

ActiveThree User Manual

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Note: This manual is only made available in electronic format (PDF)

1.1 About this Manual

This manual describes the use and maintenance of the BioSemi ActiveThree biopotential measurement system. Read this manual completely before putting the system into service. The following icons are used in this manual:



Safety warning

Failure to follow these instructions may cause harm to subjects or operators.



Important note

Failure to follow these instructions may lead to unexpected operation or defects of the system.



Background information

This information does not immediately concern the basic use of the system, but is useful for understanding the designs philosophy and scientific opportunities offered by the system.

Additional information is available on the BioSemi website at www.biosemi.com. For several topics in this manual, links to the BioSemi website are provided for additional information. The extra comments on our website are regularly updated according to user feedback, and may therefore cover extra information and user suggestions not yet available at the time of creating this manual.

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1.2 Markings on components

The following icons are used on ActiveThree components:



Attention, consult accompanying documents (IEC 348)

This manual and the relevant sections on the BioSemi Website (see references in this manual) should be read before operating components showing this icon.



Type BF equipment (IEC 878-02-03)

Components showing this icon, are equipped with a Body Floating (BF) type Applied Part as defined in international standard EN 60601-1, clause 2.2.25. For more information, see section 1.5 of this manual.



Conformité Européen

This mark is a declaration by the manufacturer that the respective component complies with the relevant directives and standards as issued by the European Union. For more information, see section 1.3 of these manual.

1.3 Certification

The ActiveThree system bears the CE mark as a declaration of the manufacturer that the system meets the applicable standard for electromagnetic compatibility (EU directive 2004/108/EC) and electrical safety for the intended use as a biopotential measurement system in research applications. The following standards apply:

EMC compatibility: EN 61326-1 (2013) & EN 61326 (2021)

Electrical Safety: EN 60601-1 (2006) + A2 (2021)

A declaration of conformity is supplied with each ActiveThree system

The conformity with the standards was examined by an accredited test house (Kiwa-Dare, Woerden, Netherlands, www.dare.nl). The test reports are available on request.



The CE mark on the ActiveThree system is not equivalent with the medical CE mark found on Medical Devices (medical CE marks can be recognized by the identification number of the responsible Notified Body). Although the ActiveThree system does comply with the demands for electrical safety stated in the Medical Device directive, the system does not comply with several other requirements of the Medical Device directive EU 2017/745.

1.4 Intended purpose

The BioSemi ActiveThree 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 ActiveThree system can be adapted to these different applications by using different versions of the (active) electrodes. Besides body surface potentials, the ActiveThree system can acquire signals from a range of additional sensors, in order to measure variables like skin conductance, body temperature, muscle force, etc.

The ActiveThree is designed, and intended to be used as an **instrument for scientific research only**. The electrophysiological data acquired with the ActiveThree is meant to be used within the framework of scientific research. The system is meant to be used only by skilled professionals in a scientific laboratory environment. The system is not intended for medical applications. The system is not approved and allowed to be used for diagnosis or treatment of disease, and the measured data shall not be used as a basis for any medical action. The system is not certified as a Medical Device as defined in EU directive 2017/745, Article 2, Section 1 (for legal background information, refer to <https://curia.europa.eu/juris/liste.jsf?num=C-219/11&language=EN>).



The BioSemi ActiveThree system is not designed to be used for diagnosis or treatment of disease. The intended use of the ActiveThree is limited to scientific research. Using the ActiveThree system as a tool for diagnosis or treatment of disease may harm patients.



Because the ActiveThree is designed as an instrument for scientific 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 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 may lead to invalid data. This is the main reason that the system shall not be used for diagnosis or treatment of patients.

1.5 System layout

The ActiveThree system is based on the concept of optimal galvanic isolation between a front-end connected to the subject, and a back-end consisting of further signal processing hardware. For a diagram of the principle please see www.biosemi.com/pics/zero_ref1_big.gif.

- Front-end:** Section of the system consisting of **Active Electrodes** (2.1), **AD-box** (2.2) and **Battery** (2.3). The front-end is galvanically connected to the subject; the front-end is galvanically isolated from the environment (other equipment, mains power supply and safety earth).
- Back-end:** Section of the system consisting of **Receiver** (2.5), and **Computer** with ActiView data-acquisition software. The back-end is galvanically isolated from the subject; the back-end is usually not galvanically isolated from the mains supply and the safety earth.

The ActiveThree front-end is designed to digitize the signals from up to 136 active electrodes and 6 auxiliary sensors. The back-end processes the data: signals are displayed on a monitor and saved to hard disk, and optionally further processed online. The digitized data is transmitted from front-end to back-end via an optical fiber data link. The optical fiber (glasfiber core, plastic sheath, good isolator) is the only connection between the two sections of the system.



The setup of the ActiveThree, with battery power supply of the front-end, and fiber optic data transfer from front-end to computer, ensures the lowest possible capacitance of the isolation barrier between the isolated (floating) and non-isolated (connected to the safety earth) sections. The resulting isolation capacitance is magnitudes lower than can be achieved with alternative designs, based on optocouplers (data transfer) and DC-DC converters and/or isolation transformers (power supply). The isolation capacitance determines the amount of leakage current in both normal operation, and during several fault conditions. Minimal leakage current during normal operation is essential for the rejection of interference. Minimal leakage current in case of accidental contact between the subject and mains supply voltages is an important safety issue (<http://www.biosemi.com/publications.htm>).

The setup of the ActiveThree system provides a BF (Body Floating) type isolation of the front-end, as defined in standard EN 60601-1. This feature is indicated by the appropriate symbol on the AD-box front-panel, please refer to section 1.3.

1.6 Safe use

The safe use of the ActiveThree system is based on the galvanic isolation between the (battery powered) front-end, and (mains powered) back-end. During the use of the system, it is essential that this isolation barrier is not jeopardized by modifications, connection of additional equipment, or any other form of misuse.



Never short-circuit the galvanic isolation provided by the optical fiber connection

Do not connect any mains powered equipment to the front-end. Do not connect the front-end to the safety earth. Ensure that the subject cannot touch any part of the back-end: keep back-end at least 1.5 meters removed from the subject. Use only Li-ion 18650 batteries as a power supply for the AD-box, do not attempt to use alternative (mains connected) power supplies.



Consult BioSemi before making additional connections to the AD-Box

For all additional signal sources interfacing with the ActiveThree system, it is always necessary to assure that the additional connection does not compromise the isolation of the front-end. Therefore, all sensors connected to AD-box should be floating: they should be powered by the AD-box or extra dedicated battery power supply, and there should be no connection with any other (mains powered) equipment. Signals sources that are not isolated from the mains-supply, should interface with the trigger ports on the USB-receiver, or with a optical fiber sensor connection.



Do not treat the skin to attempt reducing the electrode impedance

The active electrodes and optimal galvanic isolation used in the ActiveThree system ensure that high quality measurements are possible with high electrode impedances. Procedures such as scrubbing of the skin, as is required with conventional electrodes, can therefore be omitted. We strongly advise against skin scrubbing because it increases the danger of infections.



The electrical safety of the ActiveThree system is based on the following principles:

- *Complete Front-end is Body Floating (BF type isolation)*
Galvanic isolation between Front-end (electrodes, AD-box and battery), and Back-end (receiver and PC). The Front-end is battery-powered, and the optical fiber for data transfer is the only connection between Front-end and Back-end. The Back-end is not located in the subject area (at least 1.5 meter away from the subject). No part of the Front-end should ever be connected to the Safety Earth, or to a mains-powered system. For charging, the battery has to be removed from the AD-box and charged in a separate charger.
- *CMS/DRL circuit for subject grounding*
DRL is the only low-impedance connection between the front-end (BF type applied part) and the subject, the current is limited by protection resistors (current via the subject limited to 50 μ A under Single Fault Condition), all active electrode inputs have a high input resistance (> 1 GOhm) during normal operation.
- *Protection switch in power supply to active electrodes*
The CMS/DRL circuit detects when the currents flow via the subject is out of the normal operation range (and always limits the current to 50 μ A). In case of a problem, the operator is warned (blue indicator LED blinking), and the power-supply to all active electrodes is automatically switched off.

1.7 Interference

1.7.1 Radiated emission

The ActiveThree system meets the EN 61326-1 standard for Electro Magnetic Compatibility of laboratory equipment. The ActiveThree system uses data transfer via optical fiber (no wireless transmission) and battery power supply (no interference to the mains supply). The compact circuit board layout keeps the level radiated emission very low: > 10 dB below the class B (residential environment) requirement. Consequently, the change of causing interference in surrounding electrical equipment is small. If interference is suspected, test by switching the AD-box on and off.

1.7.2 Mains interference

Interference caused by the 50/60 Hz mains supply is the most common form of interference during biopotential measurements, see https://www.biosemi.com/publications/pdf/Interference_reduction.pdf. The ActiveThree system minimizes this form of interference by using active electrodes (https://www.biosemi.com/publications/pdf/lowcost_active_electrode_improves_resolution.pdf) and by providing optimal galvanic isolation of the front-end (https://www.biosemi.com/publications/pdf/Isolation_mode_rejection.pdf). Nevertheless, it is recommended to follow the below guidelines to keep the 50/60 Hz interference as low as possible:

- Keep the front-end (AD-box, electrodes, subject) as far away as possible from mains powered equipment
- Bundle and twist the electrode cables
- Use non-conductive furniture for subject and AD-box
- Locate the AD-box close to the subject.
- Inspect “raw” (not referenced) signals and try to minimize the Common Mode signal before selecting a reference.

1.7.3 High Frequency immunity

The ActiveThree system is designed to measure microVolt potential differences on the body surface. Interference with frequencies above the passband (> 5.4 kHz) may convert to lower frequencies due to non-linearities in the amplifier circuitry (AM detection). A certain susceptibility to High Frequency interference is inevitable because additional filtering at the amplifier inputs would deteriorate the required noise level and input impedance. Therefore HF sources (transmitters for GSM, DECT, Wi-Fi, Bluetooth, etc.) may cause interference. In extreme cases, the safety circuitry of the AD-box may be triggered leading to a blinking blue light (Common Mode not in range, power to the active electrodes shut down, no measurements possible). However, HF interference can not cause a safety hazard (leakage currents remain limited by protection resistors)



HF interference can be recognized in the time domain by spikes and sudden baseline shifts, and in the frequency domain by sharp spikes in the spectrum at higher frequencies (> 100 Hz). If HF interference is suspected, then it is best tested with the electrodes in a bowl of salt water (see https://www.biosemi.com/faq/check_electrodes.htm). Try different locations of the ActiveThree front-end and water bowl to identify HF interference sources and the optimal location of the subject and AD-box..

1.7.4 Electrostatic discharge

All inputs are protected for electrostatic discharge and meet the EN 61326-1 requirements. Nevertheless, it is recommended to prevent ESD as much as possible. Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%. Be cautious when wearing synthetic clothing (“fleece” sweaters are particular infamous). Discharges higher than the EN 61326-1 levels may result in shut down of the AD-box (restart required) and in extreme cases in permanent degradation of performance (increased amplifier noise level). Damaged AD-box channels do not present a safety hazard.



In cases where static electricity is encountered, it is good practice for subjects and operators to discharge themselves before using the ActiveThree by briefly touching a large metal object, water tap, or a safety earth terminal.

1.8 Specifications

Subject isolation	BF (Body Floating)
Number of channels	0 to 136 monopolar active electrodes + 6 bipolar auxiliary sensors
Output sample-rate (down-sampling available in software)	16,384 Hz
Bandwidth (-3dB)	DC – 5.4 kHz, 0.002 dB ripple in passband
Low-pass response	140 tap FIR filter, -65 dB @ 8 kHz (Nyquist frequency)
High-pass response	fully DC coupled
Digitalization	24 bit SAR converter with 4x oversampling and integrated decimation filter, one converter per channel, synchronous sampling
Sampling skew and jitter	< 1 ns
Sample rate accuracy	0.8 Hz
Quantization-resolution	LSB = 31.25 nV, no missing codes
Gain accuracy	0.1 %
Anti-aliasing filter	1st order analog filter, -3dB at 7.8 kHz
Total input noise ($Z_e < 10 \text{ k}\Omega$), full bandwidth	3 μV_{RMS} (approx. 20 $\mu\text{V}_{\text{pk-pk}}$)
1/f noise ($Z_e < 100 \text{ k}\Omega$)	2 $\mu\text{V}_{\text{pk-pk}}$ @ 0.1 - 10Hz
Input current noise	< 1 pA_{rms}
Input bias current	< 100 pA per channel
Input impedance	600 M Ω @ 50 Hz ($10^{12} \text{ }\Omega$ // 5 pF)
DC offset:	< 2 mV
Input range	+200 mV to -200 mV
Intermodulation distortion	< 0.01 % (testsignals: 2990 and 3010 Hz)
Channel separation	> 100 dB
Common Mode Rejection Ratio	> 100 dB @ 50 Hz
Isolation Mode Rejection Ratio	> 160 dB @ 50 Hz
Power Consumption	0.5 Watt (6 channels) to 1 Watt (142 channels)
Battery capacity	3500 mAh, 3.7 V Li-ion 18650 type
Battery life	10 hours (142 channels) to 20 hours (6 channels)
Leakage current, normal operation	< 1 μA_{rms}
Leakage current, single fault condition	< 50 μA_{rms}
Trigger inputs	16 inputs on optical receiver (isolated from subject section), TTL level
Trigger outputs	12 outputs on optical receiver (isolated from subject section), TTL level
Computer interface	USB2.0, Windows or Linux
Size of AD-box (width x depth x height)	162 x 149 x 62 mm
Weight of AD-box, including battery	0.8 kg
Environment	Indoor use: Temperature: +10°C to +40°C Humidity: 30 to 75%, non-condensing Pressure: 700 hPa to 1060 hPa
Warranty	3 years (1 year on electrodes)

2.1 Active Electrodes

The active electrodes contain a Ag-AgCl sintered electrode pellet, and a buffer amplifier with an input protection circuit. The electrodes are sealed in a watertight resin. The electrodes can be used in connection with most commercially available electrode gels for Ag-AgCl electrodes, but to achieve optimal results, we recommend the Parker Signa gel. The integration of the first amplifier stage on the electrode, allows impedance transformation on the electrode (the active electrode has an output impedance lower than 1 Ohm). This makes it possible to measure body surface potentials with via high electrode impedances, without encountering the noise and interference problems seen in measurements with high-impedance passive electrodes, see:

http://www.biosemi.com/publications/pdf/Interference_reduction.pdf

With the active electrodes, procedures to reduce the impedance of the electrode-skin interface, such as scrubbing of the skin as is required with conventional electrodes, can therefore be skipped. This speeds up the application time considerably and makes the measurement procedure much more comfortable for the subject. We actually advise against scrubbing of the skin because it increases the danger of infections, see section 1.6 (safe use)

The CMS (Common Mode Sense) and DRL (Driven Right Leg) electrodes are used to drive the average potential of the patient as close as possible to the AD-box reference potential, see www.biosemi.com/pics/zero_ref1_big.gif. The CMS electrode is best located approximately in the center of the other electrodes (for example on the top of the head in case of a typical EEG measurement). In practice however, the exact location is not very critical though. The DRL electrode can be located anywhere on the body.

The DRL and CMS electrodes are part of a feedback loop. The feedback loop needs to be closed to be able to drive the subject to a potential close to the AD-box reference. If the loop is working properly, the Common Mode (CM) voltage (the average potential of the subject) is within the normal input range of the AD-box. This normal operation condition is indicated by the blue indicator LED (CM in range) being illuminated. The blue indicator can be found on the AD-box top-panel (see 2.2), and on the ActiView panel.



CM can only be in range by having both the DRL and CMS electrodes properly connected to the subject

As long as the loop is not closed, the blue indicator LED will remain off. In case of CM in range problems, always make sure to check first that the blue LED comes on with only the CMS and DRL electrode making contact with the subject (all other electrodes left unconnected)

The watertight sealing of the electrode circuitry and cable is essential for proper operation of the system. If the electronic circuitry of the electrodes is not completely sealed, (conductive) electrode gel and/or subject perspiration may creep into the circuit, and cause an internal short circuit. If the cable isolation is damaged, the bare core may touch the subject body. Finally, if one of the leads of an active electrode is interrupted (core breakage, connector problem, etc.) the input circuitry of the electrode is not properly biased. If any of these conditions occurs, leakage current will try to flow from defect electrode or cable, via the subject body, and via the DRL electrode back to the AD-box. The DRL drive circuit will limit this current to a safe value ($< 50 \mu\text{A}$), detect that the current flowing through the subject is out of the normal operation range, and the power-supply to all active electrode will be switched off automatically. This action of the protection circuitry is indicated by the blue indicator LED (CM in range) on the AD-box going off. As long as the blue indicator LED is not illuminated (Common Mode voltage is not in range), no valid measurements will be possible on any of the channels.



Valid measurement are only possible when CM is in range, (blue LED illuminated)

Any defect on electrodes, cables or connectors that forces the current via the subject to be out of the normal operation range causes the power to all active electrodes to be switched off automatically as a safety measure. The problem has to be corrected before the measurement can continue. Test the electrodes in salt water to find the defect, as explained in section 3.2

The active electrode are available in different versions, please refer to www.biosemi.com/active_electrode.htm for more details



Avoid contaminating connectors with electrode gel

Electrode gel is specially made to achieve good conductivity. Contaminating the connectors with gel may cause short circuits. Such a short will trigger the safety circuitry, and the blue indicator LED (CM in range) will remain off displaying an error. Clean the connectors as explained in section 3.2

2.2 AD-box

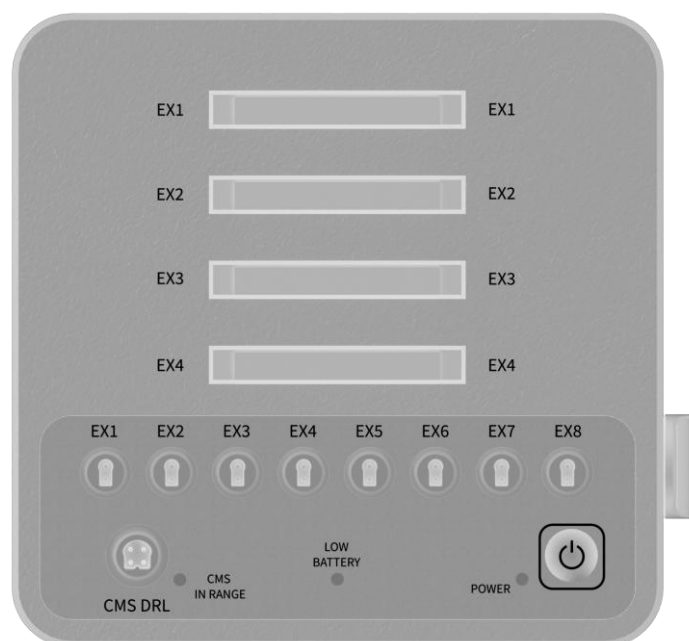
Front of the AD-box



Optical out

Connection for optical fiber with high-power data LED. Use fiber of type SC-SC MultiMode 62.5/125 um.

Top of the AD-box



A1-A32	Input for channels 1 to 32
B1-B32	Input for channels 33 to 64
C1-C32	Input for channels 65 to 96
D1-D32	Input for channels 97 to 128
EX1-EX8	Input for channels 129 to 136
CMS/DRL	Input for CMS/DRL lead
CMS in range	Blue indicator LED, continuously ON when connected electrodes are within range, blinking when electrode malfunction is detected
Low battery	Red indicator LED for low battery voltage
Power	Green indicator LED for power ON
Switch	Push button to switch power ON and OFF

The electrode signals are amplified and converted from analog to digital format in the AD-box. The amplifier/converter circuits are integrated on 8 channel modules, the AD-box can be equipped with up to 17 of these modules. This allows the AD-box to be configured for operation with up to 136 electrode channels (in steps of 8). In addition, there are 6 sensor inputs with a dedicated 6 channel module. The sensor module is always installed. All digital data is multiplexed into a serial data stream, and sent to the signal processing computer via an optical fiber.

Under normal operation, the green LED is on (showing that the power-supply circuitry operating properly), the blue LED is on (Common Mode in range, CMS and DRL electrodes properly connected, no defective electrodes or cables), and the red LED is off (battery sufficiently charged). When the battery voltage is running low, the red indicator LED will illuminate. At that time, there is 30-60 minutes operational time left (depending on the number of installed channels), before the shut-down circuitry in the AD-box will be triggered.



Signal quality is not affected when “low battery” is indicated

The shutdown circuitry in the AD-box operates at a voltage where there is still sufficient power available for the circuitry in the AD-box. As long as the shutdown is not triggered, the data quality is assured. The “low battery” warning is given 30-60 minutes prior to the moment of shutdown.



The AD-box shuts down when overcurrent of any internal (regulated) power supply is detected.

This is a safety feature to detect circuit defects or short circuits. The safety circuit can be reset by switching the power off and on again. If this does not solve the problem, stop the experiment, and return the AD-box to BioSemi (or its local representative) for repair.



The condition of all (3) indicator LEDs blinking, indicates an overcurrent of the (unregulated) active electrode power supply.

Switch off the power, and disconnect the electrodes/sensors. Return the AD-box and electrodes/sensors to BioSemi (or its local representative) for repair. There is no immediate danger for the subject because of the CMS/DRL circuit limits the subject current, and because the power to the active electrodes and sensors is shut off.

Sample-rate

The AD-box has a fixed sample-rate of 16,384 Hz per channel, with an analog bandwidth of 5.4 kHz (-3 dB). The data can be downsampled in ActiView with a factor of 2 to 64 (minimal sample rate is 256 Hz). The bandwidth of downsampled data is $1/5^{\text{th}}$ of the sample rate (minimal bandwidth is 52 Hz)

Channels

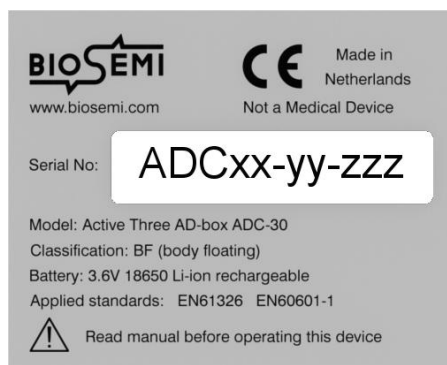
The AD-box can be configured with up to 136 active electrode channels (in groups of 8 channels). A 6-channel sensor module is always installed in the AD-box. The ActiView software will detect the number of installed channels and plugged in sensors. Only installed channels and connected sensors can be selected for display and saving to file.



After changing the configuration (number of channels and/or connected sensors), stop and start ActiView to load the new configuration

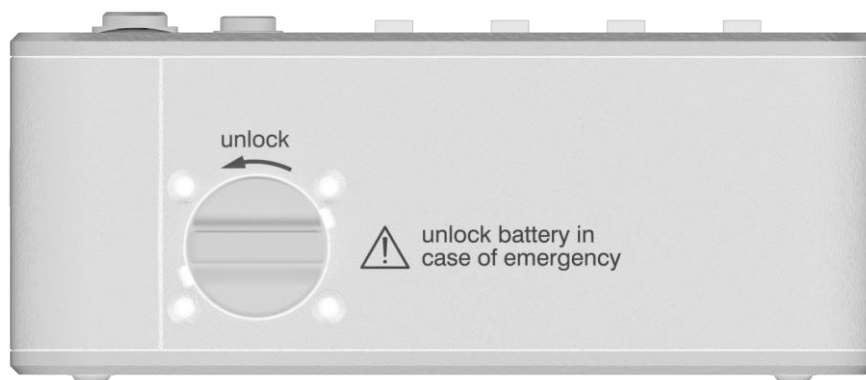
Serial Number

The serial number of the AD-box is found at the label on the underside (xx = version, yy = year of manufacturing, zzz = production number). BioSemi logs the configuration (number of installed channels, auxiliary sensors, etc.) and history (upgrades, repairs, etc.) of each AD-box. When contacting BioSemi for service, always provide the serial number of your AD-box.



2.3 Battery and Charger

Side of the AD-box



Battery holder

Use only Li-ion 18650 battery. Unscrew holder cap to insert battery, insert the battery with positive pole outwards (system is protected for reverse polarity). Unlocking the cap disconnects the battery from the internal electronic circuitry.

The ActiveThree system works on a single standard 18650, 3.7 V Li-ion battery. The 18650 cells are widely used flashlights and cameras. Replacement batteries and chargers are readily available on-line or in outdoor stores. Use batteries with an integrated protection circuit and with a capacity between 3000 mAh and 4000 mAh. Use “button top” types, do not use “flat top” types. Do not use batteries with an integrated USB charger. Batteries optimized for high output currents (> 10 A) do not offer advantages in this application. Reliable brands for the batteries and chargers are NITECORE (www.nitecore.com) and FENIX (www.fenixlighting.com). Good quality Li-ion batteries are rated for approx. 500 charge/discharge cycles.



Use only 18650 Li-ion batteries.

Do not use any other type of battery. Do not attempt to power the AD-box from any other power source.



Insert the battery with the positive pole facing outwards.

Insert the battery with the positive pole contacting the lock cap. Reversed insertion of the battery may lead to overheating of the AD-box and circuit damage.



Unlock the holder cap and remove the battery when a safety issue is suspected.

The on/off switch does not completely disconnect the electronic circuitry from the battery



Use only chargers designed for Li-ion 18650 batteries.

Using a charger designed for other types of batteries may lead to damaged cells or fire hazard.



The battery contacts are disconnected from the internal circuitry when the cap of the batteryholder is unlocked.

This prevents that electronic circuitry connected to the subject becomes accessible when the holder cap is removed.



The AD-box is protected for reversed battery insertion.

Insert the battery with the positive pole facing outwards (to the locking cap).

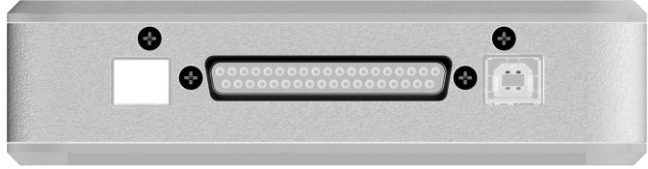


After the useful service life, dispose the batteries in a proper way.

Use a disposal method according to the regulations in your territory for Li-ion batteries. Never dispose of the batteries as normal household waste. Do not attempt to disassemble the batteries.

2.4 Receiver

USB Receiver

			
Power	Indicator LED, illuminated when powered ON via USB.		
Optic link	Indicator LED, illuminated when data is received from AD-box via optical fiber		
USB data	Indicator LED, illuminated when data is streamed to the acquisition computer		
Trigger data	Indicator LED, flashing when triggers are received via the trigger port		
Optical in	Connection for optical fiber with optical receiver. Use fiber of type SC-SC MultiMode 62.5/125 um.		
Trigger port	Input/output port for synchronizing stimuli and responses with the AD-box data. 37-pin Sub-D connector with 16 inputs lines and 16 output lines (TTL level).		
USB port	USB-B 2.0 connector for data transfer to the acquisition computer		

The receiver converts the optical data stream from the AD-box into an USB2 compatible signal to the computer. In addition, trigger input signals are added to the data stream see www.biosemi.com/faq/trigger_signals.htm. The receiver can send output pulses via the trigger port. The sampling clock signal is available at the trigger port for synchronization purposes.

Layout of the Trigger input/output connector on the USB receiver.

Pin01 = Trigger input 1	Pin11 = Trigger input 11	Pin21 = Trigger output 5	Pin31 = NIRS sync clock
Pin02 = Trigger input 2	Pin12 = Trigger input 12	Pin22 = Trigger output 6	Pin32 = Sampling frequency
Pin03 = Trigger input 3	Pin13 = Trigger input 13	Pin23 = Trigger output 7	Pin33 = n.c.
Pin04 = Trigger input 4	Pin14 = Trigger input 14	Pin24 = Trigger output 8	Pin34 = n.c.
Pin05 = Trigger input 5	Pin15 = Trigger input 15	Pin25 = Trigger output 9	Pin35 = n.c.
Pin06 = Trigger input 6	Pin16 = Trigger input 16	Pin26 = Trigger output 10	Pin36 = n.c.
Pin07 = Trigger input 7	Pin17 = Trigger output 1	Pin27 = Trigger output 11	Pin37 = Ground
Pin08 = Trigger input 8	Pin18 = Trigger output 2	Pin28 = Trigger output 12	
Pin09 = Trigger input 9	Pin19 = Trigger output 3	Pin29 = File start trigger	
Pin10 = Trigger input 10	Pin20 = Trigger output 4	Pin30 = 1 sec sync triggers	

The receiver is powered from the PC power supply via the USB connecting cable. With the receiver connected to the PC, the optic data LED indicates whether data is received from the AD-box. The USB LED indicates data transfer to the acquisition computer. The trigger LED indicates that triggers are received. In case the data LED remains off, check the fiber connection and AD-box power indicator.

The USB data LED illuminates when the USB handshake between receiver and USB is established. The handshake is operational during data acquisition with the ActiView software (press the "start" control). In case the USB data LED remains off, check the installation of the USB device drivers (www.biosemi.com/faq/install_USB.htm).



The receiver connects to both desktop and laptop computers.

The USB port should meet the 2.0 specification. ActiView acquisition software is available for Windows and Linux, and can be downloaded from www.biosemi.com/download.htm.



Several sensors can be routed to trigger lines in ActiView.

It is possible to let sensors (e.g. response switches, photo sensor, microphone, etc.) generate trigger pulses. For more information see: www.biosemi.com/faq/trigger_signals.htm.

3.1 General Maintenance

The ActiveThree system contains no user-serviceable components.



Unauthorized repairs or modifications to the Front-end components may cause a safety hazard.

Always return malfunctioning Front-end components to BioSemi (or its local representative) for inspection and/or repair.



Clean the system components with a slightly damp soft cloth.

It is permitted to use a mild soap solution if necessary, but never use aggressive or abrasive cleaners or solvents. Use any cleaning fluid sparingly. Prevent any fluid from entering the connectors or enclosures, and let the devices dry completely before putting them into service again.



It is not necessary to adjust or calibrate the system during its normal service life (10 years).

The AD-box and USB-receiver do not contain adjustable components. It is not necessary or possible to calibrate the analog circuitry. In case of doubt about the signal quality, check the complete signal chain of the system with the electrodes in water, as described in www.biosemi.com/faq/check_electrodes.htm.

3.2 Environment (use, storage and transport)

Use and store the system components in a dry, clean environment with the below specs:

Environment	Indoor
Temperature	+10°C to +40°C
Humidity	30% to 75%, non-condensing
Pressure	700 hPa to 1060 hPa



Prevent prolonged exposure of the electrode sets to direct sunlight.

The Ag-AgCl (silver) electrode tips are light sensitive and may turn black under the influence of UV light. This may increase electrode noise and offset voltages. In addition, the PVC cable isolation may become brittle, which increases the risk of damage due to flexing of the cables during application.



Use the supplied carrying case for transport.

The ActiveThree system is supplied with a bespoke carrying case that can hold all components securely (AD-box, USB-receiver, electrode sets and caps, batteries and charger)



During transport, pack the batteries in a separate plastic case to prevent short circuits.

When the system is shipped by mail or courier, it is preferable to not include the batteries (purchase them locally at the place of destination). When shipping the system with batteries included is inevitable, then do not include more than two batteries, and use the below label on the package.



3.3 Electrode handling

Five Rules of thumb:

- 1) **Do not kink the electrode wires**, especially where the wire exits the electrode housing.
- 2) **Clean** electrodes **softly immediately after use** (when the gel is still soft) by hand with **warm water**.
- 3) Do not use aggressive soaps etc, **do not let the pellets touch any kind of metals**.
- 4) **Do not pull-out the electrodes at the flat cable** (grab the electrodes at the casing)
- 5) Do not let water or gel enter the connector.

Handling

Do not bend the wires at the place where the wire exits the electrode housing.

Do not pull-out the electrodes at the flat cable. Grab the electrodes at the casing, and then pull them softly out of the headcap. Do not grab the electrode housing at the place where the wire exits the housing, this will bend the wires, resulting in kinked wires sooner. Always use the connector ejectors to unlock the electrode plug from the receptacle on the AD-box connector. **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), dry the connector thoroughly.

After applying the electrodes, it takes some time before the chemical reactions in the electrode-gel-skin interface have reached a stable equilibrium. After approx. 5 minutes baseline drift and noise will have settled to a low figure.

Soaking the electrodes in water before application is not required, nor recommended.

Cleaning

An excessive cleaning process will wear and tear your electrodes more quickly. Bending the wires too much during the cleaning process will result in kinked wires showing up sooner. So, **clean the electrodes gently after use** and then let them hang out to dry. **Use lukewarm tap water to rinse off the gel** from the electrodes (make sure to keep the connector dry). Warm water (up to 50 degrees Celsius) will dissolve the gel more quickly. Only use a soft brush for removing gel residues from the electrodes if absolutely necessary. Softly dry the electrodes with hand paper. Let them hang out to dry on the cable-rack which was supplied together with your BioSemi system. Only use soap if water does not seem to clean the electrodes properly, never use solvents (e.g. acetone), acids or alkaline. Do not let the electrodes dry without being cleaned first. When the electrodes dry up covered with gel/salt/minerals, the cleaning process will be harder and you will get kinked wires sooner due to this hard/extensive cleaning process.

Disinfection is generally not necessary because active electrodes work without skin scrubbing. In the case that disinfection is required; use only alcohol (ethanol or isopropyl). The active electrodes are tested for compatibility with alcohol. Other disinfection agents (e.g. Metricide, Sekusept) are known to cause corrosion of the Ag-AgCl electrode tips, which can cause broken electrode tips when used frequently.

The silver/silver-chloride (Ag-AgCl) 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 very long run make your electrodes noisier.

Storage/Modifications/Splitting of the flat cable

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). Exposure of the Ag-AgCl electrode tip to (UV) light also causes deterioration. Best storage method is use the cable-rack which was supplied together with your BioSemi system and hang them in a dark place. 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.

Malfunctions

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

Soak the electrodes in water with some salt added (one small teaspoon, use a non-metal bowl)

- If this causes the blue led to turn off, then the electrode set is in need of repair (return to dealer/manufacturer)
- If you experience noise, then please follow-up the directions below concerning noisy electrodes.

Noisy electrodes: (also read "Life span")

Noisy electrodes generally mean that your electrodes have reached its end of life. Noisy electrodes may be "repaired" by soaking a few hours in water. This soaking process often removes noise. A last remedy is to use a grain 400 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 of the tip.

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 approx. 200 to 400 measurement sessions, low frequency noise will gradually increase. This is seen as baseline drift and higher offset values. In addition, mechanical problems such as broken/kinked wires are inevitable after a few hundred measurements. If the salt water test displays increased noise and unstable offset values, it's time to replace the electrodes.