

actiChamp

Operating Instructions

Product revision 04

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Published by	Brain Products GmbH Zeppelinstrasse 7 82205 Gilching Germany	Phone: +49 (0) 8105 733 84 - 0 Fax: +49 (0) 8105 733 84 - 505 Web: www.brainproducts.com
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Published on*	May 2, 2016	Document version	006
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*Valid until publication of a new version of this document.

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About this document

This document describes how to use *actiCHamp* and how it is integrated into a measurement setup. This document forms an integral part of the product. It must be precisely adhered to in order to ensure that the product is used as intended and operated correctly to guarantee the concomitant safety of test subjects, users and third parties. Keep this document in a safe place and make sure that it is always available to the users.

No part of this document may be reproduced or distributed in any form without the express written permission of Brain Products. The operator may print this document to make it available for the users of the product.

Make sure that you have the most recent version of this document for your product or product revision. You can find the most recent version on our website: <http://www.brainproducts.com>.

Target group of this document

This document is intended for users in the psychological and neurophysiological research area as well as physicians and medical experts with experience in performing physiological data acquisition. Staff must also know how to work safely and reliably with the permitted amplifier and the associated recording software.

Structure of this document

This document is divided into the following chapters:

- ▶ [Chapter 1](#) provides an overview of all the system components.
- ▶ [Chapter 2](#) describes how to operate the amplifier system correctly.
- ▶ [Chapter 3](#) contains useful information on handling the active electrodes of *actiCAP*.
- ▶ [Chapter 4](#) contains notes on the maintenance and cleaning of the equipment.
- ▶ [Chapter 5](#) offers assistance with troubleshooting.
- ▶ In the Appendices you find the [technical data](#), a description of the [active shielding](#) mode and the functional principles of the [active electrodes](#) as well as [actiCHamp](#).

Conventions in this document

Typographical conventions

Bold	indicates items on the user interface (menus, buttons, switches, connectors, options) and is used for emphases in the text
<i>Italic</i>	indicates titles of dialog boxes/tabs, file locations and is used to indicate product names
<u>Underscore</u>	indicates cross-references and web addresses
Monospaced	indicates text or characters to be entered at the keyboard

Symbols



Caution: This symbol indicates that incorrect use of the product(s) may result in a **personal injury** to the test subject, the user and/or a third-party. Failure to observe the information in this document constitutes incorrect use.



Notice: This symbol indicates that the incorrect use of the product(s) may bring about a risk of **damage to property**.



Note or Tip: This symbol draws your attention to important information relating to the current topic and to recommendations on how to use the product(s).



Cross-reference: This symbol indicates a reference to a related chapter, section or document.



New: This symbol indicates changes or new content at this point.

Revision history

Page	Status	Subject
7	modified	Product identification (CE marking)

Reporting errors and support

If you use *actiCHamp* in combination with the *PyCorder* recording program, you can register on the dedicated forum, where you can discuss issues with other users and read the help topics. You find the forum at <http://www.actichamp.com/forum/>.

We would ask you to report without delay any error you find in this document, any fault on the products or any malfunction that you observe when using this product. To do so, please contact your local dealer, who will also assist you in general questions about the product.



NEW

Product identification information

Product designation: *BrainVision actiCHamp* (32-/64-/96-/128-/160-channel)

Manufacturer: Brain Products GmbH
Zeppelinstraße 7
D-82205 Gilching (Munich)
Phone: +49 8105 73384 - 0
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Web site: <http://www.brainproducts.com>
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Electrical safety: Protection class II, tested in accordance with IEC 60601

CE marking The Brain Products GmbH confirms the electromagnetic compatibility (EMC) of this product according to the Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

Warranty <http://www.brainproducts.com/contact.php>



Identify the product revision

The product revision is stated on the label at the bottom of *actiCHamp* by the indication 'Prod.-Rev.'

Explanation of the markings on the products



Observe the manual.



MR unsafe: Products with this symbol are not safe for use in an MR environment.



This symbol indicates that defective products must not be disposed of with household waste. Dispose of in accordance with national regulations or return the products and its accessories to the manufacturer.



The Brain Products GmbH confirms the electromagnetic compatibility (EMC) of this product according to the Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the approximation of the laws of the Member States relating to electromagnetic compatibility.



This symbol confirms compliance with the environmental requirements for electronic products (only applies to China).



About actiCHamp

What is actiCHamp?

actiCHamp is a modular, extensible amplifier system for the digitization of up to 160 EEG channels. It possesses eight auxiliary inputs for recording signals via sensors, for example GSR, breathing or pulse. *actiCHamp* is used in combination with *actiCAP* active electrodes.

The signals acquired via the electrodes and sensors are amplified, digitized and then transferred to a computer via USB for display and storage. Users can easily add up to five plug-and-play modules each with 32 channels to the *actiCHamp* base module.

actiCHamp can be used together with *BrainVision Recorder* or *BrainVision PyCorder* to record EEG and ExG signals.

Intended use

actiCHamp is intended to be used for amplifying and digitizing electrophysiological signals (e.g. EEG, EMG, ECG, EOG).

actiCHamp is not a medical device. It may be used in the context of non-medical applications in order to carry out fundamental or applied research on the basis of neurophysiological methodology and data.

Use of *actiCHamp* for diagnosis, therapy, monitoring of vital physiological processes (such as cardiovascular functions etc.) or other medical purposes is expressly forbidden.

Correct use

actiCHamp is permitted to be used by users in the psychological and neurophysiological research area as well as physicians and medical experts.

It must not be used by unqualified persons (e.g. laymen), and persons who cannot read (e.g. due to visual impairment) or understand (e.g. due to a lack of language skills) the operating instructions.

actiCHamp can be used to record neuro-/electrophysiological signals from healthy or sick adults, children and animals.

Provided that all stipulations regarding the correct use are met and that the product is used in accordance with its intended use, the use of *actiCHamp* is permitted in the following environments:

- ▶ research institutes and other non-medical environments (e.g. at home),
- ▶ hospitals, clinics and other medical environments.

actiCHamp must not be used in the following environments:

- ▶ MR scanner environment,
- ▶ vicinity of explosive gases as may be the case in operating theaters, for example,
- ▶ oxygen enriched atmospheres,
- ▶ underwater (e.g. sea, swimming pool, bath tub) or in environments in which significant amounts of water could enter components of the *actiCHamp* (e.g. under shower, under water-tap).

The user is solely liable for any risks to test subjects associated with the investigation if the product is not used in accordance with the correct use.

Combination with other products

actiCHamp is permitted to be combined with the following products:

Category	Product name	Manufacturer
Caps	actiCAP	EASYCAP GmbH
Software	BrainVision Recorder, BrainVision PyCorder	Brain Products GmbH
Hardware	TriggerBox & TriggerBox Extension EP-PreAmp BIP2AUX StimTrak	Brain Products GmbH
Sensors	Respiration Belt GSR-MR module 3D Acceleration sensor Photo Sensor	Brain Products GmbH
	Acceleration sensor Temperature sensor GSR Module Blood pulse sensor	Becker Meditec
Computer	The computer to which you connect the amplifier must fulfill the IEC 60950-1 or EN 60950-1.	



Safety information

Please read the following safety information carefully since it helps to prevent personal injury and damage to property. It is assumed that you have the required specialist knowledge in handling the product and accessories.

Brain Products will not accept any liability for loss or damage resulting from a failure to follow these operating instructions and, in particular, the safety instructions.

General precautions

- ▶ Handle the product and its accessories with care!
- ▶ Do not drop the product or allow it to fall and avoid impacts.
- ▶ Do not unplug connectors by pulling on their cable. Instead unplug a connector by releasing the hooks (if applicable) and pulling on the connector itself.
- ▶ Do not crush or kink the cables.
- ▶ Use *actiCHamp* only in the environments for which it has been designed.
In particular, *actiCHamp* must not be used in the following environments:
 - ▷ MR scanner environment,
 - ▷ vicinity of explosive gases as may be the case in operating theaters, for example,
 - ▷ oxygen enriched atmospheres,
 - ▷ underwater or in environments in which significant amounts of water could enter components of the *actiCHamp*.
- ▶ Heat, direct sunlight (UV radiation), moisture, dust, liquids, conductive foreign matter and excessive radiation can shorten the lifetime of the product.

actiCHamp

The simultaneous use of a defibrillator while the amplifier and its accessories are in operation is prohibited.



CAUTION

Risk of electric shock when using AUX inputs

The AUX inputs are not galvanically isolated from each other.

An incorrect combination of equipment connected to the AUX inputs may result in the test subject receiving an electric shock.

If you connect equipment that is galvanically connected to the test subject to an AUX input of the amplifier, do not connect equipment that can inject dangerous electric currents (EN 60601-1, 3rd edition) to the other AUX inputs of the amplifier.



NOTICE

Damage to actiCHamp

Before you connect an equipment to the trigger output of actiCHamp, make sure that:

- ▶ the amplifier is connected to the computer;
- ▶ the amplifier is connected to the power supply;
- ▶ the recording program has been started.

This is the only way of preventing unwanted pulses of the trigger output from damaging your hardware.



For information on ambient conditions, please refer to [Appendix A](#).

actiPOWER

- ▶ *actiPOWER* loses its charge when it is disconnected from the charger or if the mains power supply fails. A deep discharge permanently damages the rechargeable battery. ALWAYS recharge *actiPOWER* immediately AFTER USE.
- ▶ Recharge *actiPOWER* once per month! This prevents the deterioration of the rechargeable battery.
- ▶ It typically takes four and a half hours to charge an empty battery at room temperature. Rechargeable batteries are subject to gradual wear, resulting in longer charging times.
- ▶ Do not use third-party chargers, as this destroys the battery. Only use original chargers and accessories from Brain Products.
- ▶ Connect the charger first to *actiPOWER* and then to the mains.



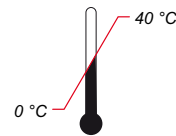
CAUTION

To avoid injury or burns, never allow metal objects to touch the battery contacts and never short-circuit the battery contacts.



NOTICE

- ▶ After use IMMEDIATELY DISCONNECT *actiPOWER* from *actiCHamp* and RECHARGE it. Otherwise you risk deep discharging the batteries, which leads to a permanent damage of the battery.
- ▶ Do not expose *actiPOWER* to temperatures below 0 °C or above 40 °C or to direct sunlight. If *actiPOWER* is exposed to temperatures above 40 °C, allow it to cool down slowly to its normal operating temperature. At temperatures below 0 °C, the electrolyte freezes, which destroys the battery.
- ▶ *actiPOWER* and the charger heat up during charging. Always make sure that as much free space as possible is available around both components so that the heat can dissipate freely.
- ▶ Do not stack several *actiPOWER*s on top of one another if you are charging them at the same time.



actiCAP electrodes and splitter box

Never plug the *actiCAP* electrode branches or the splitter box into equipment for which they were not intended.



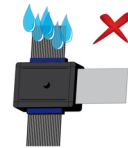
NOTICE

- ▶ Do not open the splitter box by force.
- ▶ Never remove the electrodes from their holders by pulling on their cables. This results in cable breaks. Instead, remove the electrodes from their holders by holding the electrode housing (see [Figure 4-1](#)).
- ▶ Never disconnect the splitter box from the amplifier by pulling on the flat-ribbon cable. Instead, open the clamps and pull the plug from the socket.
- ▶ Never allow the electrodes to come into contact with metal. Metal causes a chemical reaction, through which the Ag/AgCl pellets of the electrodes to break.



Notes on cleaning

- ▶ Do not allow the splitter box and plug come into contact with liquids or water.
- ▶ Do not leave the electrodes and electrode cap soak for extended periods.
- ▶ Never use alcohol to clean the electrodes and electrode cap.
- ▶ Do not store the electrodes in a disinfectant.
- ▶ Do not chlorinate the electrodes as this may result in corrosion.
- ▶ Do not use any hot sterilization methods (e.g. autoclave) since this may damage the cable insulation.
- ▶ Never clean the electrodes in a metal bowl and do not use any objects containing metal when cleaning the electrodes (nail files, for example).



You will find further information on how to clean the electrodes in accordance with requirements in [Section 4.2.2](#).





Chapter 1 Overview

1.1 Scope of delivery

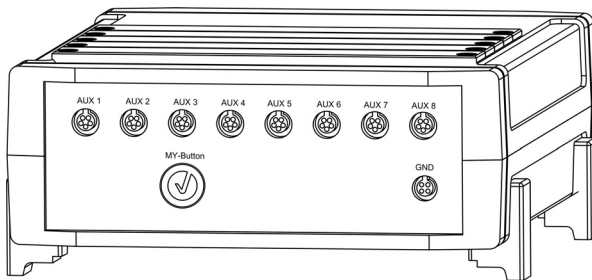
The components listed below are included in the scope of delivery.

Upon receipt of the delivery make sure, that the product or package does not show any signs of damage, or that the delivery is incomplete.

actiCHamp

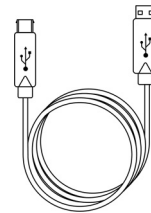
actiCHamp base module

BP-09100



USB cable (A/B)

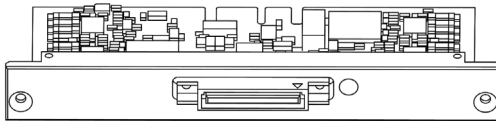
BP-09140



actiCHamp 32-channel module

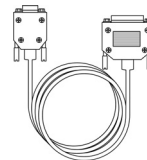
(installed upon delivery)

BP-09110



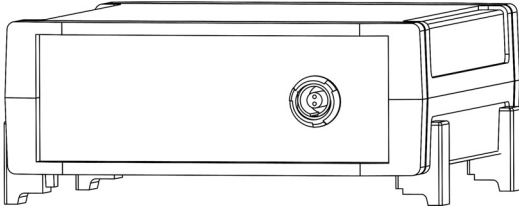
Trigger cable (9/25 pin)

BP-01975

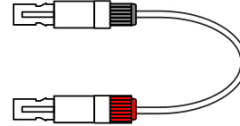


actiPOWER

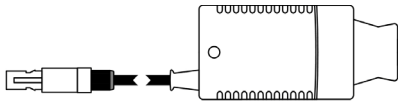
actiPOWER
BP-203-0001



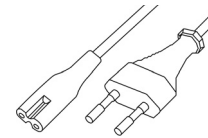
actiPOWER cable
BP-203-0003



actiPOWER charger (including manual)
BP-203-0002

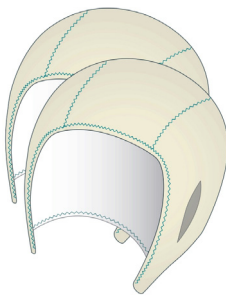


Power cord (country specific)
BP-308-0002

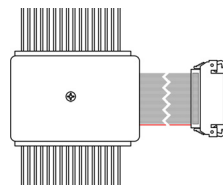


Electrode caps and accessories

2 Electrode caps^{a, b}
BP-094XX



Active electrodes (incl. splitter box)
BP-04243-32



Ground electrode (4-pin)
BP-04243-GRD



Spare electrode^c
BP-04243-SIG



Flat electrode
BP-04243-FL3



- a. Number of channels depends on the individual ordering.
- b. Three spare electrode holders are included (e.g. for EOG, EMG).
- c. One for each active electrode set (splitter box).

Software and starter kit

Application Suite DVD

BP-270-6000



Dongle

BP-170-4020

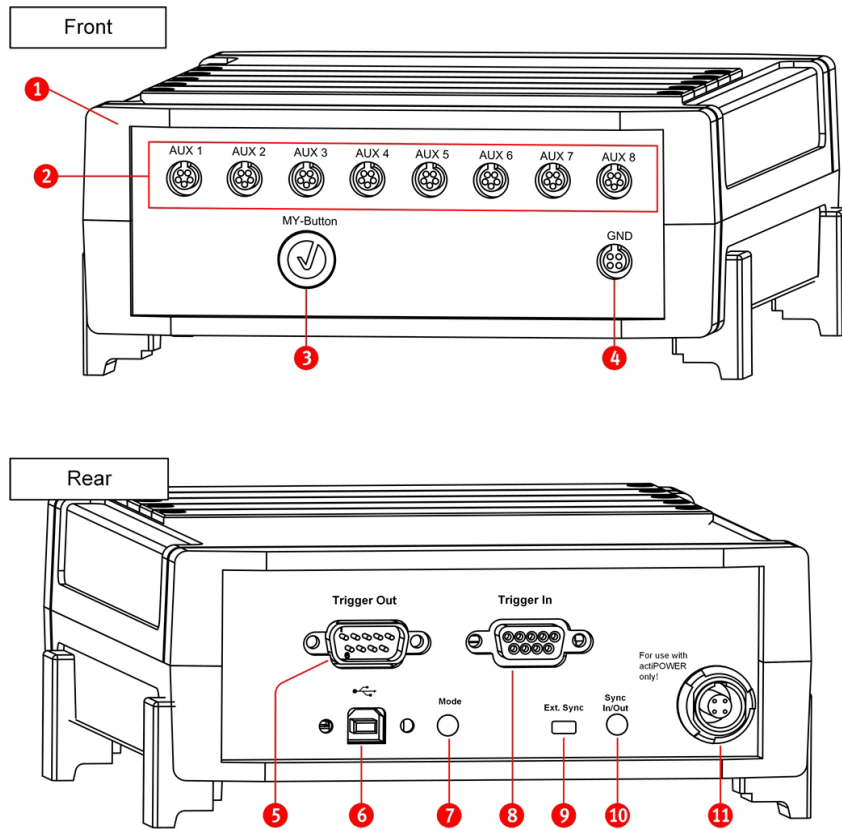


Starter kit

BP-09150

- ▶ Pre-filled syringes with electrode gel
- ▶ Blunt needles
- ▶ Self-adhesive rings
- ▶ Measuring tape

1.2 actiCHamp at a glance



No.	Description
1	Base module
2	AUX inputs
3	MY-Button (Soft key that is set in the recording software. For details please refer to the user manual of <i>Recorder</i> or <i>PyCorder</i> .)
4	GND socket (for the ground electrode)
5	Trigger Out (TTL signals)
6	USB connector (type B)
7	Mode LED (blinks green when base module is connected to a computer)
8	Trigger In (TTL signals)
9	Ext. Sync LED (indicates external synchronization)
10	Sync. In/Out stereo jack (outputs the synchronization signal)
11	Power supply socket (4 pin, for use with <i>actiPOWER</i> only)



Notes on the AUX channels

The base module has eight AUX sockets (**AUX 1** to **AUX 8**) for sensors to record additional peripheral signals (for example acceleration sensor, respiration belt). They are galvanically isolated from the test subject.

The resolution of the AUX channels is different from that of the EEG channels. If, for example, you want to connect passive electrodes at the AUX inputs, you must use an additional pre-amplifier module to adapt the input voltage of the EEG channels to the input voltage required for the AUX inputs. A corresponding *BIP2AUX* pre-amplifier is available from Brain Products (ordering code BP-MCS-01).

1.3 32-channel module at a glance

Installing a 32-channel module

If you have an additional 32-channel module, install it before using *actiChamp*. Do the following:

- ▶ Remove the two screws of a blind cover and then remove the blind cover.
- ▶ Carefully slide in the 32-channel module. Be sure to have it aligned correctly.
- ▶ Insert the two screws into the 32-channel module and tighten them.

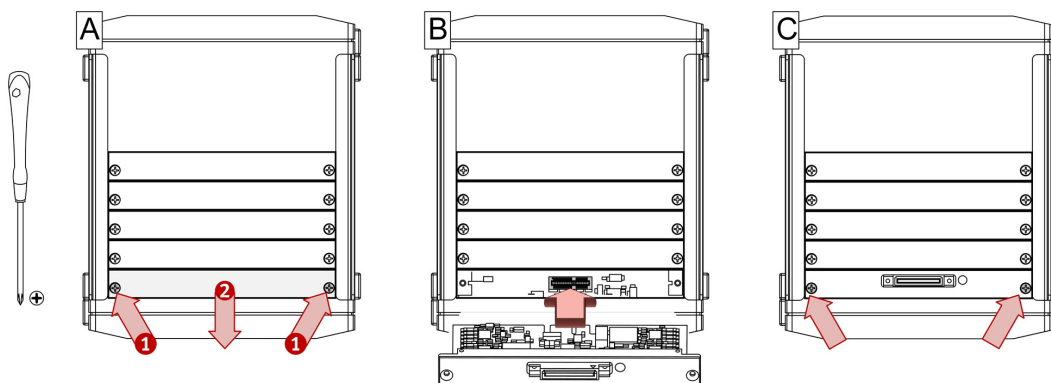


Figure 1-1. Installing a 32-channel module

**Note**

The 32-channel modules must be positioned correctly and in the correct sequence:

The slot closest to the front panel is intended for the channels 1 to 32. The subsequent slot for the second module (channels 33 to 64), etcetera.

If you do not observe the correct sequence, the 32-channel modules are not recognized.

32-channel module in operation

The status of a 32-channel module is indicated by the **Mode** LED located on each module. The LED illuminates:

- ▶ green on correctly functioning modules;
- ▶ red at start-up or if an internal error has occurred. In this case, check the communication path between the recording program and the amplifier (USB cable) as well as the supply voltage to the amplifier.

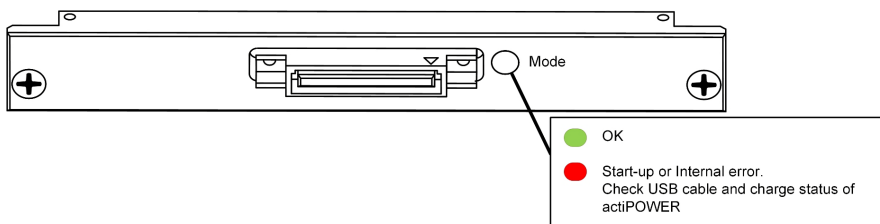
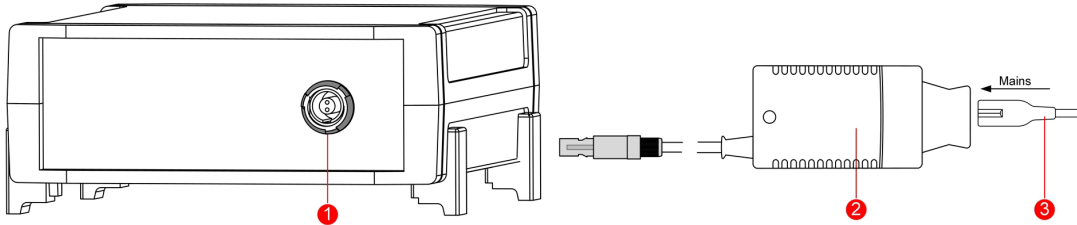


Figure 1-2. Status indicator of a 32-channel module

1.4 actiPOWER at a glance



No.	Description
1	Power socket (2 pin)
2	LED (green = fully charged, amber = charging)
3	Power cord (supplied, with country-specific jack)

The power plug on *actiPOWER* is used to charge *actiPOWER*, and to supply *actiCHamp* with power.

Correct handling of *actiPOWER*

Take note of the following to avoid damages to the battery:

- 1 Immediately upon receipt of shipment, charge *actiPOWER*.
- 2 When not in use, leave *actiPOWER* connected to the charger.

The charger has a **charge retention**. *actiPOWER* loses its charge when it is disconnected from the charger or the mains power supply fails. A deep discharge permanently damages the rechargeable battery.



- 3 Under all circumstances, recharge *actiPOWER* once per month! This prevents the deterioration of the rechargeable battery.



Notes

Charge *actiPOWER* ideally at room temperature. It typically takes four and a half hours to charge an empty battery at room temperature.

Rechargeable batteries are subject to gradual wear, resulting in longer charging times.

**Notice**

- ▶ *After use IMMEDIATELY DISCONNECT actiPOWER from actiCHamp and RECHARGE it.*
- ▶ *Connect the charger first to actiPOWER and then to the mains.*
- ▶ *actiPOWER and the charger heat up during charging. Always make sure that as much free space as possible is available around both components so that the heat can dissipate freely.*
- ▶ *Do not stack several actiPOWERS on top of one another if you are charging them at the same time.*





Chapter 2 Using actiCHamp

2.1 Before use

1 Charge *actiPOWER*

Each time before the operation you must fully charge *actiPOWER*. Do the following:

- ▷ Connect the charger first to *actiPOWER* and then to the mains.
- ▷ The LED on the charger illuminates amber while the battery is charging.
- ▷ When the battery is fully charged, the LED illuminates green.

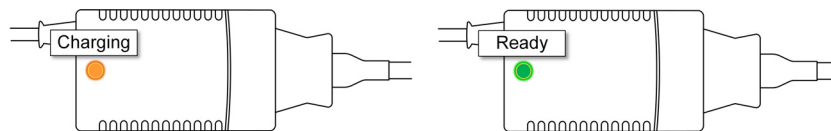


Figure 2-1. *actiPOWER* charger



Note

Leave the charger connected to *actiPOWER*, if not in use. The charger retains the charge of the battery.

2 Install the recording software (before the first use)

The installation of the recording software (*Recorder* or *PyCorder*) includes the drivers for *actiCHamp*. For details on this subject, please refer to the user manual of your recording software.

2.2 Using actiCHamp

1 Set up the power supply

- ▷ First unplug the charger from the mains and then from *actiPOWER*.
- ▷ Place *actiCHamp* on top of *actiPOWER*.
- ▷ Connect *actiPOWER* to *actiCHamp* by using the supplied power cable.

2 Connect to a computer

Note: The computer to which you connect the amplifier must fulfill the IEC 60950-1 or EN 60950-1.

- ▷ Connect *actiCHamp* to the computer with the supplied USB cable.
- ▷ The **Mode** LED blinks, when the connection is established.

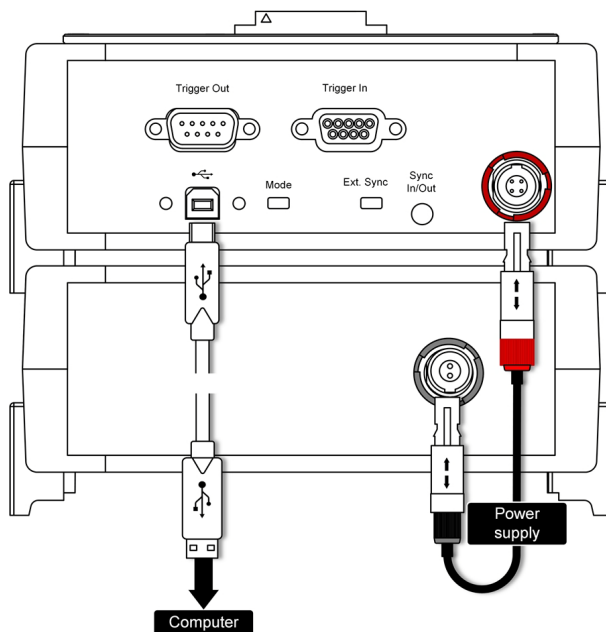


Figure 2-2. Setting up the power supply and connecting to a computer

3 Installing the drivers

The first time you connect *actiCHamp* to your computer, Windows® initializes the drivers on the corresponding USB port.

4 Connect the ground electrode

Connect the ground electrode to the **GND** socket at the front of the amplifier.

5 Connect the electrode cap

The flat-ribbon cable of the electrode cap is connected to the sockets on top of the amplifier. The plug on the flat-ribbon cable and sockets on the amplifier have an arrow. Align the arrows when connecting the splitter box. For more details on the electrode cap, please refer to [Chapter 3](#).

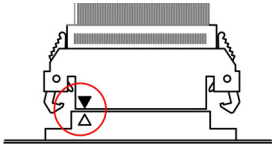


Figure 2-3. Correctly align the flat-ribbon cable

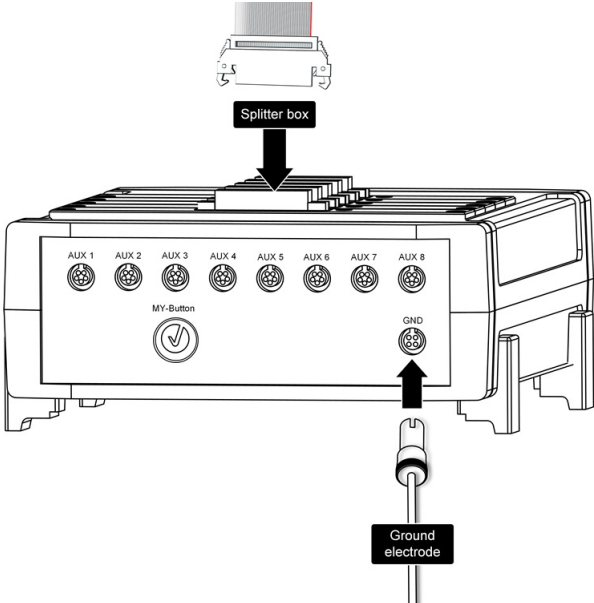


Figure 2-4. Connecting the ground electrode and actiCAP splitter box

The splitter boxes must be connected in the correct sequence: The front-most slot in the base module is intended for the first 32-channel module (channels 1 to 32); the subsequent slot for the second (channels 33 to 64), etc.

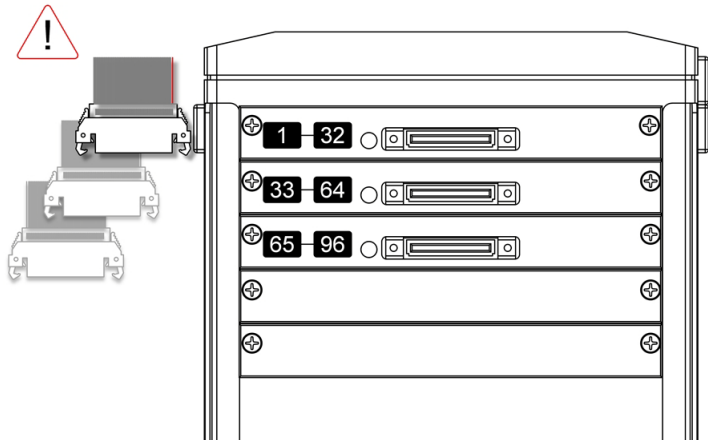


Figure 2-5. Correct sequence when connecting the splitter boxes

Connecting the trigger lines (optional)

► **Trigger In**

In the scope of delivery there is a trigger cable with a 9- and 26-pin connector. Connect this cable to the **Trigger In** port of the amplifier and the LTP port of your computer.

► **Trigger Out**

The trigger output is used to control external equipment. For the specifications of the trigger pulse, please refer to [Appendix A](#).

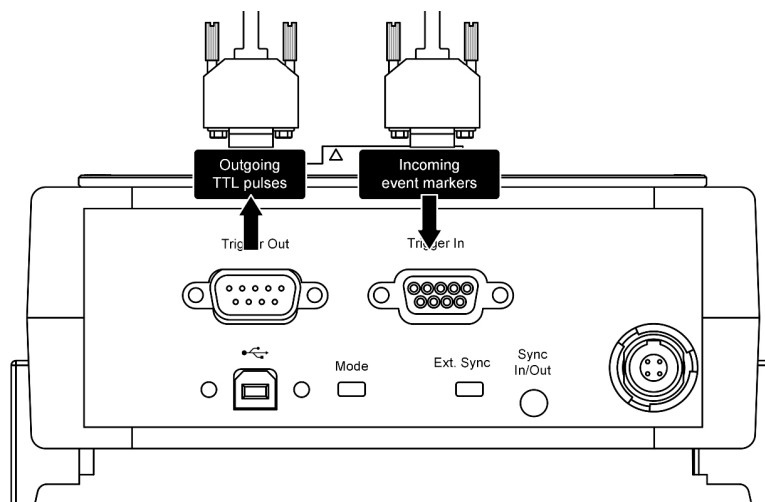


Figure 2-6. Connecting the trigger lines



Notice

Before you connect an equipment to the trigger output of actiCHamp, make sure that:

- the amplifier is connected to the computer;
- the amplifier is connected to the power supply;
- the recording program has been started.

This is the only way of preventing unwanted pulses of the trigger output from damaging your hardware.

Using the synchronization output (optional)

The signal on the synchronization output is a TTL signal that corresponds to one of the three basic sampling rates of *actiCHamp*. The table below maps the basic sampling rates of *actiCHamp* to the selectable sampling rates in *Recorder*.

Sampling rate selected in <i>Recorder</i>	Output signal on Sync Out.
≤ 10 kHz	10 kHz
25 kHz to 50 kHz	50 kHz
100 kHz	100 kHz

The synchronization signal allows you to synchronize an external equipment, for example tDC/tAC stimulators, with *actiCHamp*. You can use it to start the stimulation precisely with a sample and to subtract the stimulation artifact optimally in the data analysis.

The output is designed as 3.5-mm stereo jack. For more details, please refer to [Appendix A](#).

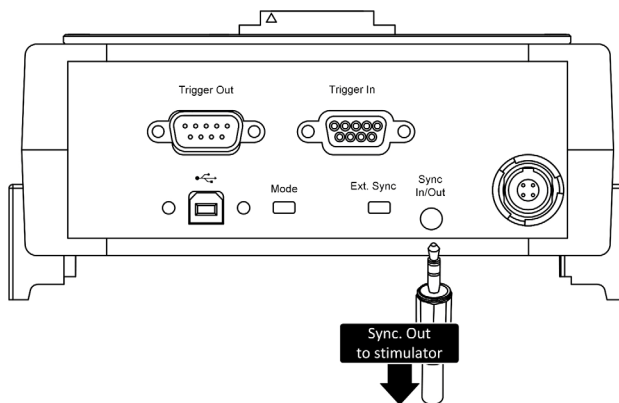


Figure 2-7. Connecting to the synchronization output



Note on the Sync In/Out jack

The synchronization input is not yet implemented.

Using the recording software

When you have completed the installation of the hardware components and the drivers, you can start to view and/or record data.

actiCHamp has four operating modes:

- ▶ monitoring
- ▶ test
- ▶ impedance measurement
- ▶ recording.

Switching between the modes is performed via the recording software. For more detailed information on this subject, please refer to the user manual of your recording software.

2.3 After use

After use IMMEDIATELY DISCONNECT actiPOWER from actiCHamp and RECHARGE it. Otherwise you risk deep discharging the batteries, which leads to a permanent damage of the battery.

Remember to connect the charger first to *actiPOWER*, before you connect it to the mains.











Chapter 3

Using the actiCAP electrode cap

3.1 Prepare actiCAP for acquisition

1 Insert the electrodes into the cap

Insert the electrodes in the holders of the *actiCAP* electrode cap. Each electrode set consists of 32 numbered electrodes (1 to 32). The cap has colored holders for each branch, that are labeled from 1 to 32. The colors and numbers help you insert the electrodes into the holders quickly.

	Color	Channel
	green	1-32
	yellow	33-64
	red	65-96
	white	97-128
	blue	129-160
	black	ground electrode

Example: The first branch corresponds to the color green. Consequently, you must insert the electrode numbered 1 in the green *actiCAP* holder which is also numbered 1. The second branch is yellow, i.e. you insert the first electrode of the second branch into the yellow *actiCAP* holder which is numbered 1.

2 Place the EOG, EMG or ECG electrode (optional)

You can also use the electrodes to acquire EOGs, EMGs or ECGs. When doing so, use the supplied *actiCAP* holders:

- ▷ Insert the electrode in the holder (1).
- ▷ Use an adhesive ring to apply the electrode to the required part of the body (2).

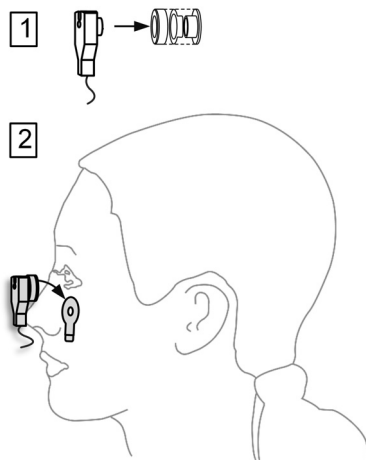


Figure 3-1. EOG electrode

3 Start the recording software

In the recording software, assign the physical channels to the electrode positions (e.g. Fp1). The first electrode of the first branch has the physical channel 1 and the first electrode of the second branch has the physical channel 33, for instance.



Note

Take note of channel 1 in module 1 ([Section 3.3](#)).




3.2 Minimize the impedances

Do the following to minimize the impedances:

- 1 Switch *actiCHamp* to impedance mode. The LEDs in the electrodes illuminate red.
- 2 First minimize the impedance of the ground electrode and electrode 1 in module one (physical channel 1). Only then minimize the impedances of the EEG electrodes (see also [Section 3.3](#)).
 - ▷ Carefully push the blunt needle through the electrode aperture as far as the subject's scalp (see [Figure](#)).
 - ▷ Gently roughen the subject's scalp by circular movements of the needle. This increases the contact area between the electrode gel and the scalp.
 - ▷ Use the nozzle to apply a small amount of gel (0.2 to 0.3 ml) directly to the scalp.
 - ▷ Fill the remaining space in the electrode with gel.

In this way, you can easily achieve an impedance of 25 to 35 kOhm at the ground electrode that is required in order to measure the impedances of all other electrodes.

When the impedance value changes, the electrode LEDs change from red to yellow or green depending on the ranges you have set.

	Color	Default impedance thresholds
	red	greater than 60 kOhm
	amber	between 25 and 60 kOhm
	green	less than 25 kOhm

The impedances improve with time: First of all, fill all the electrodes with gel as described above. Once you have prepared all the electrodes accordingly, perform a visual check of the impedances.

If the impedance in one or more electrodes has not been sufficiently minimized (LED lit yellow or red), use the blunt needle in the nozzle to push through the electrode aperture again and roughen the test subject's scalp a little more by means of circular movements. If necessary, use a little more gel.

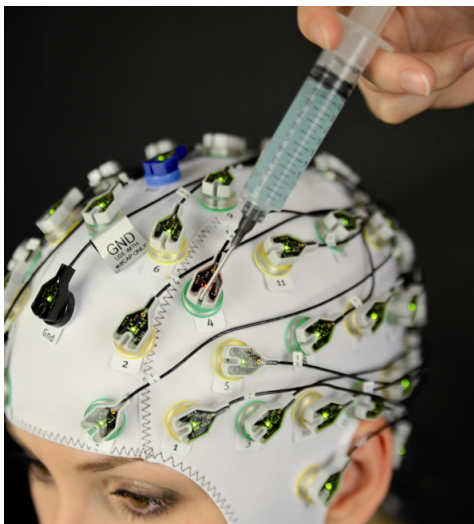


Figure 3-2. Filling the electrodes with gel

Using this procedure and with a little practice, two people should be able to prepare 32 channels in four to five minutes or 64 channels in approximately eight minutes.

3.3 The role of channel 1 in module 1

The channel 1 in module 1 has two important functions:

1 Impedance measurement

During the impedance measurement, the impedance of the ground electrode is determined with the help of channel 1 in module 1. In order to measure the impedances correctly, channel 1 in module 1 must be present.

2 Active shielding mode ([page 49](#))

The active shielding mode uses channel 1 in module 1 as signal source for determining the environmental noise.





Chapter 4 Maintenance, cleaning and disposal

4.1 Maintenance

In principle, the amplifier is maintenance-free. It is recommended to apply the test signal at regular intervals (for example, once per month) in order to ensure that the amplifier is functioning correctly. For details on this subject, please refer to [Section 5.4](#).

Repairs or repeat testing as laid down in VDE 0751-1/IEC 62353 may only be carried out by Brain Products.

If any pins or connections on the products are dirty or the products show damages, return them to Brain Products.

4.2 Cleaning

4.2.1 *actiCHamp* and *actiPOWER*

Use a soft, slightly moist cloth to clean the housing of *actiCHamp* and *actiPOWER*.

For disinfecting the surfaces of the products, we recommend to use a cleaning agent based on propylalcohol, for example a solution containing 25 % Ethanol and 35 % Propan-1-ol. Adhere to the safety precautions of the manufacturer of the cleaning agent.



Notice

- ▶ *Never clean the products under running water.*
- ▶ *Never use aggressive or corrosive cleaning agents.*
- ▶ *Never clean the products when the test subject is connected to them or when they are connected to the power supply.*

4.2.2 *actiCAP electrodes*

We recommend that you clean the electrode cap and the electrodes immediately after every use. When doing this, first disconnect the test subject from the cap.

The electrodes, and the electrode pins in particular, are sensitive components. Handle them with great care. Always place the electrodes on a soft surface (e.g. a towel).

Proceed as follows to clean the electrodes:

- 1 Remove the electrodes from the holders by twisting them carefully. Do not pull on the electrode cables. Instead, lock the electrode holder and twist the electrode by its housing.

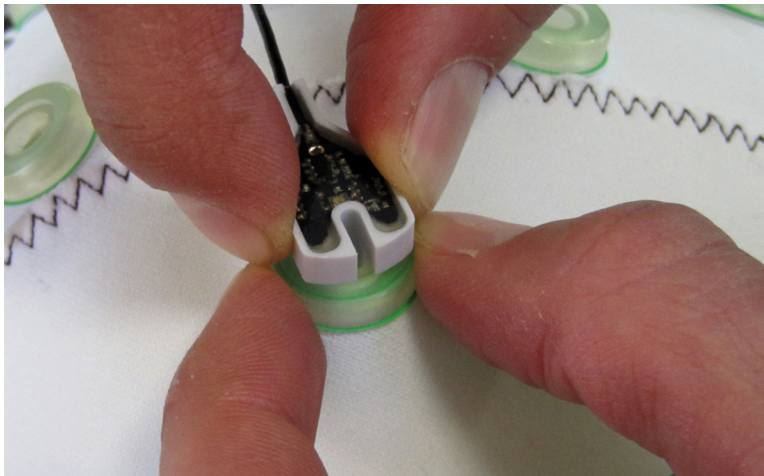


Figure 4-1. Removing the electrodes from the holders

- 2 Fill a plastic bowl with lukewarm water. Do not use a metal bowl. Metal causes a chemical reaction that destroys the Ag/AgCl pellets of the electrodes.
- 3 Place the electrodes in the water bath and let them soak for approx. 10 minutes.



Figure 4-2. Electrodes in the water bath

- 4 Then clean the electrodes with a toothbrush (see [Figure 4-3](#)). If the electrodes are particularly dirty, you can use a mild cleaning agent, for example children's shampoos. Then rinse the elec-

trodes briefly under lukewarm running water. If the water in your region is hard, stir the electrodes in distilled water.

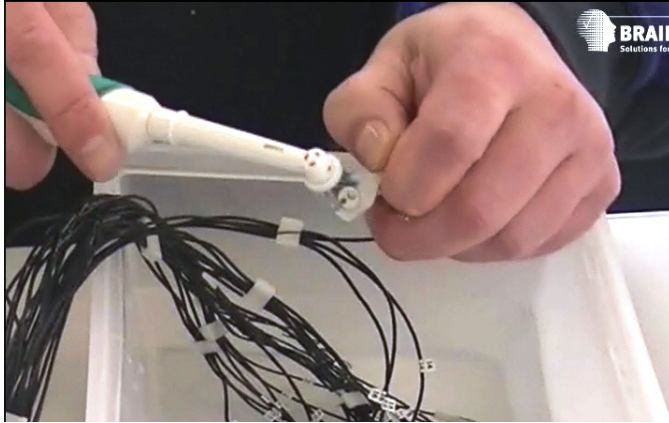


Figure 4-3. Cleaning the electrodes with a toothbrush

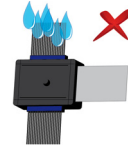
- 5 If necessary, you can also clean the electrode cables by rinsing them briefly in the water bath.
- 6 Remove the electrodes from the water. When doing so, make sure that the splitter box does not come into contact with water. We recommend that you first cover the splitter box with a towel.
- 7 Wrap the electrodes in a towel. Any residual dampness can dry off in the air.



Figure 4-4. Wrap the electrodes in a towel after cleaning

**Notes**

- ▶ Do not allow the splitter box and plug to come into contact with liquids or water.
- ▶ Do not leave the electrodes and electrode cap to soak for extended periods.
- ▶ Do not use alcohol to clean the electrodes and electrode cap.
- ▶ Do not store the electrodes in a disinfectant.
- ▶ Do not chlorinate the electrodes as this may result in corrosion.
- ▶ Do not use any hot sterilization methods (e.g. autoclave) since this may damage the cable insulation.
- ▶ The plug on the splitter box must be clean. You can clean it with compressed air if necessary.



You can find a video illustrating how to clean the *actiCAP* electrodes on our web site at: <http://www.brainproducts.com/downloads.php?kid=21&tab=3>.

4.3 Disposal

As soon as the amplifier, accessories and cables have reached the end of their service life, dispose of them in accordance with the relevant national regulations. In Germany, for example, the legislation governing electrical and electronic equipment (known as the ElektroG) is applicable. In the EU and EFTA, the WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment applies.

Do not dispose of your products, accessories and cables with ordinary household waste.

Subject to the proviso that only original equipment supplied by Brain Products is involved, Brain Products accepts return of the equipment and handle disposal on request.





Chapter 5 Troubleshooting

This chapter contains test scenarios and recommendations that assist you when conducting tests and localizing faults.

5.1 Errors in the recording software

Errors that occur during program operation and are trapped by the recording software are displayed in the software. The user manual of the software contains a description of possible error causes.

5.2 Troubleshooting for actiPOWER

Symptom	Possible cause	Remedy
Battery does not charge anymore	Battery defective	It typically takes four and a half hours to recharge an empty battery. If a few minutes after connecting the charger to an empty <i>actiPOWER</i> , the LED on the charger illuminates green, the battery might be defective. See page 11 for correct handling of <i>actiPOWER</i> .

5.3 Troubleshooting for the electrodes

Troubles during the impedance measurement

The following symptoms can occur during the impedance measurement on the test subject.

Symptom	Possible cause	Remedy
High impedance values for one or more electrode(s)	Impedances not minimized correctly	Confirm that you minimized the impedances of the ground electrode and electrode 1 in module 1 correctly. Confirm that you minimized the impedances of the other electrodes correctly (see Section 3.2). Reset the impedance thresholds in the software to the factory settings (see Section 3.2).
	Gel residuals on the electrodes	Remove dried in gel or gel residuals from the electrode (see Section 4.2.2).
	Electrode faulty (pin worn, broken or corroded)	Test the electrodes in a saline bath (see below).

Troubles during monitoring or recording

The following symptoms can occur during monitoring/recording EEG signals.

Symptom	Possible cause	Remedy
Flat EEG signal	Gel bridges	Check for gel bridges and remove the bridges.
	One or more electrodes defective	Apply the test signal (see Section 5.4).
Noise in EEG signal	Mains noise (50/60 Hz)	Remove mains noise, for example by powering the laptop through the battery.
	Insufficient impedance	Make sure that the impedances of the electrodes are low (see Section 5.4).
In order to obtain a high-quality EEG signal, it is essential to remove any sources of interference that may be present before each data acquisition.		

Identifying faulty electrodes in a saline bath

The following symptoms can occur during the impedance measurement in a saline bath.



Note on the saline bath

You can check the *actiCAP* electrodes for faults with the help of a saline bath.

Do the following:

- ▶ Mix approximately 3 tablespoons of salt with 1 liter of water in a plastic bowl. Do not use a metal bowl or sink, because this causes the electrodes to break.
- ▶ Place all electrodes including the ground electrode in the saline bath.
- ▶ Switch into the impedance mode.

Symptom	Possible cause	Remedy
LEDs light up green	No fault	Electrodes that light up green are working properly.
All LEDs light up red	Ground electrode missing	Confirm that the ground electrode is in the saline bath.
	Ground electrode defective	Replace the ground electrode (see Section 5.5).
LED of a single electrode not working	The LED is defective (electrode could still be working properly)	Replace the faulty electrode (see Section 5.5).
High impedance values for one or more electrode(s)	Electrode faulty (pin worn, broken or corroded)	Depending on the salinity of the bath the impedance values are usually between 0 and 5 kOhm. If the value for an electrode exceeds 20 kOhm, the electrode might be faulty. Replace the faulty electrode (see Section 5.5).

5.4 Applying the test signal

You can use the *actiCHamp's* internal test signal generator to check the signal.

- 1 Place the electrodes in a saline bath (see [Section 5.4](#)).
- 2 Switch your recording program to test mode.
- 3 Deactivate all software filters in your recording program.

Symptom	Possible cause	Remedy
Square-wave signal	No fault	Electrode is working properly (Figure 5-1 or Figure 5-2).
No signal of one electrode	Electrode defective	Replace the faulty electrode (see Section 5.5).
No signal of all electrodes	Ground electrode defective	Replace the ground electrode (see Section 5.5).

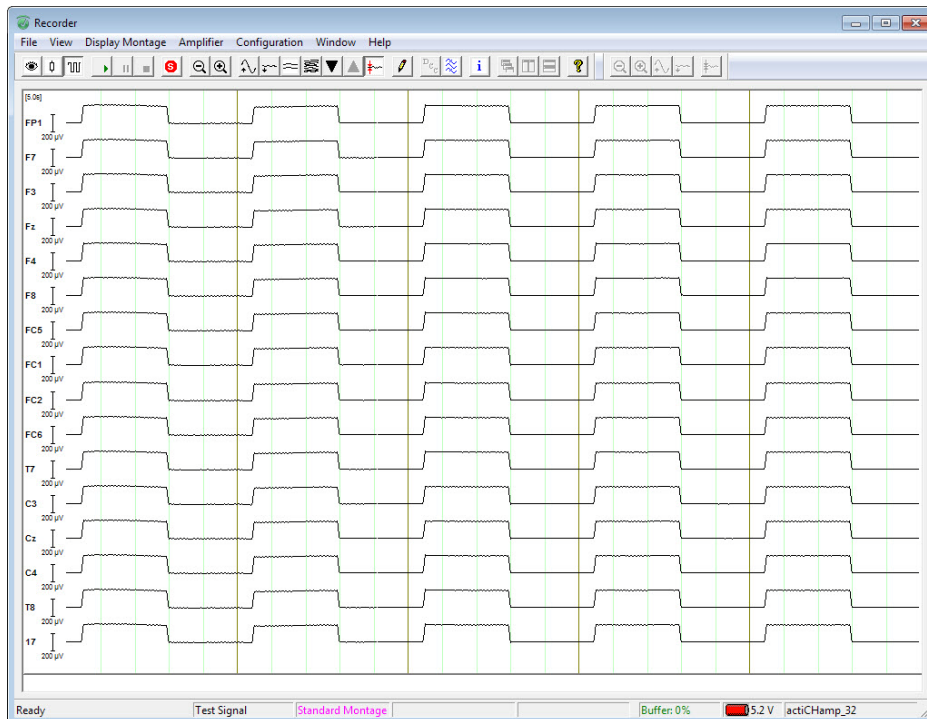


Figure 5-1. Square-wave signal in the Recorder (containing 50 Hz noise of external source)

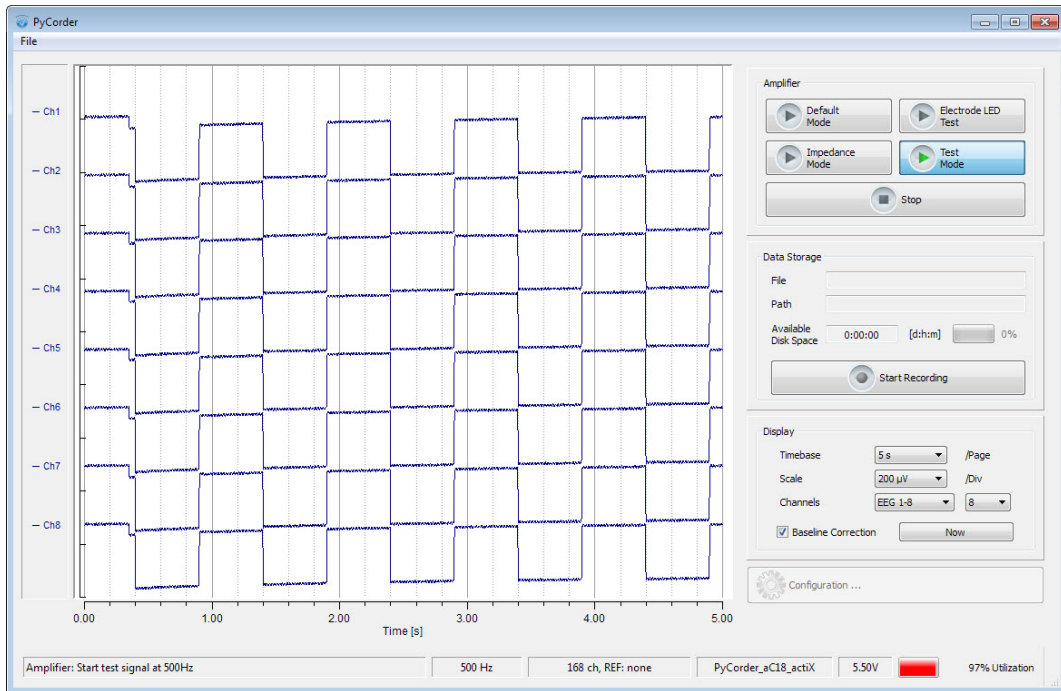


Figure 5-2. Square-wave signal in the PyCorder



Note

The baseline may vary due to DC drift. Wait for a few minutes until the electrode potentials are harmonized and the water in which the electrodes are lying is completely still and there are no more disturbances. Even small movements in the water may negatively affect the baseline.

5.5 Replacing a faulty electrode

Proceed as follows to replace a faulty electrode:

- 1 Before replacing the electrode, disconnect the splitter box from the amplifier.
- 2 Open the splitter box by unscrewing the screw in the center of the cover.
- 3 Remove the splitter box cover.
- 4 Unscrew the metal bar on the side of the faulty electrode, by releasing the two small machine screws at the end of each bar.
- 5 Carefully withdraw the faulty electrode from the splitter box (see [Figure 5-3](#)). This is best done by taking a toothpick or small screwdriver, for instance, and carefully removing the front part of the electrode from the splitter.

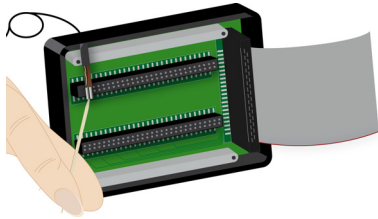


Figure 5-3. Removing the faulty electrode from the splitter box

- 6 Carefully insert the new electrode. Ensure that the four metal teeth engage correctly in the splitter and that the rubber sheathing is aligned and does not protrude. If the electrode connector is not correctly seated in the splitter then the electrode does not function correctly.

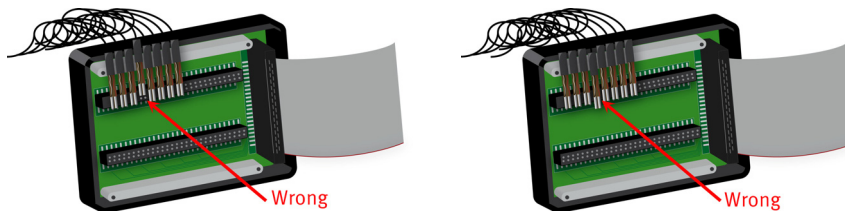


Figure 5-4. Incorrect positioning of an electrode

- 7 Mount the metal bar with the flat side facing down and secure it with the screws.
- 8 Mount the cover on the splitter box and secure it with the small screw in the middle.

If, during data acquisition, the corresponding channel signal is flat, if an impedance measurement is not possible or if multiple electrodes exhibit a defective signal, check again that the electrode connector is seated correctly and correct its seating if necessary.





Appendix A Technical data

actiCHamp

Specification	Value
Maximum sampling rate:	100,000 Hz*
Maximum number of channels:	160 EEG + 8 AUX
Maximum bandwidth of the EEG channels:	DC up to 7,500 Hz
Digitization:	24-bit, one converter/channel
Input noise:	2 μV_{pp} (DC – 35 Hz)
Input voltage range:	+/- 400 mV (EEG), +/- 4.8 V (AUX)
Common-mode rejection (CMR):	100 dB
Trigger input:	8 bit TTL signals, 0 to +5 V, max. 10 mA
Trigger output:	8 bit TTL signals, 0 to +5 V, max. 10 mA
Use with active electrodes:	Yes
Impedance measurement:	Yes, three colors, displayed via LEDs
Easy replacement of faulty electrodes:	Yes, by removal from splitter box
Filling aperture for electrode gel:	Present
Recording software:	BrainVision Recorder, BrainVision PyCorder
Integrated AUX/bipolar channels (base module):	Yes, 8 AUX channels
Synchronization output:	3.5 mm stereo jack TTL signal, always ON Clock signal of A/D converter, based on the three basic sampling rates of the amplifier (10 kHz, 50 kHz, 100 kHz).
Dimensions (H x W x D):	Approx. 68 mm x 160 mm x 187 mm
Weight:	Approx. 1.1 kg
Medical device:	No
CE marking:	Yes
EMC-tested in accordance with IEC 60601-1-2:	Yes

Specification	Value
Checked for electrical safety in accordance with IEC 60601-1:	Yes

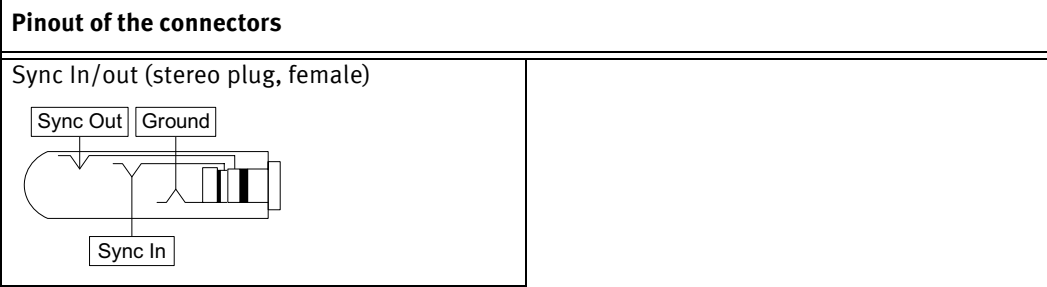
*Please note that the maximum sampling rate depends on the number of channels used. The employed recording program and the computer used to record the data also have a significant impact on the maximum transmission speed.

The following table contains the recommended values based on the optimum configuration of the computer used for data recording:

Maximum number of channels:	PyCorder	Recorder as of version 1.20
160 EEG channels + 8 AUX channels	10 kHz	25 kHz
128 EEG channels + 8 AUX channels	10 kHz	25 kHz
96 EEG channels + 8 AUX channels	10 kHz	25 kHz
64 EEG channels + 8 AUX channels	25 kHz	50 kHz
32 EEG channels + 8 AUX channels	50 kHz	100 kHz
16 EEG channels + 8 AUX channels	100 kHz	100 kHz

Ambient conditions	
Operation	Temperature: 10 °C to 40 °C (50 °F to 104 °F) Relative humidity: 25 % to 75 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa
Storage and transport	Temperature: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 25 % to 85 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa

Pinout of the connectors	
<p>Auxiliary (AUX) (5 pin, female)</p>	<p>Ground (GND) (4 pin, female)</p>
<p>Trigger In (D-Sub 9, female)</p>	<p>Trigger Out (D-Sub 9, male)</p>



actiPOWER

Specification	Value
Max. number of amplifiers:	1
Rated voltage:	6 VDC
Rated capacity:	7,200 mAh
Output current:	Max. 2 A
Rechargeable battery type:	Lead rechargeable battery
Operating time for one amplifier:	Max. 6 hours (with a fully charged, new battery)*
Charging time:	Typically 4.5 hours (with empty battery at room temperature)
Dimensions (H x W x D):	Approx. 68 mm x 160 mm x 187 mm
Weight:	Approx. 1.7 kg

Ambient conditions	
Charging	Temperature: 10 °C to 30° C (50 °F to 86 °F)
Operation	Temperature: 10 °C to 40 °C (50 °F to 104 °F) Relative humidity: 30 % to 80 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa
Storage	Temperature: 0 °C to 40 °C (32 °F to 104 °F) Relative humidity: 30 % to 80 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa
Transport	Temperature: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 30 % to 80 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa

actiCAP electrodes

The following conditions must be satisfied for the use of the *actiCAP* electrodes and the splitter box:

Ambient conditions	
Operation	Temperature: 0 °C to 30 °C (32 °F to 86 °F) Relative humidity: 30 % to 95 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa
Storage and transport	Temperature range: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 25 % to 85 %, non-condensing Atmospheric pressure: 700 hPa to 1,050 hPa





Appendix B Active electrodes

How the active electrodes work

The *actiCAP* electrodes possess high-quality Ag/AgCl pellets as well as “active” circuits that are integrated in the electrodes. These make it possible to perform recording at high impedances (e.g. 60 kOhm).

Alongside the integrated impedance converter, the electrodes also possess special electronic components, which enable the amplifier system to measure the impedances between the electrode and the scalp. Multi-color LEDs in the electrodes indicate the impedance ranges. The default ranges are as follows:

- ▶ green = less than 25 kOhm
- ▶ yellow = between 25 and 60 kOhm
- ▶ red = greater than 60 kOhm.

For information on identifying and correcting defective electrodes, see [Chapter 5](#).

The principle of impedance conversion

The term “impedance conversion” refers to the transformation of an input resistance R_I into an output resistance R_O . The input voltage U_I at the input resistance R_I is identical to the output voltage U_O at the output resistance R_O .

In practice, it can be assumed that the impedance converter possesses a very high input resistance R_I and a low output resistance R_O . This reflects the fact that most signal sources have a high internal resistance R_S which cannot be modified. In the field of electroencephalography, this is due to the physiological characteristics, i.e. the electrical properties of tissue and bone, interposed between the signal source (nerves) and the receivers (electrodes).

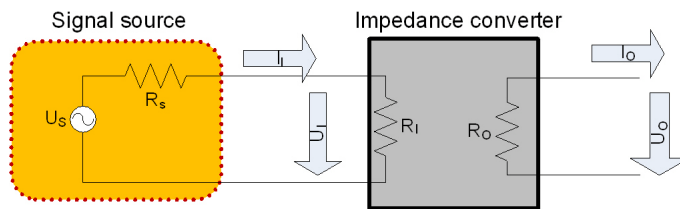


Figure B-1. Impedance conversion

In combination with the internal resistance R_s of the signal source U_s , the input resistance R_i of the impedance converter acts as a voltage divider. If, as assumed, the input resistance R_i has a very high value compared to the internal resistance R_s then the attenuation due to the acquisition system can be ignored. Because the impedance converter does not allow any feedback from its output, the signal source is not distorted. At the impedance converter output, the small output resistance R_o acts as a power amplifier (drive). At the low-impedance side of the impedance converter, the parasitic characteristics of the electrode lines and any external sources of interference have a far smaller impact on subsequent transmission quality.

It is therefore vital to use impedance conversion to prepare the signal as close as possible to the electrode. The *actiCHamp* system meets this requirement through the use of active electrodes.

Active shielding

actiCHamp supports two modes of recording: The default mode and the active shielding mode. The shielding mode is available in *Recorder* and can be activated in *PyCorder* in the source code. It can be used with the referential and reference-free montage, and depending on the combination, the shielding mode suppresses the environmental electrical noise slightly differently.

Environmental noise can have different characteristics depending on their source (AC power lines, computers, displays, wireless equipment). The critical distinctive features are the mode (normal mode and common mode) and the distribution across the EEG channels. AC line noise usually is common mode noise but shows a large variation regarding the topographical distribution: The frontal positions are often more affected than occipital channels (by facing a computer screen, for example).

As a rule of thumb, the better the noise fulfills the common mode characteristics and the more uniform the distribution is, the better shielding mode works.

In contrast, for channels that are less affected by common mode noise, shielding mode can cause an over-compensation, which results in more noisy signals, since the assumptions of the noise characteristics are not fulfilled.

In any case the data are modified: Either reversible (referencing) or irreversible (active shielding).

Thus, for using a reference channel (i.e. referencing) together with the active shielding mode, the characteristics of the noise and the environment have to be considered. The best way of selecting the appropriate strategy is to carefully evaluate the recorded pilot data in both time and frequency domain.

Even though *actiCHamp* is highly immune to environmental electrical noise due to the flexible handling of referencing and shielding mode, the best way is to eliminate electrical noise at the source.

The principle of reference-free acquisition

The signals are acquired without a physical reference electrode. Internally, the amplifier forms a virtual ground point as the reference system for the acquisition. This virtual ground cannot be tapped externally. All signals are referenced via it.

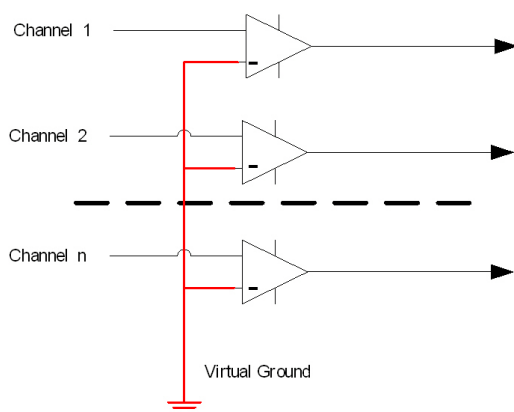


Figure B-2. Representation of the virtual ground

The recording program allows you to define any electrode of your choice as the reference. The system calculates the difference between this and the other acquired channels for each data point.



Note on role of the ground electrode

The physically present ground electrode prevents the DC drift of the virtual ground in the amplifier system. If you use the *actiCHamp*'s default recording mode without active shielding then the positioning of the ground electrode is crucial in determining the signal quality for recording. Position the ground electrode in a location that is particularly exposed to external interferences.



Appendix C Block diagram and signal flow

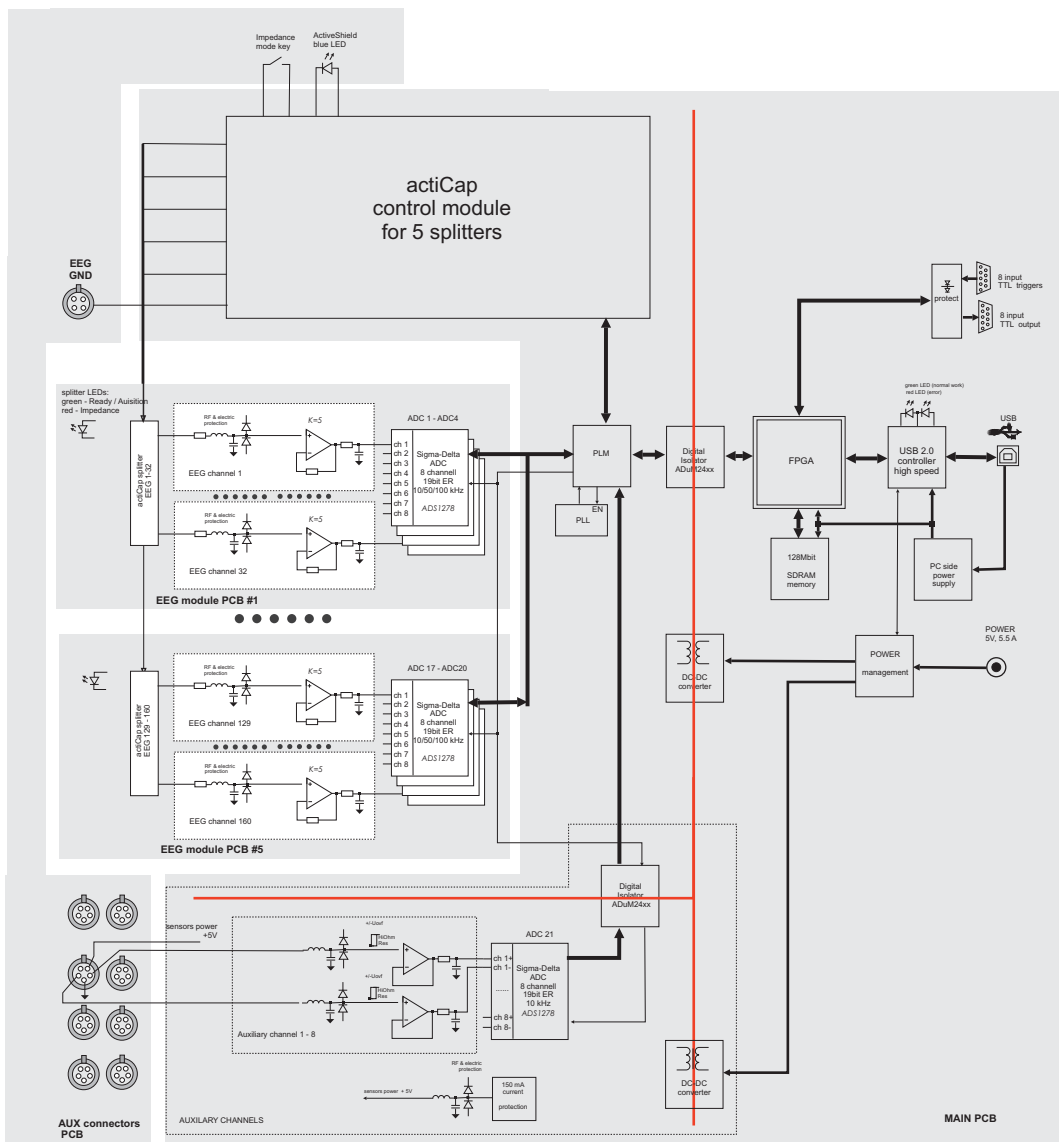


Figure C-1. Block diagram

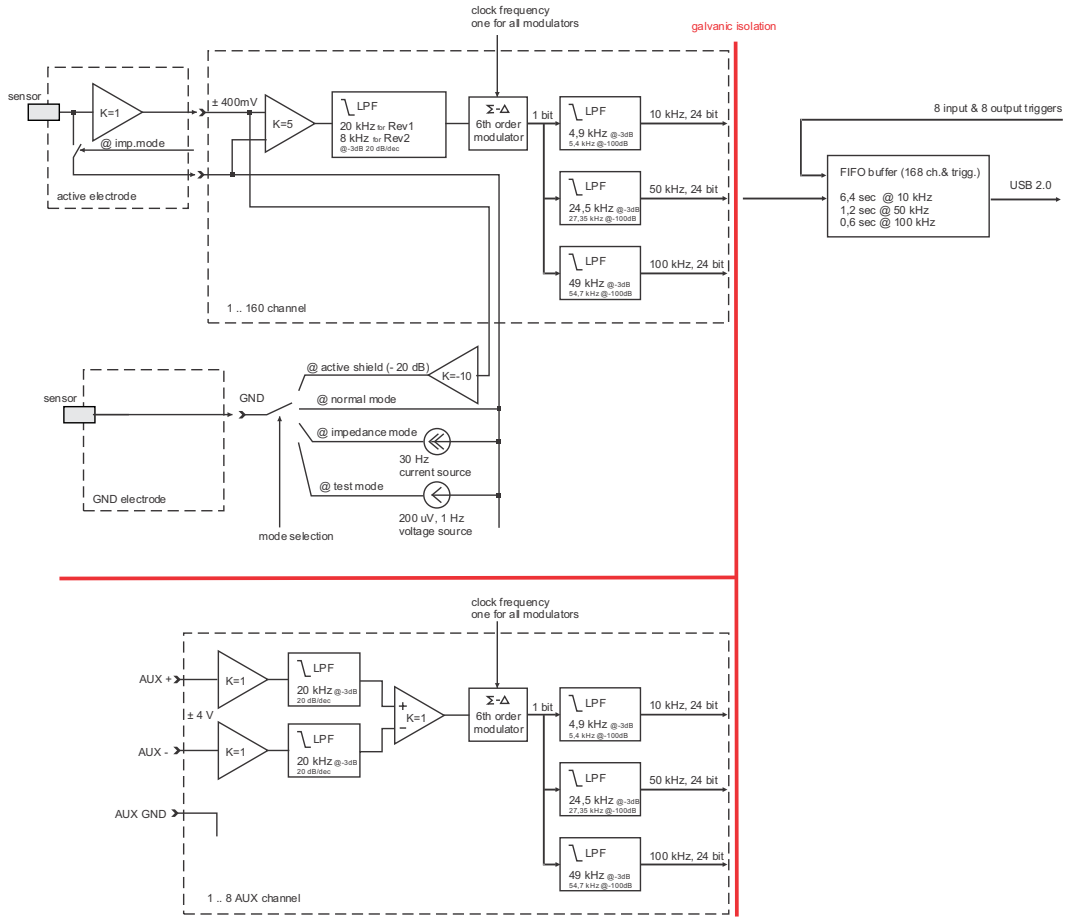


Table C-1. Signal flow

List of abbreviations

AUX	Auxiliary
CE	Conformité européenne (European Conformity)
CMR	Common-mode rejection
DC	Direct current
ECG	Electrocardiogram
EEG.....	Electroencephalography
EFTA	European Free Trade Association
EMC	Electromagnetic compatibility
EMG	Electromyogram
EOG	Electrooculogram
GND.....	Ground
GSR	Galvanic Skin Response
IEC	International Electrotechnical Commission
tAC	Transcranial alternating current stimulation
tDC	Transcranial direct current stimulation
TTL.....	Transistor-transistor logic
VDE	Verband der Elektrotechnik Elektronik Informationstechnik e.V. (German Association for Electrical, Electronic and Information Technologies)

Glossary

A

Active electrodes: Electrode with integrated circuits (impedance converters) which makes it possible to perform recordings at high impedances.

Active Shielding: Recording mode that allows ambient noise, interference due to electrical effects and artifacts due to cable movement to be minimized.

AUX channel: Supplementary channel for simultaneously recording polygraph signals such as breathing, ECG, eye movement, oxygen saturation, etc.

B

Baseline: An assumed horizontal line marking the vertical zero point in the EEG (voltage = 0).

I

Impedance: Impedance is the measure of the opposition that a circuit presents to an alternating current when a voltage is applied.

M

Mode LED: There is one Mode LED on the actiCHamp base module and one on every 32-channel module. The Mode LED on base module blinks green, when actiCHamp is connected to a computer. The Mode LED on every 32-channel module illuminates green in normal operation and red if the communication is disturbed. If it illuminates red, check the USB cable and status of the power supply

P

Physical channel: Hardware-related assignment of a channel on the basis of its position in an EEG system.

Potential: Frequently used as a synonym for EEG wave.

S

Sampling rate: Number of data points measured per second when acquiring an EEG digitally.

Splitter box: Component in which the cables of the actiCAP electrodes are brought together and via which the electrodes can be connected to the actiCHamp.

T

Trigger: Pulse generated by an equipment or software program and which initiates an operation. A presentation software package can, for example, generate a trigger each time an image appears. The trigger is sent to the amplifier via the parallel port of the computer and recorded by the recording program as a marker simultaneously with the EEG. EEG activity (e.g. an EEG signal of sufficient amplitude or length) can also be used to generate a trigger pulse that starts a process (e.g. control of a program).

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