D box.

It is particularly important to keep each lead near the CMS/DRL lead, but it is also useful to keep each lead close to its reference lead. Use Velcro cable ties or tape to keep leads together.

4. Keep power cables, power supplies and cables carrying other high-level signals away from the participant

Power cords, power strips, video/audio cables and AC/DC converters are examples of potential sources of interference to be aware of.

X. Triggering for event-related potentials

The best method for triggering ActiveTwo depends to some degree upon the type of stimulus apparatus you choose to use and the type of software you will use to analyze the resulting data. Follow these general guidelines to trigger ActiveTwo:

A. Connect the triggering device/computer to the ActiveTwo Trigger Input Port.

If a trigger cable was provided with your system for this particular stimulator, it should work fine without modification. Typically, trigger cables provided by Cortech Solutions are designed to connect a standard PC parallel port to the ActiveTwo trigger input port. Consult your support contact for assistance or see the ActiveTwo Trigger Input Port pin-out information in the ActiveTwo User Guide or at http://www.biosemi.com/faq/trigger_signals.htm.
Triggering is possible through three different methods:

1. Trigger Inputs on the USB Receiver

a. Features 16 independent trigger inputs and 16 trigger outputs
b. Plugged into the rear of the USB interface box with a parallel port
c. ActiView always automatically saves all 16 triggers in an extra channel even when an independent Lab view thread is integrated with the BioSemi acquisition software

2. Response switches connected to the A/D box

a. A maximum of 2 response switches can be plugged into the ERGO or switch inputs.
b. *RespSwitch* = Trigger 9 & 10 = USB Input triggers 9 & 10
c. *RespSwitch* = Trigger 9 & 10 = Response Switches 1& 2 (ERGO)
d. *RespSwitch* = Trigger 9 & 10 = Response Switches 1 & 2 (Switch)

3. Pressing the Function keys on the ActiView computer

Short the inputs 9-16 on the ActiveTwo trigger port to provide access to all eight (8) function key inputs.

Function Key	F1	F2	F3	F4	F5	F6	F7	F8
Trigger Input	9	10	11	12	13	14	15	16

B. Assemble ActiveTwo and turn on power.

Make sure that the ActiveTwo hardware is assembled correctly, the power to the system is on and the ActiView software is up and running.

C. Select Analog under trigger format in the Monopolar Display page.

D. Observe the state of the trigger input port.

See if the used bits are being held low or high. Each pin on the trigger port is the equivalent to one trigger bit. The port has 16 pins/bit plus a ground. The standard ActiveTwo trigger cable provided by Cortech Solutions is designed for use with a standard PC parallel port and has only 8 bits plus ground connected (pins 2-9 on the DB25 connector = pins 1-8 on the DB37 connector, pin 25 on the DB25 = pin 37 on the DB37 = ground. The other (unused) pins/bits (pins 9-16 on the DB37 connector) are shorted to ground so that these bits are always held low.

E. Start the device/application that will send the trigger signals.

Start sending triggers and observe the analog trigger input signals to see if the port goes first to zero (all bits low) followed by brief pulses (colored lines) on the used bits.

F. If trigger signals are visible and reliable…

Switch Trigger Format to 'Decimal' to see if the trigger values are what you expected.

G. If trigger signals are not visible/reliable…

Increase the duration of trigger pulses to a value slightly higher than 1/R where R = the final sample rate to file. The sample rate to file can be determined by multiplying the overall sample rate associated with the selected speed mode by the decimation ratio selected in ActiView.

H. Save a short test data file with triggers.

Read the sample file in your analysis program to ensure that triggers are faithfully represented.

I. Trigger timing problems…

Be aware that the ActiveTwo trigger port is very reliable, and any timing problems are guaranteed to be on the stimulus delivery side. It is advisable to test trigger output timing using a two-channel scope (video: photocell signal to channel one, trigger bit to channel two; audio: audio line-level signal to channel one, trigger bit to channel two). If testing with a scope reveals no problems, it is possible to test ActiveTwo trigger timing by connecting a photocell or mic signal to one ActiveTwo channel (optional photocell and mic sensors are available) and a trigger bit to the ActiveTwo trigger port.

XI. Basic file reading and analysis steps for EEG/ERP in EMSE Suite 5

A. Basic steps

1. File->New Workspace

2. Right-click Project 1, and select Add->Time series data.

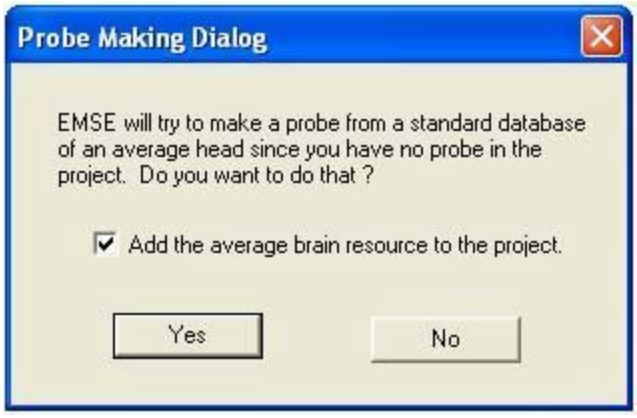
3. Browse to a data file, and double click.

4. Right-click on new data file and select Load (or double-click).

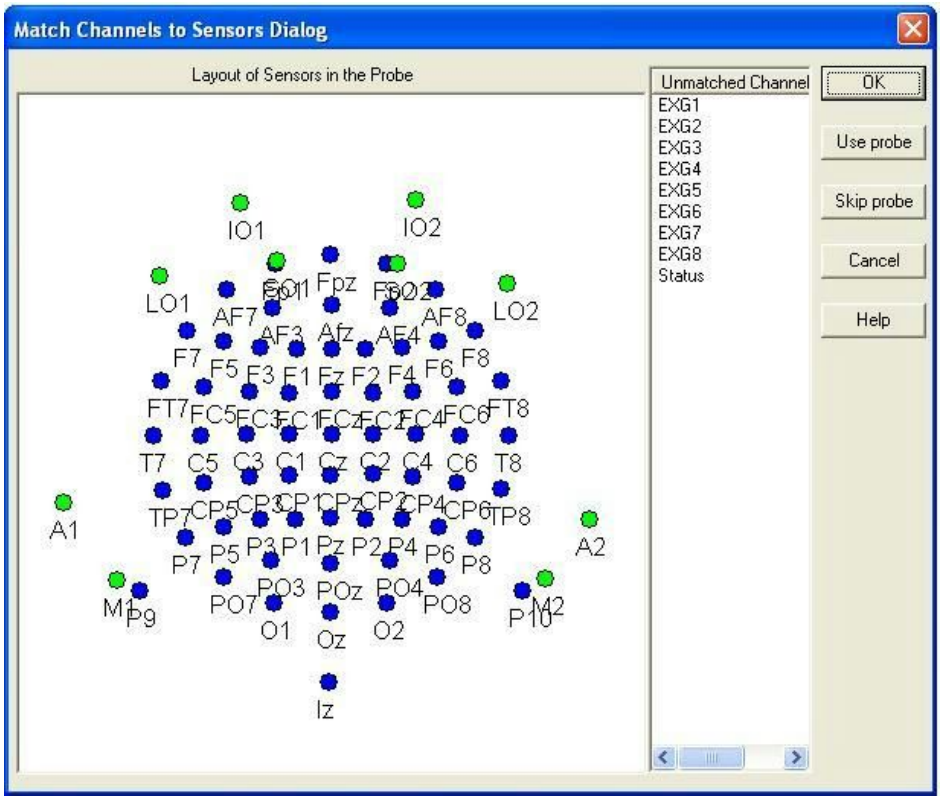
5. Probe-making dialog appears, allowing the user to determine whether to let EMSE:

a) automatically select a probe file that is the best fit for your data file (recommended if you did not measure actual electrode positions at the time of data collection)

b) add the average brain resource to the workspace (recommended if you will perform source analysis and you will not have access to an individual MRI scan for this participant)



6. Match channels to sensors dialog appears if there are any unrecognized channel labels in your data file



The Match Channels To Sensors dialog allows the operator to drag unmatched channel labels from the column at right onto sensors in the 2D diagram to match channels to sensor positions. If the channels in the right hand column match sensor positions in the 2D diagram that appears, you can avoid this manual matching step next time by changing the labels of the channels in the ActiView CFG file you use so that the correct labels appear in the data file. Once all the relevant matches have been made, click OK to proceed.

7. EMSE analyzes the event channel

EMSE creates a new table of events in a text file with the extension EVT and attaches this event table under the node depicting the BDF data file. EMSE defaults to positive logic, so if you are using any devices with negative or mixed logic be aware that you may have to use Edit->Events->Trigger Search to identify trigger events accurately. The most common problem with negative or mixed logic starts with EMSE finding the right number of event codes but the codes numbers do not match your expectations. This happens when negative logic caused EMSE to find the end of an interval rather than the beginning. Thus, event timing is also compromised.

8. Turn off some channels

To optimize the display of EEG, you may want to view only the EEG channels or only polygraphic channels, since the relatively large scales of polygraphic channels may conflict with the small scale of EEG channels.

9. Change the state of any active non-EEG channels to PassThrough.

This will simplify later display and signal processing steps. Any remaining unmatched channels in the right-hand column of the Match Channels To Sensors dialog will be turned off by default. If these channels contain non-EEG signals that you want to work with in EMSE, you may need to change the state of these channels to PassThrough using Edit->Channels and setting the channel state as desired.

10. What if my data appear as flat lines?

If there appears to be no signal on any of the channels, it is most likely a problem of there being a very high signal value on one or more channels (e.g. one saturated or unused channel), which confuses the autoscaling algorithm. In this case, click the second icon from the left to apply a polynomial (default = order 1 or linear) detrend to the signals. This will center the traces on their channel labels at left and compensate for any offset or drift that may confuse the autoscaling algorithm.

B. Applying an EEG reference

ActiView always stores signals WITHOUT A REFERENCE (single-ended or monopolar), no matter what choice of reference you select on the left hand panel of the ActiView screen.

1. Version dependencies in EEG reference handling

a) How reference was handled in EMSE 5.0

If you load BDF data in EMSE 5.0, the software will ask you to specify what kind of reference was used, and you should select the "implicit" option, even though this is not strictly correct. This was a work around made necessary by the fact that BioSemi is the only system supported by EMSE Suite that does not include an implicit reference in the stored data.

b) How reference is handled in EMSE 5.3

The way the reference is handled for BDF data files has been improved in later versions. The software now knows that BioSemi files are always stored without a reference, so it does not ask you to specify a reference when you read the file. This does not change the fact that you must apply a reference using the Filter Pipeline. Moreover, EMSE now analyzes the characteristics of the data file (e.g. number of channels) and, assuming you are using one of the standard BioSemi electrode layouts, EMSE loads a suitable default electrode position data file (Probe).

2. Applying a reference in EMSE Data Editor

a) Load the data in EMSE Data Editor

Double-click the data file name in the workspace at left or right-click the data file name and select Load.

b) Select Analysis->Filter Pipeline->Add and select from the reference options available under the Montage section:

(1) Bipolar montage

(2) Common average reference montage

(3) Digital reference montage

(4) Laplacian montage

(5) Linear derivation montage

The most common choices are a) Common Average Reference (using the average of all scalp EEG channels as the reference for each EEG channel) and b) Digital Reference Montage (a single channel, such as the nose; or the average of a few channels, such as left and right mastoids).\

C. Applying filters

ActiView always stores signals WITH NO HIGH-PASS FILTER AND LOW-PASS FILTERED ONLY BY THE ANTI-ALIASING FILTER, no matter what filter settings you make on the left-hand side of the ActiView screen. You will most likely want to include either an IIR or an FIR temporal filter in the filter pipeline before applying further signal processing (such as ERP averaging). At minimum, a low cut (high-pass) filter is recommended to eliminate electrode offsets from the record before averaging. To learn more about digital filtering, visit http://www.dspguide.com/ch14.htm.

1. FIR (finite impulse response) filter

An FIR filter can also be referred to as a forward or causal filter, and it acts much like an analog (hardware) filter in that it does not take future data into account when filtering. Thus, energy in the signal tends to be pushed forward, and this can cause phase shifts in your data that differ across frequencies. This undesirable trait should be balanced against the desirable characteristic that an FIR filter will not disturb the pre-event baseline period. In event-related potential paradigms where the pre-event baseline is short, an FIR filter may be more desirable for the low cutoff (high-pass) than an IIR filter.

2. IIR (infinite impulse response) filter

An IIR filter can also be referred to as a zero-phase shift or non-causal filter, and it is a typical digital filter, taking into account past data and future data by moving through the data in both the forward and reverse directions. An IIR filter spreads energy evenly in both directions, so in experimental paradigms in which the pre-event interval is equal to or greater than the post-event interval, an IIR filter may be more desirable for the low cutoff (high-pass) than an FIR filter.

XII. Measuring physiological signals other than EEG

A. Apply any additional sensors

ActiveTwo supports a variety of other sensors for measuring physiological and non-physiological signals. A relatively current list is maintained in the Accessories section under ActiveTwo on the Cortech Solutions web site (www.cortechsolutions.com). New sensor options are periodically added, so the latest sensor options may take a few weeks to make it onto the web site. If you need a sensor that was not provided with your system or that you do not find in the Accessories listing on-line, please contact us.

B. Turn on the display of desired sensors

1. In ActiView, select the *Auxiliary Sensors* tab.

2. Select sensors to display

In the left panel of the Sensors page, left-click to select the sensors to display (Ctrl+left-click to select multiple).

3. Choose suitable scale settings for the selected sensors

Note that ActiView provides special scale selectors for built-in sensors. Use these to set the desired scale for each type of sensor being used.

4. Set 'DC reset at screen start' ON or OFF

ActiView can set the first data point for each sensor channel to zero (artificially correcting the baseline) to make it easier to see signals with different scales or offsets in a single display window. For some situations you may prefer to see the actual signal level without any artificial baseline correction.

C. Save the displayed sensors

After you use *Start* at the top left side of the *Monopolar Display & Triggers* page, you will have the option at the lower right side of the page to select *Save File.* Click *Save File* and select the green option button labeled *Displayed Sensors* to include in the saved data file the data from the displayed sensors.

XIII. Analyzing physiological signals other than EEG

ActiveTwo is a flexible data acquisition system, with the capability to record EEG and a wide variety of other physiological (and non-physiological) signals.

A. ActiveTwo is typically used with at least a few non-EEG signals

The majority of our customers use ActiveTwo to record EEG along with a few other types of signals. How many other signals are recorded varies widely as do the signal processing requirements for these non-EEG physiological (and non-physiological) signals.

B. ActiveTwo / ActiView file format: BDF

The ActiView data files are stored in a format know as BDF, which is an open, documented file format pattered after the European Data Format (EDF) supported by so many signal analysis software tools.

C. EDF vs BDF

In fact, the only substantive difference between BDF and EDF files is the fact that the EDF data files have 16 bits per data sample and the BDF data files have 24 bits per data sample.

D. Which signal analysis tools read BDF files?

The BDF file format is supported by a wide variety of signal analysis software tools, including:

1. **EMSE Suite**
2. **BESA**
3. **g.BSanalyze**
4. **EEGLAB**
5. **BIOSIG**

E. Which ones are designed for analysis of non-EEG signals?

Of these tools, g.BSanalyze and BIOSIG include the widest variety of non-EEG analysis techniques. EMSE Suite, BESA and EEGLAB are mainly EEG-oriented, but there is a great deal of overlap between the techniques used for EEG and those you might want to use for other signals.

F. Signals often combined with EEG

1. Signals measured with active electrodes

a) EOG (electrooculogram)

There are a few different reasons why one would want to measure EOG in combination with EEG:

(1) Artifact detection and trial rejection

Eye movements and blinks produce significant artifacts in EEG. Consequently, EOG is most often monitored along with EEG to improve one's ability to distinguish between artifact and real data. EMSE Suite, BESA, g.BSanalyze and EEGLAB offer this capability.

(2) Artifact removal

Algorithms can be applied for removing EOG artifacts from EEG. This is sometimes necessitated by the fact that the population of interest is unable to control their eye movements. It is sometimes necessitated by the experimental paradigm. EMSE Suite, BESA, g.BSanalyze and EEGLAB offer this capability.

(3) Rejection of trials based on eye-movements

In experiments where visual fixation is required, EOG is often used simply to exclude trials on which a participant moved her eyes. EMSE Suite, BESA, g.BSanalyze and EEGLAB offer this capability.

b) ECG (electrocardiogram)

(1) Monitoring heart-rate as a dependent variable or for trial selection/rejection

Most often, ECG would be combined with EEG to permit monitoring of heart-rate on a moment-by-moment basis for purposes of trial selection/rejection or categorization. For this purpose, one may be better-off using a version of ActiView (i.e. BETA release of ActiView 5.35B) that calculates heart-rate on-line from EXG7-EXG8 and saves it in the Sensor channel named Ergo1. Strangely enough, even with all of the fancy algorithms they incorporate, EEG signal analysis tools generally do not incorporate mechanisms that can easily derive heart rate from an ECG signal.

(2) Artifact detection/rejection and/or removal

ECG sometimes produces an artifact in the EEG record, so it may be combined with EEG for some of the same reasons as above. In fact, some of the same algorithms offered in software tools for handling EOG artifacts also could be applied to ECG artifacts.

c) EMG (electromyogram)

EMG signals are typically recorded from a bipolar pair of electrodes placed over the muscle group of interest.

(1) EEG / EMG: time-locking the EEG/ERP analysis window to motor events

EMSE Suite, BESA, g.BSanalyze and EEGLAB offer the capability to insert event markers either manually or based on some kind of simple threshold applied to an EMG channel.

(2) Surface EMG (no EEG)

When EMG is used as a dependent variable (e.g. blink-reflex), EEG is not typically measured. Very sophisticated analysis algorithms do exist for EMG, but by-and-large, EMG is analyzed using relatively simple algorithms that are available in EEG analysis tools. Two relatively special mechanisms that are often used for EMG analysis are rectification (taking the absolute value of the signal) and smoothing. EMSE Suite, BESA, g.BSanalyze and EEGLAB all offer these capabilities and more.

2. Signals measured with specialized sensors

a) Skin conductance (SC)

(1) Some overlap in methodology with EEG analysis

EMSE Suite, BESA, g.BSanalyze and EEGLAB can be used to average event-related GSR signals, and to some degree, these tools can also be used to make measurements of signal amplitude and latency on a trial-by-trial basis.

(2) Not well standardized

The methods used to analyze GSR signals are not as well standardized as those used for the other types of signals we discuss here. Consequently, there seem to be a wide variety of analysis methods in use in the literature.

(3) Not handled all that well by EEG analysis tools

Some commonly-used analysis methods for SC signals (e.g. counting 'turns') are not implemented in EEG analysis tools.

b) Respiration

Analysis of respiration signals is similar in many respects to the analysis of ECG signals. Respiration would most often be monitored alone as a dependent variable or with EEG for trial selection/rejection or categorization. For this purpose, one may be better-off using a version of ActiView that calculates respiration-rate on-line and saves it in a special Sensor channel. Strangely enough, even with all of the fancy algorithms they incorporate, EEG signal analysis tools generally do not incorporate mechanisms that can easily derive respiration rate from a respiration signal. We hope to have a BETA release of ActiView in the coming months with the capability to calculate respiration rate on-line.

c) Temperature

Only a few customers are using our temperature sensor, but generally they seem to be interested in sleep and circadian rhythms. In combination with EEG, temperature would most-likely be used for segment selection/rejection or categorization. This could be accomplished in EMSE Suite, BESA, g.BSanalyze and EEGLAB.

d) Plethysmograph

Although the signal looks entirely different, the Pleth signal would be used for the same primary purpose as ECG: derivation of heart-rate for selection/rejection/categorization of data segments or trials.

XIV. Basic file reading and analysis steps for EEG / ERP in EEGLAB

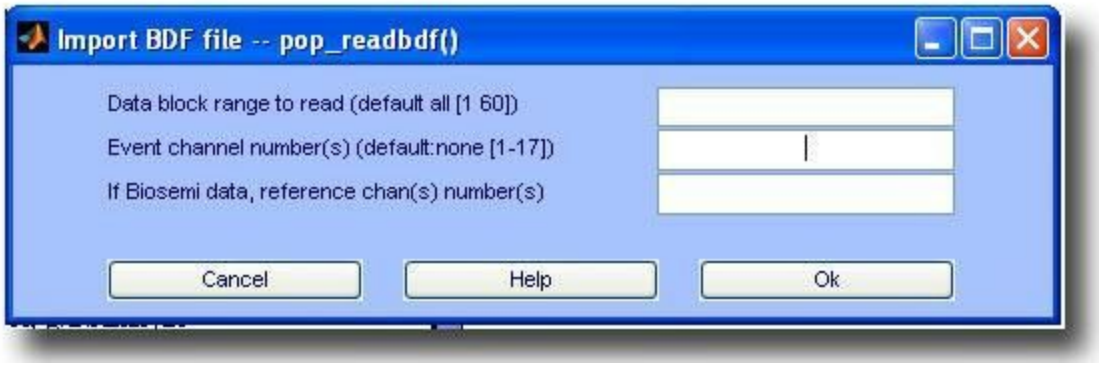
A. Start MATLAB and EEGLAB

B. Select File->Import data->From BioSemi BDF File using BIOSIG

C. Browse to the file and double-click on it.

D. ImportBDF dialog

A dialog box will appear asking you to specify some characteristics of the data file.



1. Reading only part of the file

If you want to read only part of the data file (because your PC does not have enough memory to read and analyze the whole file), then specify which blocks to read in the first field.

2. Event channel designation

Enter the last channel number as the event channel (the prompt will tell you how many there are, so if it says [1 17], enter 17. IMPORTANT: The built-in EEGLAB function that handles reading events from the Status channel is limited to data collected from ActiveTwo Mark I systems (all ActiveTwo systems up to about October or November, 2005). For data collected with Mark II systems, it is best to use the events derived by BIOSIG. For specific instructions on this, please consult the EEGLAB list and/or Alois Schloegl, the developer of BIOSIG.

3. Reference

EEGLAB knows that ActiveTwo data are stored unreferenced, so it wants the operator to say which channel should be used to rereference the data. Enter a channel number and click OK. Example: if 64 channels are bring used, enter 65 and 66 as the reference channel numbers.

XV. Electrode care and cleaning

The silver/silver-chloride (AgAgCl) sintered electrodes behave like sponges, they absorb water and electrode gel. The deeper the water/gel has penetrated the electrode, the longer it will take afterwards for the water to vaporize. As long as your electrodes are 'wet', corrosion processes will take place. This corrosion process will in the long run make your electrodes noisier. That is why it is important to clean the electrodes immediately after use and dry them immediately to eliminate the opportunity for corrosion to develop.

A. Handling and cleaning

1. Use connector ejectors

The A/D box has small white plastic levers next to each D connector on top. These are the connector ejectors, and they are designed for easy removal of the connector. Always make sure to use them.

2. Remove from cap gently

Do not pull the electrodes by the wire or cable. Grasp the electrodes firmly by the plastic housing, and avoid pressing on the wire exiting the electrode housing.

3. Clean before allowing to dry

Do not let the electrodes dry without first being cleaned . When the electrodes dry up covered with gel/salt/minerals, the cleaning process will be harder and takes more time, making your electrodes become polluted and/or corroded sooner.

4. Clean with water, but don't use soap.

Clean electrodes softly immediately after use (when the gel is still soft) by hand with warm water. Use warm tap water to rinse off the gel from the electrodes. Warm water (up to 50 degrees Celsius) will dissolve the gel quicker. Do not use aggressive soaps etc. Only use soap if water does not seem to clean the electrodes properly, never use solvents (e.g. acetone), acids or alkaline.

5. Soft brush if necessary

Use a soft brush for removing gel residues from the electrodes only if absolutely necessary.

6. Dry with paper or cloth towel;

Dry the electrodes gently with a paper or cloth towel. Let them air dry fully before storing.

7. Keep connector clean and dry

Keep the connector clear of water/gel. When a connector is polluted with gel or salt water, it should be rinsed with distilled water, followed by a rinse with

alcohol (ethanol) and finally the connector should be allowed to dry completely before putting into operation again.

8. Avoid contact with other metals.

Do not let the pellets touch any kind of metals. Do not store the electrodes in a metal box. In general, prevent the electrode tips from touching any metal objects, because this causes pollution of the Ag/AgCl pellets with "strange" metal particles (increasing noise).

9. Store away from direct sunlight.

Store the electrodes in a dark, dry place. Exposure of the Ag/AgCl electrode tip to light also causes deterioration. Keep out of direct sunlight or other bright sources of light when the electrodes are not being used.

10. Avoid airtight storage containers

Do not store the electrodes in an airtight container. Best storage method is to wrap the electrodes in a paper towel and place them in a cardboard box or to hang them freely in a dark place.

B. Balancing to minimize electrode drift

After applying the electrodes, it takes some time before the chemical reactions in the electrode-gel-skin interface reach a stable equilibrium. It will typically take approximately 5 minutes before baseline drift and noise have settled completely. Quicker settling of the electrode noise to a low level can be achieved by placing the electrodes in water approximately 5-10 minutes before the measurement is started. During these 5-10 minutes, the salt water will be absorbed in the Ag/AgCl pellet, enabling the pellet to make better chemical contact with the gel. Please note that the longer the electrodes are placed in water, the longer it will take the water to evaporate and this will accelerate the corrosion process of the Ag/AgCl pellet.

C. Modifications/Splitting of the flat cable

1. Do not split cables

The electrodes are not intended to be modified by the customer. Especially "splitting" the flat-cable further may lead to a non-repairable malfunction and void your warranty! If you have a request for different splitting of an electrode set contact BioSemi (or its local representative)

D. Malfunctions

1. If an electrode is not operating as specified, please do the following:

a) Soak in salt water

Soak the electrodes in water with some salt added (approx. one small teaspoon per liter, use a non-metal bowl). Do not exceed 10 minutes of soaking.

(1) If this causes the blue led to turn off, then the electrode set is in need of repair (return to dealer/manufacturer)

(2) If you experience noise, then please follow-up the directions below concerning noisy electrodes.

(3) Noisy electrodes: (also read "Life span")
Noisy electrodes generally mean that your electrodes have reached its end of life. You can extend the life a little bit by placing the electrodes in salt water for up to ten minutes before you start your measurement. This soaking process often minimizes noise. A last remedy is to use a grain 600 or higher waterproof abrasive paper to polish the electrode tip. Use very soft circular movements, preferably no more than 2-3 times on the same area, removing an even very thin layer across the entire surface.

E. Life span (Life expectancy)

Ag-AgCl sintered electrodes have a limited life span. This is caused by several processes such as corrosion, the dissolving of the Chloride in the pellets and the wearing of the pellet during the cleaning process. After approximately 200 measurements, the color of the pellets will change from gray/brown (silver–chloride) to silver, due to the disappearing of the chloride. The AgCl slowly dissolves in gel and water during the

cleaning. Eventually, this leaves only silver behind. The resulting pure silver electrode has much higher drift and noise characteristics than the original Ag/AgCl electrode, forcing your electrode set to be replaced.

XVI. Troubleshooting ActiveTwo

A. ActiView display: partial screen or blue/gray screen

ActiView was developed in LabVIEW, and LabVIEW tools are notoriously difficult to resize dynamically within Windows (reliably). Consequently, BioSemi have decided to maintain a few versions of the ActiView software, each operating at a fixed display resolution. If the current display mode has an inadequate number of lines to display the ActiView screen, you will see a display like this:

If the bottom of the screen is cut-off, or you see only a blue-gray screen without any controls at left, right, top or bottom, try changing the video display mode to accommodate the number of lines (900, 1024 or 1200) required by the chosen version of ActiView.

1. Changing your display mode settings in Windows

To change the display mode, follow these steps:

a) Go to Control Panel

Go to *Start->Control Panel* (or *Start->Settings->Control Panel* when operating in Classic Start Menu mode).

b) Select Display

In the Control Panel, select *Appearance->Themes->Display* (or select *Display* when operating in Classic Control Panel mode).

c) Set resolution

In the *Display* dialog, click the *Settings* tab, and move the *Screen Resolution* slider to the right to increase the resolution to a mode that has an adequate number of display lines to support the version of ActiView you have selected. The second number in the pair (e.g. 1024 in "1280 x 1024") should be greater than or equal to 900 if you selected the laptop version, 1024 if you selected a LoRes version of ActiView or greater than or equal to 1200 if you selected a HiRes version of ActiView. You should not have to worry about the horizontal resolution value for LoRes or HiRes versions, as long as the vertical resolution (number of lines) is adequate. For HiRes Wide versions of ActiView, you will need a display mode with resolution equal to or greater than 1920 x 1200.

2. If a suitable display mode is not available

If your display (graphics adapter + monitor) does not support a video mode with adequate resolution to display the version of ActiView you are using, then you may consider using a lower resolution version of ActiView. If you are already using the LoRes version (1280 x 1024), then consider upgrading your monitor.

a) If you are using a notebook or laptop

Because notebook and laptop displays that support SXGA or greater resolution are becoming rare, BioSemi now offers a lower resolution wide screen version (1440 x 900) for notebooks.

b) If you are using an LCD monitor

LCD monitors tend to offer fewer display modes than most graphics cards these days, so try switching to a CRT (traditional monitor with cathode ray tube).

c) If you are already using a CRT

If you are already using a CRT, then you may need to upgrade to a new graphics adapter or an entirely new computer.

B. Noisy active electrodes

Noisy signals on certain active electrodes during a recording session may indicate a problem with the electrode, but noisy signals can also result from a poor contact with the subject's scalp. Noise during measurement can by caused by several factors: electrode tip contaminated with metal particles, electrical noise from other sources (lights, power cord,

fan), or EMG (only on a few electrodes located close to magnets). Perform the one-bucket test to troubleshoot active electrodes.

C. CM in range does not come on while a participant is connected

If the *CM in Range* LED either fails to come on or it goes out during a recording session, there can be more than one possible cause. At the simplest level, it may indicate a poor contact with the participant at the CMS/DRL electrodes. Gently press on the electrodes to ensure better contact. However, there is a safety circuit designed into the ActiveTwo A/D box that can be engaged by either an over-current or an over-current situation detected at the CMS electrode. Such situations are normally associated with faulty leads or connectors.

1. Possible causes

a) Inadequate connection between CMS and/or DRL electrode and participant's body

Check to be sure that the CMS and DRL electrodes are making good contact with the participant, and be sure they are plugged into the A/D box. Thick hair is the usual suspect to this issue. Try parting the hair, apply a minimal amount of gel, and then reinsert the electrode to resolve this problem

b) More than one CMS/DRL set plugged in

The last two leads on the A connector and the A ribbon cable can serve CMS/DRL electrodes. If you have CMS/DRL connected at the front panel of the A/D box, check to be sure that the A electrode set you are using does not also have CMS and DRL electrodes. If it does, then use these CMS/DRL electrodes and unplug the CMS/DRL set at the front panel.

c) Faulty EXG wire

A broken lead wire inside one of the EXG electrodes (even if the insulation is not damaged) will be detected by the ActiveTwo safety circuit as a fault. In particular, old-style EXG electrodes (flat electrodes with individual leads and touchproof key-shaped connectors) are subject to this problem. The old-style EXG electrodes can be identified by their dark gray wire insulation jacket, on which there is black printing. If you have this type of EXG electrode, and it is causing CM to go out of range, then it is probably due to a lead wire fault inside the insulation near the junction with the active electrode. The new-style EXG electrodes have light-gray lead wire insulation with no printing. These lead wires have proven much more robust than the old style lead wires.

d) Faulty wire near any active electrode

A broken lead wire in an electrode ribbon cable will be detected by the ActiveTwo safety circuit as a fault. In particular, old-style EXG electrodes (flat electrodes with individual leads and touchproof key-shaped connectors) are subject to this problem. The old-style EXG electrodes can be identified by their dark gray wire insulation jacket, on which there is black printing. If you have this type of EXG electrode, and it is causing CM to go out of range, then it is probably due to a lead wire fault inside the insulation near the junction with the active electrode. The new-style EXG electrodes have light-gray lead wire insulation with no printing. These lead wires have proven much more robust than the old style lead wires.

e) Faulty ribbon cable/connector junction on 32-channel electrode set

Old style 32-channel active electrode sets with ribbon cables and 68-pin D connectors do not have a strain relief to keep the ribbon cable from pulling the D connector apart. Some very old electrode sets do not have epoxy glue in the joint where the connector clamps onto the ribbon cable. Check for an intermittent contact at the junction between the ribbon cable and the D connector.

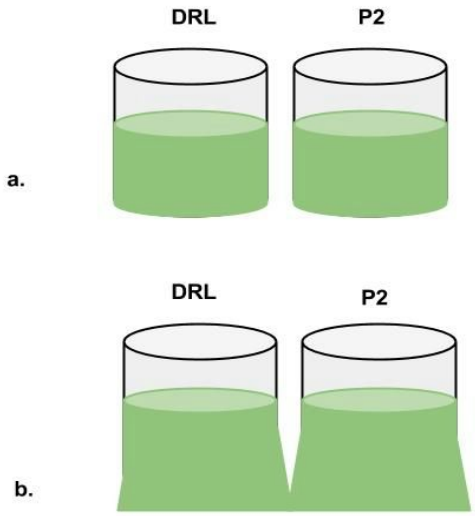
f) Faulty lead insulation

If the wire insulation is broken but the wire is still intact, it is possible for gel or other moisture) on the electrode and lead wire (even very small amount) to conduct between the electrode contact and the exposed wire, resulting in an electrical short circuit. This will be detected by the ActiveTwo safety circuit as a fault.

g) Other common faults

(1) Water/gel in the A/D box or connectors on top: be careful not to get moisture into the A/D box. This is evident if the A/D box immediately shuts off but the battery is fully charged and functional. In addition, the Blue LED light turns off (blinking), or all 3 LED's turn off or are blinking. Turning the A/D box off and flipping it over to drain may help. If gel is in the pin connectors, the gel can create a bridge between the pins inside the connector and the metal shielding around the connector. The guard protective circuitry will detect the current and the A/D box will shut down. To remove the gel, first make sure to use an un-bent ribbon pin and the gel has dried: connect and press the connector in and then eject. Repeat this step until the gel has been broken down and removed.

(2) DRL short: DRL and the surrounding electrodes are closer together compared to other electrode locations throughout the cap. If too much gel is placed in the holder, then a bridge may form between DRL and a neighboring site. It's best to have too little gel and add more when needed (a), than to have too much gel and form a bridge (b). See figure below for illustration.



(3) Electrode offset IZ: if this electrode shows electrode offset, but is inserted correctly with gel, the white tag may be tucked under the cap. Simply bring out the white tag, part hair, reapply gel, and reinsert the electrode.

2. Troubleshooting procedure

The best practice is to bench-test the electrodes (no participant connected – just a virtual participant in the form of a bucket of water). However, if you are in the midst of a recording session, it is possible to isolate a problem electrode / lead / connector and make the best of the session. Most times this will mean losing just one channel of data.

a) If a participant is connected, and you want to proceed with recording data

(1) If your A1-32 electrode set has CMS/DRL on it, then leave A1-32 plugged in and unplug each of the other connectors (e.g. B1-32,…EXG1, …) one at a time to see if one of them causes the CM in Range light to come on.

(2) If your CMS/DRL electrodes are plugged in at the front panel of the A/D box, then leave them connected and unplug each of the other connectors (e.g. A1-32,…EXG1, …) one at a time to see if one of them causes the CM in Range light to come on.

(3) If you isolate one EXG electrode that causes CM in Range to come on, then simply remove that electrode and replace it if possible.

(4) If you isolate one D connector that causes CM in Range to come on, then plug that connector back in and remove the active electrodes associated with that connector from the head cap one at a time until CM in Range comes on. If more than one electrode is at fault, it may not be possible to identify the offending electrode in a reasonable amount of time using this procedure.

D. The system worked earlier, but now I get error 5000

If the system worked fine before, and nothing has changed as far as connections or computer configuration, then the Power settings of your computer (Control Panel) may have caused the computer to go into Standby mode. When standby is activated, the power to the USB port is lost, which causes the firmware in the ActiveTwo USB interface to "crash". The *Data* LED next to the fiber optic connector on the Optical Receiver / USB Interface will still light up, indicating the USB port is supplying power to the box and data are coming in from the A/D box, but the *Data* LED next to the USB port on the Optical Receiver will not light up. If this happens, just disconnect and reconnect the USB cable at the computer or at the USB Interface. This will force the firmware in the USB interface to reinitialize, and it should correct the problem.

XVII. Other technical details not elsewhere documented

A. Structure of the CFG file

The .CFG contains configuration options for the ActiView program. The file format is similar to a Windows INI file with bracketed section headings followed by variables and arguments. Some of these options can be set from the ActiView menu, and some can be set only by editing the .CFG file with a text editor.

1. Options that are set in ActiView and saved in the text .CFG file

The entries in the sections listed below are best set within ActiView by using the interactive menus. The purposes of these entries are mostly apparent from their names.

a) [Selectors]

b) [FreeChoice]

c) [TCP]

2. Options that you may want to adjust in the text .CFG file (underlined below)

Note that any entry not underlined below is inadvisable to change by editing the text .CFG file.

a) [System]

Warning=1
Motherboard=12
ElecGain=0 //0: 31.25nV/bit, 1: 125nV/bit
RespSwitch=0 //0: standard ergo, 1: ergo 1 & 2 coupled to trigger 9 & 10, 2: switch input coupled to trigger 9 & 10
LineWidth=1 //1 to 5, thin to thick
Cursor=0 //0: LabVIEW cursor, 1: Windows cursor
PopupKiller=1
BreathBelt=1 //0: Nihon Kohden TR-753T, 1: SleepSense 1387

b) [Labels]

(For the entries below, be careful to change only the text to the right of the equal sign! Keep labels to four characters or less for convenience of data display.)

Chan1=Fp1
Chan2=AF7

Chan3=AF3
…
Tou1=EXG1
Tou2=EXG2
Tou3=EXG3
…
Aux1=GSR1
Aux2=GSR2
Aux3=Erg1
Aux4=Erg2
Aux5=Resp
Aux6=Plet
Aux7=Temp
Aux8=Batt
Jazz1=EyeX
Jazz2=EyeY
Jazz3=AccX
Jazz4=AccY
Jazz5=Heam
Jazz6=Oxyh
Jazz7=Amb
Jazz8=Mic
Jazz9=Pow
Box1=Ana1
Box2=Ana2
Box3=Ana3
…
Trig=Status

c) [Save]

[Save]
Subset=0
Touchproofs=1
Sensors=1
Jazz=1
Anas=1
SaveBox=15
PauseOff=-1 //-1 is disabled, 0-255 is enabled
PauseOn=-1 //-1 is disabled, 0-255 is enabled
SavePath=D:\BDFdata\Testdata.bdf

Appendix A. Disinfection Guidelines

The Division of Healthcare Quality Promotion (DHQP) of the US Centers for Disease Control (CDC) maintains detailed guidelines on sterilization or disinfection of patient-care equipment.

See http://www.cdc.gov/hicpac/pdf/guidelines/disinfection_nov_2008.pdf to access the CDC document: "Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008.

Here we reproduce for your convenience a set of General Principles on the topic published on the CDC website.

Sterilization or Disinfection of Medical Devices

The following principles are applicable to most questions CDC receives about sterilization or disinfection of patient-care equipment. However, these statements are not comprehensive.

General Principles

1. In general, reusable medical devices or patient-care equipment that enters normally sterile tissue or the vascular system or through which blood flows should be sterilized before each use. Sterilization means the use of a physical or chemical procedure to destroy all microbial life, including highly resistant bacterial endospores. The major sterilizing agents used in hospitals are a) moist heat by steam autoclaving, b) ethylene oxide gas, and c) dry heat. However, there are a variety of chemical germicides (sterilants) that have been used for purposes of reprocessing reusable heat-sensitive medical devices and appear to be effective when used appropriately, i.e., according to manufacturer's instructions. These chemicals are rarely used for sterilization, but appear to be effective for high-level disinfection of medical devices that come into contact with mucous membranes during use (e.g., flexible fiberoptic endoscopes).
2. Disinfection means the use of a chemical procedure that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms (e.g., bacterial endospores) on inanimate objects. There are three levels of disinfection: high, intermediate, and low. High-level disinfection kills all organisms, except high levels of bacterial spores, and is effected with a chemical germicide cleared for marketing as a sterilant by the Food and Drug Administration. Intermediate-level disinfection kills mycobacteria, most viruses, and bacteria with a chemical germicide registered as a "tuberculocide" by the Environmental Protection Agency (EPA). Low-level disinfection kills some viruses and bacteria with a chemical germicide registered as a hospital disinfectant by the EPA.
3. Heat stable reusable medical devices that enter the blood stream or enter normally sterile tissue should **always** be reprocessed using heat-based methods of sterilization (e.g., steam autoclave or dry heat oven).
4. Laparoscopic or arthroscopic telescopes (optic portions of the endoscopic set) should be subjected to a sterilization procedure before each use; if this is not feasible, they should receive high-level disinfection. Heat stable accessories to the endoscopic set (e.g., trocars,

operative instruments) should be sterilized by heat-based methods (e.g., steam autoclave or dry heat oven).

5. Reusable devices or items that touch mucous membranes should, at a minimum, receive high-level disinfection between patients. These devices include reusable flexible endoscopes, endotracheal tubes, anesthesia breathing circuits, and respiratory therapy equipment.
6. Medical devices that require sterilization or disinfection must be thoroughly cleaned to reduce organic material or bioburden before being exposed to the germicide, and the germicide and the device manufacturer's instructions should be closely followed.
7. Except on rare and special instances (as mentioned below), items that do not ordinarily touch the patient or touch only intact skin are not involved in disease transmission, and generally do not necessitate disinfection between uses on different patients. These items include crutches, bedboards, blood pressure cuffs, and a variety of other medical accessories. Consequently, depending on the particular piece of equipment or item, washing with a detergent or using a low-level disinfectant may be sufficient when decontamination is needed. If noncritical items are grossly soiled with blood or other body fluids, follow instructions outlined in the section on HIV-related sterilization and disinfection of this information system.

Exceptional circumstances that require noncritical items to be either dedicated to one patient or patient cohort, or subjected to low-level disinfection between patient uses are those involving:

1. Patients infected or colonized with vancomycin-resistant enterococci or other drug-resistant microorganisms judged by the infection control program, based on current state, regional, or national recommendations, to be of special or clinical or epidemiologic significance
   or
2. Patients infected with highly virulent microorganisms, e.g., viruses causing hemorrhagic fever (such as Ebola or Lassa).

If you have questions about a low- or intermediate-level disinfectant and certain sterilants, contact the manufacturer, or the Antimicrobial Program Branch, Environmental Protection Agency (EPA) hotline (703) 308-0127 or email: info_antimicrobial@epa.gov. The EPA is the federal regulatory agency for low- or intermediate-level disinfectants and some sterilants.

If you have questions about high-level disinfectants (sterilants), or how to clean, disinfect or sterilize a particular medical device, first contact the manufacturer of the product. If you are unable to obtain sufficient information in this manner, contact the Food and Drug Administration (FDA) regional office or the FDA Center for Devices and Radiological Health at (301) 443-4690. FDA is the federal regulatory agency for safe and effective use of medical devices and is now also responsible for regulation of chemical sterilants.