BRAIN PRODUCTS
Solutions for neurophysiological research

Press Release

Products & Applications

Easycap EEG recording caps: An overview

by Falk Minow - General Manager (Easycap GmbH)

Despite some interesting new developments in the area of EEG Recording Caps like sponge-and-saltwater-nets or dry-electrode-headsets, the majority of EEG research is still done with electrolyte-gel-filled-electrode-caps. Easycap manufactures caps with any channel number, any layout and for connection to any amplifier. This is not only for recording EEG alone, but also for recording EEG simultaneously with other data acquisition technologies like fMRI, MEG, NIRS, or during TMS or AC/DC stimulation. The caps come with active or passive electrodes, or with electrodes optimized for specific technical requirements. We have also designed special caps and belts for mobile EEG.

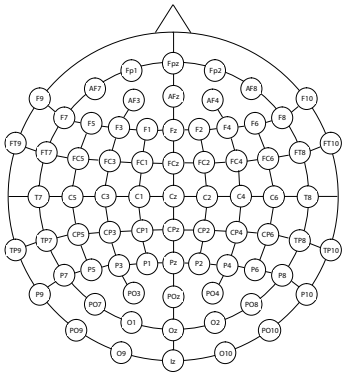
The variety of applications results in a multitude of different caps. So, in everyday life one is mainly concerned with which cap for what, or which cap do I need? This overview is organized around these important questions.

The Fabric Cap Itself

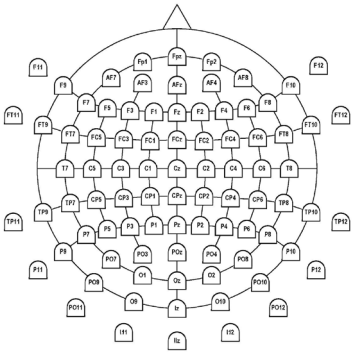
Cap Types

Easycap supplies two different types of cap, **Subtemporal and SubInion**. The SubInion type covers a larger area and is equal to Subtemporal in terms of comfort. There are slight advantages for the SubInion type as it provides a better fit to a larger number of head shapes and grips well on the forehead so there is less slipping. For new caps we specify the SubInion type and it is necessary to choose this type when electrode positions lower than a line from the canthi to the Inion are requested. The Subtemporal type is the older version and it is still used for many of the Standard Caps listed below.

Comparison Subtemporal vs. SubInion Type



10%-System down to row 11/12 SubInion Type



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Cap Cuts

Both cap types, Subtemporal and SubInion, are available in **two cap cuts**. One cap cut provides a better fit for more oval/rectangular head shapes and is commonly used worldwide (called “Caucasian cut”). The other one is cut for rounder head shapes and typically provides a better fit for participants from countries like e.g. Korea, China, Taiwan and Japan (called “Asia Cut”).

Cap Fabrics

All caps can be made with your choice of two different types of fabric: **high-precision fabric and high-comfort fabric.** High-precision fabric is of medium elasticity and has advantages in that it provides a precise reproduction of electrode positions, a longer life span and a quick drying time. High-comfort fabric is of higher elasticity and works with a variety of head shapes. In the majority of caps, we use the high-precision fabric for adult and juvenile cap sizes and the high-comfort fabric for baby cap sizes.

Cap Sizes

The size of a cap is expressed in **centimeter head circumference**. All caps are made in 2 cm increments, beginning with a circumferences of 22 cm (premature babies) up to 64 cm (very large adults). Table 1 shows the average head circumferences for adult men and women, and the head circumferences of babies and children per age.

Note: While our fabric caps are denoted with even numbers (56, 58, …) the sponge-and-saline nets (R-Nets) are denoted with odd numbers (55, 57, …). If you encounter a head circumference in between two cap or net sizes, then choose the next-larger cap size and the next-smaller net size. For example, a cap of size 56 and a net of size 55 both cover the same range from 54.5 to 56.4 cm.

Table 1 also shows which cap sizes can comfortably accommodate how many electrodes/channels.

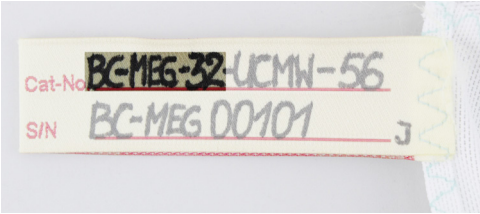
Recommended Cap Sizes per Age, updated reference table

Cap size	Age	Can comfortably accommodate this number of electrodes
20	Preterm week 22	19
22	Preterm week 24	19
24	Preterm week 26	19
26	Preterm week 28	19
28	Preterm week 30	19
30	Preterm week 32	32
32	Preterm week 34	32
34	Preterm week 37	32
36	**Newborn**	**32**
38	**1 month**	**32**
40	**3 months**	**32**
42	**5 months**	**64**
44	**7 months**	**64**
46	**1 year**	**64**
48	**2 years**	**64**
50	**3-4 years**	**64**
52	**5-10 years**	**128**
54	**11-14 years, Adult small female**	**128**
56	**15-17 years, Adult medium (female)**	**128**
58	**18 years, Adult medium (male)**	**128**
60	**Adult large male**	**128**
62	**Adult very large**	**128**
64	**Adult very very large**	**128**

To summarize: If you are unsure about Cap Type and Cap Fabric, don‘t worry. We are happy to select the right cap type and fabric for your application or advise you when making your choice. However, please make sure to provide your desired cap cut/s as well as size/s when placing your order with Easycap, Brain Products or your local Brain Products distributor.

The Standard Cap Variants

All our caps come with a flap at the occipital end, which shows the catalogue-number and the serial number. The catalogue-number begins with a designation of the respective cap variant, followed by more details about number of channels, type, cut, and size. To find out the cap variant, use the first part of the catalogue-number. To identify an individual cap, use the serial number. Caps of identical make will share the same catalogue-number, but the serial number is always unique.



Flap of cap with high-lighted cap variant.

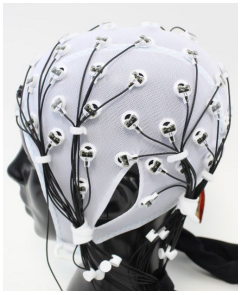
The following list contains all Standard Cap Variants with a short description. A full list with every channel number, every layout and specification files of each cap variant can be obtained from info@easycap.de.

If your experiment requires a non-standard solution, let us know and we'll work with you to find the perfect cap.

actiCAP slim and actiCAP snap

The latest generation of Brain Products' active electrodes are called actiCAP slim. They can be used in caps in two different ways:

- On the **actiCAP slim**, the active electrodes can be buttoned directly into the cap, they therefore stay attached to the cap and do not need to be removed. The advantages are that the cap is always ready for use and no electrodes need to be swapped from cap to cap. The height of the electrodes is only 5.5 mm, so they are more comfortable when lying down or when close coil positioning is needed with TMS studies. However, as the electrodes are permanently fixed to the cap, a full set of electrodes is required for each cap (size).
- On the other hand, with the **actiCAP snap**, the fabric cap is equipped with holders for the active electrodes. Therefore, only one set of electrodes is required and can be swapped between caps when you need a different size.

AS	Cap with actiCAP slim electrodes built permanently into the cap. These caps can be used with old actiCHamp and – via ControlBox – with BrainAmp and other stationary amplifiers. 
ASP	Cap with actiCAP slim electrodes built permanently into the cap, for actiCHamp Plus only
CAS	Replacement Cap for AS and ASP: only fabric cap with openings and Velcro. 

CACS	Cap with Holders for actiCAP slim electrodes 

Variant with piggyback tornister on cap for LiveAmp (mobile use)

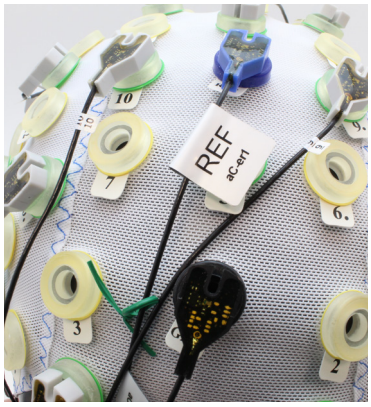
CLACS	Cap with holders for actiCAP slim electrodes and tornister for LiveAmp. *Please note that for LiveAmp a special version of the actiCAP slim electrodes set is necessary.* 

The coloured **actiCAP snap** holders are available without a cap, as sets of 1-32. REF, GND, and un-numbered holders are available individually.

Caps for "classic" actiCAP Electrodes

Before the slim active electrodes were available (June 2017) there were the ("classic") actiCAP electrodes and caps. These had a different holder shape and the electrode itself was higher. Many of these systems are still in use and the classic actiCAPs with holders are still available.

All classic actiCAP caps have electrode holders. There have been various layouts, all depending on which amplifier they would be used with. There have been layouts with a dedicated REF electrode, as needed for BrainAmps and other amplifiers using a REF electrode, and there have been layouts without a REF electrode. In the last few years, there have been combined layouts for use with and without a REF electrode. Please refer to the respective specification files for more details.



"Classic" actiCAP holder and electrode

Standard Cap Variants for classic actiCAP electrodes

CAC	Cap with actiCAP slim electrodes built permanently into the cap. These caps can be used with old actiCHamp and – via Control-Box – with BrainAmp and other stationary amplifiers.
CAP	Cap with classic actiCAP holders, without REF, channel count topographical adjacent.
CMA	Cap with classic actiCAP holders, usable with/without REF, channel count topographical adjacent.

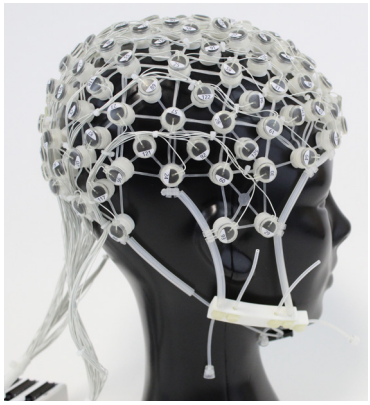
Cap Variant for classic actiCAP electrodes and LiveAmp

CLA	Cap for LiveAmp with tornister, with classic actiCAP holders, usable with/without REF, channel count topographical adjacent.

Note: The coloured labels of classic actiCAP holders are available as sets of 1 – 32.

R-Net – Sponge-based electrode system:
Nets with Passive Electrodes for Various Amplifiers and (available soon) for Simultaneous EEG-fMRI Acquisition

The R-Nets are manufactured with **connectors specific to the amplifier they are to be used with.** The R-Net for BrainAmp will soon be available in a version suitable for combined EEG-fMRI recordings. In R-Nets the catalogue number and the serial number can be found on the connectors.



R-Net

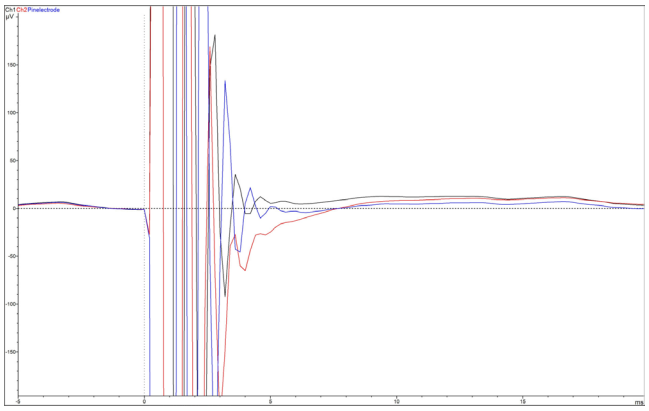
R-Net Variants

RPA-BA	R-Net for use with BrainAmp Standard | BrainAmp DC
RNP-BA-MR	R-Net for use with BrainAmp MR | BrainAmp MR plus in fMRI (available soon)
RNP-AC	R-Net for use with actiCHamp Plus
RNP-LA	R-Net for use with LiveAmp

BrainCaps: Caps with Built-in Passive Electrodes for Simultaneous Data Acquisition from fMRI, TMS, MEG and for Various Amplifiers

"BrainCap" is a group of caps which **use passive Multitrodes as electrodes, that are permanently built in**. Multitrodes always have sintered Ag/AgCl sensors and a large central opening. It is therefore easy to minimize impedances and to create a wide-spread contact area between the skin and electrolyte-gel, and from gel to sensor. Together this allows for stable and noise-free signals. The BrainCaps come in several variants optimized for EEG Recordings simultaneously with other data acquisition technologies, where active electrodes cannot be used.

BrainCap Variants for EEG & fMRI, EEG & TMS and EEG only

BC-MR3	Latest version of the MR-suited BrainCap MR with improved safety features. 
BC-MR	Previous BrainCap MR and will still be supported and repaired.
BC-TMS	BrainCap TMS … made with induction-safe Multitrodes and with adjustable cable pathways  to keep the leadwires away from the TMS pulse to minimize the artifact to an extent as below. 

BC-MEG	Magnetoencephalography measures the electro-magnetic field of groups of neurons. This can be inhibited already by magnetic materials in the magnitude of a few Pico-Farad. The BrainCap MEG for concurrent acquisition of EEG and MEG is made from special materials and under very careful production conditions, while still preserving the well-known Easycap quality and long life-span. MEG and EEG can be achieved with a synchronized BrainAmp, but we also make the BrainCap MEG for direct connection to NeuroMag, Triux, or CTF.
BC	BrainCap variant for EEG only. Besides the standard layouts and connector to BrainAmp it can always be made with customized layouts and/or connector to other amplifiers.
LC	BrainCap variant (called "LiveCap") especially for mobile EEG with LiveAmp. The amplifier can be carried in a tornister directly on the cap, or in a chest belt where also a power bank can be stowed.

BrainCap SLEEP Variants

BC-SL	BrainCap variants especially for Sleep EEG, according to AASM standards and also with higher channel numbers. 
LC-SL	Also the LiveAmp with its bipolar channels, memory card, powerbanks, and a stream-lined BrainCap SLEEP for LiveAmp is an appropriate candidate for location-independent Sleep Recordings.

EasyCaps: Robust and Modular Caps where One Set of Electrodes is Moved from Cap to Cap

While in "BrainCaps" the electrodes are built-in, **"EasyCaps" come with holders and one set of electrodes, which is then moved from cap (size) to cap (size)**. As the electrodes are what make an EEG recording cap expensive, this is a great way to minimize costs, especially when many cap sizes are required. Further advantages are that different layouts and a different number of channels can be chosen for every new experiment.

In fact, **this is a cap style which Easycap started way back in 1996**. EasyCap won over the scientific community with the painless and effective impedance minimization and the easy way to establish good contact between electrolyte gel and skin. Not to mention the stable, noise-free signal. In the course of the proceeding years we have learned that when handled with care these caps and electrodes can stay in service for a very long time.

EasyCap Variants

EC	Designates a set with one cap with holders, one set of electrodes, a Quick-Connect-Interface plus further accessories and consumables to start right out of the box. Electrodes and Quick-Connect-Interface use the universal 1.5mm touchproof DIN safety sockets, usable with many different amplifiers. 
CEC	The initial EC-set can then be expanded infinitely with more caps with holders, arranged according to the same layout. Furthermore, all items of an EC-Set can be re-ordered individually.
QA	QA-Sets are compiled analogously to EC-Sets, but they come with shielded electrodes and without Quick-Connect-Interface. The connectors match the amplifiers with active shielding, e.g. QuickAmp (Brain Products)
CQA	Designate the caps with holders with the layouts of QA-Sets.

TinCaps: Caps with Built-In Electrodes and Tin Electrodes

Tin electrodes are widely known as a cheaper alternative to sintered Ag/AgCl electrodes, therefore Easycap also offers a cap variant with built-in tin electrodes. However, it needs to be noted that their signals are much more susceptible to movement artifacts and noise, and frequencies smaller than 3Hz cannot be recorded. Therefore, **we recommend them only for training purposes** and for experimental settings where the head is fixed in a chin-rest. As always, the mechanical quality is as good as with all other Easycaps.

TC	TinCap with built-in, ring-shaped tin electrodes with 6mm central opening (like Multitrodes).
TN	Same, but with 2mm-openings for users who prefer to work with blunted needle.

Other Cap Variants

Caps for fNIRS

These fabric caps are sturdy enough to hold not only EEG electrodes in place, but also NIRS optodes, e.g. from NIRx, Hitachi and Artinis. It is possible to record EEG and NIRS simultaneously by placing electrodes and optodes into the same cap.

We can create caps from black fabric with openings for optode-grids according to the specification of the user. In some situations we can also supply the respective holders, and of course we can contribute the electrodes for simultaneous recordings.

While in the early years of NIRS, fixed inter-optodes distances had been required, this belief seems to have changed. This means that caps with openings according to 10%-system allow for temporary grids, whether they are frontal, lateral, parietal, or over certain brain areas (e.g. Broca/Wernicke) and then move the optode holders to other openings for the next experiment.

Landmark-Caps

One feature of a cap is that it can be positioned repeatedly in the same place by aligning it to anatomical landmarks, i.e, Nasion, Inion, Vertex. If a cap is labelled with the 10/20 positions or individually determined spots, it can speed up identifying relevant locations, such as with rTMS applications. For this reason we also offer empty caps, or caps with marks and/or openings according to requests.

Animal-Caps

Caps for animals are always customizations which are created together with the user. We have already worked with users through the years to create caps for monkeys, dogs, horses, piglets, and sheep.

We are more than happy to share our experiences.

Carbon Wire Loops (CWL) - in preparation

In simultaneous recordings of EEG in fMRI the artifact correction in 3D space can be improved if movement data is available, as they can be registered from resistive loops mounted onto the cap. Such Carbon Wire Loops (CWL), for BrainCap MR and recorded by a BrainAmp ExG MR are currently in development. Once released they will be available both for the new fMRI-suited caps and also as a later add-on for existing caps.

KRIOS Compatibility

KRIOS by Northern Digital Instruments NDI, is an infrared camera system including software used to digitize individual, real-life electrode positions. In order to work, the electrodes are equipped with permanent reflectors in a highly qualitative and precise manner. **Many Easycap/Brain Products electrodes can be equipped with these KRIOS markers**: Multitrodes with large or small openings, R-Net electrodes and actiCAP slim electrodes. KRIOS markers are released for use in fMRI.

KRIOS compatibility can be ordered as an option for many caps and nets, but only for new versions.

Repair-Sets for BrainCaps and R-Nets

Although rare, it can happen that an electrode of a BrainCap or an R-Net requires repair. **Easycap offers repairs and reconditioning for all caps**. Sometimes it may seem uneconomical to ship a cap half way around the world and back just to replace an electrode; therefore, for BrainCaps (except BrainCap MR, BrainCap MEG) and for R-Net (except R-Net MR) **repair sets are available**. After purchasing the to-be-replaced electrode and the repair set you can follow the instructions provided and carry out the replacement procedure yourself.

A repair set for exchanging the silicone patches of R-Nets will be available soon.

Closing Remarks

Hopefully this overview provides you with all the information required to find the best suited cap for your needs. Whether you want to try something new or replace and add to your existing inventory, we are here to help. We would like you to see **Easycap as your extended workbench**: please contact us with any cap or electrode related plan, problem, or idea you might have.