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Press Release

Support & Tips

actiCAP slim active Electrodes Walkthrough

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This guide focuses on **how to use the new actiCAP slim active electrodes**. For information on how to use the original actiCAP active electrodes, please refer to the actiCAP walkthrough.

The new actiCAP slim electrodes were introduced in June 2017. Although the original actiCAP electrodes have been the gold standard when it comes to high data quality in EEG research, we managed to add some improvements that will make your life as a researcher easier and expand your possibilities even more.

The new actiCAP slim electrodes are three times thinner than the original actiCAP electrodes. The significantly reduced height is particularly relevant when recording EEG during Transcranial Magnetic Stimulation (TMS). The new electrodes also weigh less and are, therefore, more comfortable to wear and less prone to cause motion artifacts. Although they are thinner and lighter, the new electrodes are more robust as the sensor pellet is now better protected by the housing. Finally, preparation has become even easier, again due to the much smaller size and thanks to the wider opening for gel injection. For a more detailed description of what is new and why you should use actiCAP slim electrodes, look at actiCAP slim.

You can use the new actiCAP slim electrodes in two different cap variants: the slim cap and the snap cap. In the slim cap, electrodes are already embedded in the fabric (and not supposed to be removed under normal circumstances). In the snap cap, color-coded holders instead of electrodes are embedded and actiCAP slim electrodes (available in bundles of up to 32) can be inserted depending on your current research goals. See Figure 1 for the differences between the two caps.

Figure 1: slim cap on the left versus snap cap on the right. In the slim cap, electrodes are embedded directly in the fabric, whereas in the snap cap only the holders are embedded into which electrodes can quickly be inserted.

The new small and light-weight snap holders in the snap cap provide a firm hold for the electrodes while still allowing quick and easy insertion and removal with just a “snap” (see actiCAP snap). The main improvements of actiCAP slim electrodes and the new holders are demonstrated in Figure 2.

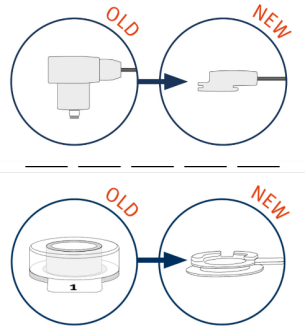

Figure 2: Differences between old actiCAP and new actiCAP slim electrodes and differences between old actiCAP holders and new actiCAP snap holders which are used in the snap cap.

Aside from these improvements, all the advantages that made the original actiCAP electrodes so successful – e.g., the active impedance conversion circuitry or the on-location LED impedance feedback – are, of course, still there. actiCAP slim electrodes are still your go-to solution if you want the best data quality in your EEG research with the most flexibility and comfort. The new actiCAP slim electrodes still work with all our amplifiers and with many amplifiers from other companies, either directly or by using the actiCAP ControlBox.

In this guide, we provide a detailed walkthrough showing how to use actiCAP slim electrodes. We add tricks and tips that help make your recording sessions as smooth as possible. In case you have any further questions, you can always contact your local distributor or our support team (techsup@brainproducts.com). Remember: Our support is free of charge.

1. Before the participant arrives

a. Washed hair and right clothes

Inform your participant to come to the EEG recording session with freshly washed and dried hair (no hair conditioner!). This is important for good skin conductance and avoiding conduction bridges between electrodes.

Inform your participant to wear clothes that can become dirty in case any electrode gel gets onto the clothes. Also let them know that they will have to wash their hair afterwards (if you have the facility to do so) or that they will have to leave the lab with gel in their hair.

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b. Preparation of materials and cap selection training

Make sure that all the materials you will need for your experiment are readily available, such as gel, clean syringes, towels and a measurement band. Also, inspect the caps and electrodes that will potentially be used and make sure that they are free from gel residues and that they are properly dried. Train all your lab assistants to measure participant head sizes (circumferences). This will help you to obtain consistent measurements and cap selections. It is important to measure the circumference at the widest part of the head, i.e., at the hat line.

c. Pre-populate or select the correct cap (if size is known)

Since the actiCAP slim caps have the electrodes embedded in the cap fabric, you only need to select the correct size. If multiple different layouts are used in your lab be sure to select the correct one for your measurement.

The actiCAP snap caps can be pre-populated to save you some time. In studies with repeated measures or if a participant already took part in another EEG study in your lab, you may already have the correct head measurements before the participant arrives. In this case you can save time in the recording session by pre-populating the cap before the session (see 2.b for instructions).

2. When the participant arrives

Caution: Always ask the participant to switch off their mobile phone.

a. Cap fitting

If you do not know the head size already (see 1.c) you should start by measuring the head circumference at the hat line of the participant. Choose the appropriate cap size and check how well it fits the head of the participant.

Tips

- *Average head shapes vary across the globe. For example, there are considerable differences between Asian and Caucasian populations. We offer caps optimized for different head shapes and your local distributor will know which cap cut to use for your intended target population.*
- *You can find the cap size in centimeters on the small label that is attached to the back (occipital) side of each cap.*
- *If you measure a head size (e.g., 57 cm) for which you do not have a fitting cap (e.g., you have 56 cm and 58 cm caps), try a larger one (58 cm). This makes sure that the cap can go over the widest part of the head. Use chin- or chest-straps to ensure a firm yet comfortable fit and smooth out potential folds in the fabric.*
- *Decide which fabric type works best with your experimental needs. You can choose between "high comfort" or "high precision". The first favors comfort by being slightly more flexible, whereas the latter offers maximum precision of electrode placement with a more rigid fabric.*

b. Populate the snap cap

If you are using slim caps, this step is not needed as the embedded actiCAP slim electrodes remain in the cap all the time. Just make sure to select a slim cap with the correct layout.

While the participant fills out screening forms, questionnaires, or performs practice trials, you have time to prepare the actiCAP snap cap.

The easiest way to attach the electrodes to a cap with snap holders is to make use of a Styrofoam head model. Take a seat on a chair and place the Styrofoam head between your knees with the face away from you. Fit the cap onto the Styrofoam head. Hang the actiCAP slim cable bundle over your own shoulder. This way you automatically attach the electrodes with their cables running to the back of the head. Start to attach electrodes to the respective snap holders of the actiCAP snap electrode cap, beginning at the back of the head. Work your way towards the front of the head. This will result in clean cabling on the cap (i.e., few crossing cables and little strain on cables during head movements).

For more details on cable routing refer to 2.c. To insert electrodes into their respective snap holders, carefully slide the electrode into the holder until the electrode reaches its firm end position, which is indicated by a mechanically noticeable "snap".

Each electrode bundle consists of 32 numbered electrodes (1 to 32). The actiCAP snap cap has embedded colored holders for each bundle that are also labeled from 1 to 32. The colors and numbers help you insert the electrodes into the correct holders and match the electrode bundles with the correct connectors. In principle, electrode bundles are exchangeable (before populating the cap) allowing you to quickly check and replace an electrode bundle between sessions in case of malfunction. However, the associations between channel numbers and color groups are fixed. Therefore, marking bundles with the associated color is good practice and prevents errors while plugging in the ribbon connectors. In addition to the normal electrode holders, there is a black holder for the ground electrode and a blue holder for the reference electrode.

Check the operating instructions of actiCAP slim, Section 6.1., to determine if you need to use a reference electrode and, if so, where to connect it.

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See Figure 3 for an example of how to populate the cap based on color-coded bundles.

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

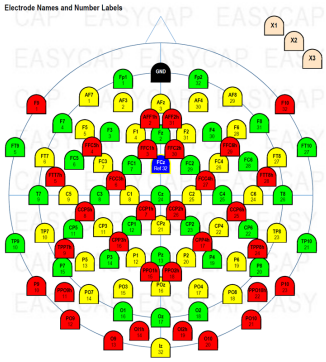

Figure 3: Example: The bundle that you connect to the first amplifier slot corresponds to the color green. Consequently, you must insert the electrode numbered 1 of this bundle into the green actiCAP snap holder which is also numbered 1. The second bundle corresponds to yellow, i.e., you insert the first electrode of the second bundle into the yellow actiCAP snap holder which is numbered 1. As an example, please see a 96-channel montage on the right-hand side of the figure.

If members of your lab team are colorblind and have problems identifying the different actiCAP slim bundles and snap holders you can purchase special glasses that help in this situation: http://enchroma.com

c. Cable routing

Proper cable routing on the cap is very important and considered good practice. For example, in the snap cap, having clean cabling makes an organized detachment of electrodes after the recording session much easier.

To take good care of the cable routing, use the white cable guides on the electrode bundles to adapt cable lengths and the Velcro straps on the cap (see Figure 4) to fixate the cables as needed. Of course, when using the snap cap, you can directly influence the routing while populating the cap. In the slim cap, you can still reroute cables of electrodes if the prepared layout is not suitable for your setup.

Figure 4: Velcro straps and cable guides on actiCAP slim and snap caps that can be used for routing the cables.

In experiments with TMS, the way cables are positioned around the stimulation site can have huge effects on generated artifacts. It was shown that TMS-induced artifacts could be reduced dramatically by rearranging the cables relative to the coil's orientation (see Sekiguchi H., Takeuchi S., Kadota H., Kohno Y., Nakajima Y. (2011). TMS-induced artifacts on EEG can be reduced by rearrangement of the electrode's lead wire before recording. Clinical Neurophysiology, 122, 984–990. https://doi.org/10.1016/j.clinph.2010.09.004).

Clean cabling also makes sure that LEDs on top of the electrodes are always visible. These LEDs are not only used for observing impedances but are required when using CapTrak, Brain Products' accurate and fast electrode localization tool. CapTrak makes use of cameras that detect LEDs and triangulation techniques to quickly determine the positions of actiCAP electrodes.

d. Putting on the cap

Before you mount the cap, put a hair dressers robe or a towel around the shoulders of the participant. This protects their clothes from any spilled electrode gel.

When you are done with the attachment of the electrodes, place the cap onto the head of the participant following your lab's standard procedures (as a reference, see Luck, S. (2014). An introduction to the event-related potential technique. Chapter 5. Basic Principles of ERP Recording. MIT press).

Tips

- *In case of a sub-optimal fit of the cap due to individual head shape variances, you can make use of Surgilast wrapping (www.dermasciences.com) or an elastic "Sports-Pre-Wrap" band to fixate the cap after you are done with the electrode preparations.*
- *If the participant has long hair make sure that not all hair is put behind the ears as this may make the preparation of temporal electrodes very difficult.*
- *Not all hair has to go under the cap - it is OK if there is some hair on the forehead. However, it should not cover the eyes of the participant.*

e. Place the EOG, EMG or ECG electrode (optional)

You can also use actiCAP slim electrodes to acquire EOG, EMG or ECG by placing them without using a cap. Before placing the electrode, use rubbing alcohol to remove any oil on the skin. Fix an adhesive ring to the electrode and make sure that the sensor (the conductive Ag/AgCl part underneath the electrode) is directly above the center of the ring. Then apply the ring with the electrode to the required part of the body and use a syringe to inject gel into the opening until skin and sensor have a good contact (read 2.g to see how to improve conductance/reduce impedance). Instead of placing the electrode directly on the adhesive ring, you can also put a snap holder between ring and electrode. This results in a higher distance between sensor and skin but facilitates a more convenient gel injection. To further fixate the position of the electrode you can use a medical tape.

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f. Start the recording software and switch to impedance measurement

Here, we assume that you have set up your workspace correctly. For instructions on how to do so, please refer to the user manual of your recording software (e.g., BrainVision Recorder).

In the recording software, the first electrode of the first bundle should have the physical channel 1 and the first electrode of the second bundle should have the physical channel 33 (and so on).

Switch to impedance mode and wait for the LEDs in the electrodes to illuminate.

g. Gel application

Even with active electrodes, impedances do matter (see Kappenman, E. S., & Luck, S. J. (2010). The Effects of Electrode Impedance on Data Quality and Statistical Significance in ERP Recordings. Psychophysiology, 47(5), 888–904. http:// doi.org/10.1111/j.1469-8986.2010.01009.x); however, in our extended experience, we found that impedances of up to 25 kOhm work perfectly fine. The traditional ‹5 kOhm criterion corresponding to passive electrodes is not needed. Reaching this level would take longer to prepare and, in our experience, you would not gain anything in data quality. Depending on how electrically noisy your environment is and depending on what data quality you need, you can even go much higher, for example up to 100 kOhm. In the long run, it pays off to take the time for testing ideal settings in a pilot session. You can (and should) change your desired target impedances in the control software so that the colors of the LEDs reflect your desired impedances (e.g., green is 50 kOhm; see one possible setting in Figure 5). Please note that the default settings vary depending on the type of used equipment.

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

Figure 5: Example of default impedance thresholds. LEDs show colors from green to red, depending on the respective impedance levels.

Use a target impedance level that works best for your project/ paradigm/population.

Start by filling the ground and reference (if applicable) electrode and electrode 1 in module one (physical channel 1). If you do not prepare these first, or not well enough, then the entire impedance measurement is invalid.

Tips:

- *Start from the back of the head and work your way towards the front as electrodes in the back of the head usually take longer to reach good impedances because of the amount of hair. Time is on your side: typically, the water and salt in the gel will improve the impedances over 3 minutes to about half of their value.*
- *Speak to your participant about what is comfortable/ uncomfortable during the electrode preparation. However, only do so at the start and do not continue to ask about it once you have a ‚feeling' for the comfort of the participant. Otherwise, the increased level of attention towards the preparation procedure will make the preparation uncomfortable in turn. Try to keep the participant distracted during the preparation (e.g., play a movie).*
- *Participants with little or no hair often have tougher skin on the head. This can (counterintuitively) make it more difficult to achieve low impedances with bald participants.*

This is the general procedure to fill an electrode with gel:

1. Take the syringe in one hand. With your other hand, apply some pressure on the actiCAP slim electrode where the cable exits the housing to tilt the electrode and give room beneath the electrode.

2. Carefully push the blunt needle through the electrode aperture as far as the participant's skin. Angle the needle to target the skin area directly beneath the electrode sensor.

3. Gently move some hair to the side by pushing the tip of the needle side to side.

4. Lift the syringe up just slightly (otherwise the blunted needle will be covered by the skin and no gel can come out; see Figure 6).

Figure 6: Inserting gel in an actiCAP slim electrode.

5. Use the nozzle to apply a small amount of gel (0.2 to 0.3 ml).

6. Use the needle to spread the gel in a circular motion on the scalp. Remember, impedance is inverse to area. Double the area equals half the impedance. But do not overdo it, you want to avoid bridges between electrodes.

7. Slowly retract the needle and as you retract, inject enough gel, so there are no air pockets left where the needle was. Such air pockets would lead to bad contact between sensor and skin. This step is usually the one that takes some practice since often there is too little gel applied when removing the syringe.

8. When done, release pressure on the electrode; the electrode will tilt back and distribute the gel evenly.

9. Prepare until the LED on the actiCAP slim electrode turns amber. Let it sit and continue with the next electrode as impedances generally improve within a few minutes after initial preparation.

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10. After all electrodes are done, quickly inspect the cap. If there are still amber electrodes repeat steps 6 to 8 until all LEDs have turned green.

This may sound quite complex but in reality you develop motor habits quickly and the process becomes like „1 - 2 - 3 - finished“ while you do not even have to think about what you are doing. In that sense it is like riding a bike.

Preparation time vs. data quality

Our recommended gel, SuperVisc, is one of the most viscous (non-fluid) among our electrode gels: it takes some time to prepare but provides the best data quality and longest recording time. Depending on your research project, very short preparation times might become relatively more important (clinical population, infants, etc.). In such cases, it is important to know that you can trade in a bit of data quality for an even faster preparation time. By diluting the SuperVisc gel with up to 30% water you can make it much more fluid which will speed up preparation time as impedances drop faster This comes, however, at the increased risk of creating bridges between electrodes (especially in high-density recordings).

If, in contrast, preparation time is not an issue and you need a setup for the longest possible recording times (e.g., for sleep research), the larger openings on top of actiCAP slim electrodes make it easier for you to use high viscous gels or even pastes. Talk to your local distributor and test whatever electrolyte is best-suited to your needs.

h. Troubleshooting

Our electrodes are very sturdy and do not break easily when handled appropriately (see 3.b and 3.c). If you do not get good impedances with a certain channel and wonder whether the electrode is broken, there is an easy way to check:

- Make sure that you get a good impedance on a neighboring electrode.
- Fill the neighboring electrode and the problematic electrode with ‘too much’ gel so that there is a small amount coming out of the aperture in the electrode.
- Put a stripe of gel onto your finger (or some wooden spatula for example) and touch both electrodes with it to create a temporary bridge/connection.
- If the impedance of the problematic electrode becomes better, you know that you need to further prepare the electrode. If, however, the impedance stays bad, there is likely a technical problem with the electrode and it needs a replacement. Don’t worry: you can easily replace single electrodes within 5 minutes; just follow our guide.

If you suspect that you have a faulty electrode another quick way to check impedances if the cap is not on the head of a participant is to place the electrodes in a saline bath in a plastic container. Check the actiCAP slim operating instructions, Section 9.4, for more details.

3. After the participant leaves

a. Data saving

This is not part of handling the actiCAP slim system; however: copy your data first (USB drive, network share, etc.) before continuing with anything else! Do not forget behavioral data from your presentation software and, if applicable, data from CapTrak.

b. Electrode cleaning

Caution:

- The most important thing when you clean actiCAP slim electrodes is to take good care of the splitter box: it must never get wet! To keep it dry, please always wrap the splitter box in a separate towel when cleaning the electrodes.
- Do not use too hot water; temperature must not exceed 50 °C (122 °F).
- Do not clean electrodes directly in a metallic sink as this can damage the sensors.
- Do not remove actiCAP slim electrodes from slim caps; the electrodes are embedded in the fabric and are not meant to be removed.
- Do not let the cap and the electrodes soak for more than 30 minutes.

We advise cleaning the electrodes directly after the recording session as the cleaning process becomes much harder when the gel dries out on the electrodes.

Take a plastic pasta strainer/colander and put it into the sink. Put the cap with the still attached electrodes into the pasta strainer/colander. Soak the cap and electrodes under flowing water and pull the electrodes by the housing (not the cable) out of the holders (only for the snap variant!) while water is still running. actiCAP slim electrodes in the snap cap can easily be removed from the snap holders by carefully twisting and sliding the electrode out of the opening which is located at a 90° angle relative to the tag (see Figure 7). Note that you can also leave the electrodes in the snap cap if the electrodes are not needed elsewhere and you want to save time by leaving the cap populated for your next measurement.

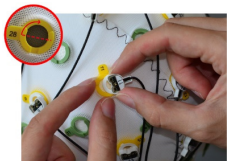

Figure 7: Removing actiCAP slim electrodes from their snap holders.

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Detached electrodes can be cleaned easily: put the electrodes in the pasta strainer/colander and into the sink. Hold the electrodes, one by one, under the running water. If there is no tap insert/faucet aerator installed, free falling water of about 20 cm is enough to clean the electrodes of the gel quickly. The use of a pasta strainer/colander serves two purposes: it prevents any hard drops of the electrode tips and contact with any non-precious metals (if you have a stainless-steel sink) that could lead to the formation of an alloy. When cleaning the slim cap and/or the snap cap with electrodes left in the holders, take care to focus on each electrode one-by-one while still making sure not to drop parts of the cap.

c. Drying electrodes

Do not dry the caps and electrodes with a hairdryer. These devices can become unexpectedly hot. While the electrodes can sustain some heat, the caps can quickly become damaged. Although the cap appears only warm to the touch, it can be locally overheated. This damages the Elastan-component and shortens the lifespan of the caps. Instead, after drying with a towel, place them on a rack or something similar. Again, pay attention to the splitter box: no remaining moisture from the electrodes should be able to run down the cables into the splitter box. Therefore, put the splitter box on a higher elevation than the electrodes.

Disinfection

Simply washing and drying the caps will be sufficient for most applications. However, it can occur that your institution and/or the participant population make cap and electrode disinfection mandatory. There are different solutions.

All disinfectants will act aggressively on the Elastan-components of the cap fabric, so it is surely worth choosing a disinfectant as mild as possible to rubbers, soft plastics, etc.

On the other hand, even an aggressive disinfectant will not destroy the cap within a few applications; however, it will accelerate the aging of the fabric. The good news here is that electrodes and holders remain in good working order and only the fabric of the cap must be exchanged.

The electrodes can handle more aggressive disinfectants. Still, they can get damaged if they are left in any disinfectant for a very long time. Soaking them over night is not a good idea - doing so every night can destroy them in a couple of weeks.

A good way to choose a disinfectant is to look for products with the description “disinfectants for instrument disinfection with corrosion inhibitor”. For example, the disinfectant we recommend for Germany contains Cocospropylendiaminguanidiniumacetat and Didecyclox-etylmethylammoniumproprionat as active agents. Many of our US customers use Metricide or Envirocide without any major complaints.

Another note on ‘visual‘ cleanliness: lack of bleaching components and the frequent encounter of facial makeup leads to stained caps. Some hospitals use bleaching disinfectants and people complain that the disinfectant we recommend does not make things nice and white again.

More tips & tricks?

Do you have other tips and tricks in your lab that we did not mention here? Please let us know at marketing@brainproducts.com, we are happy to learn from you.

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