BRAIN PRODUCTS
Solutions for neurophysiological research

BrainAmp

Operating and Reference Manual for use in a laboratory environment

For the models
BrainAmp Standard
BrainAmp DC
BrainAmp ExG
BrainAmp MR
BrainAmp MR plus
BrainAmp ExG MR

www.brainproducts.com

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About this manual

This manual describes how to use the BrainAmp and BrainAmp MR series of amplifiers and their accessories[1] under **laboratory conditions**.

The manual forms an integral part of the amplifier system. It must be precisely adhered to in order to ensure that the amplifier system is used as intended (see the relevant section on page 14) and operated correctly and to guarantee the concomitant safety of test subjects, users and third parties. Make sure that this manual is always available to users.

The amplifier is operated using the BrainVision Recorder recording software. Refer to the User Manual for the Recorder for a description of the relevant functions (impedance measurement, DC offset correction, configuration of the digital port, setting the resolution and configuring filters).

Topics covered by the BrainAmp MR Operating and Reference Manual

You will find detailed information on the use of the BrainAmp MR, BrainAmp MR plus and BrainAmp ExG MR amplifiers for **combined EEG-fMRI measurements in an MR scanner** in the BrainAmp MR Operating and Reference Manual, which is available for download from our web site under the link http://www.brainproducts.com/downloads.php.

The structure of the manual

The manual has five chapters:

- Chapter 1 contains the installation instructions. On the one hand, this chapter describes those installation steps you must perform irrespective of whether you want to use the amplifier system under laboratory conditions or in an MR environment. On the other hand, those installation steps are described which are only relevant if the amplifier system is to be used in a laboratory.

  You will find those installation steps that are required if the amplifiers of the BrainAmp MR series are to be operated in an MR environment in the separate BrainAmp MR Operating and Reference Manual.

- Chapter 2 contains notes on using the amplifiers within a conventional laboratory environment.
- Chapter 3 describes how to maintain and clean the products.
- Chapter 4 contains notes on disposal of the products.

1. The amplifiers and the accessories supplied by Brain Products are referred to as the "amplifier system" below.

Who is the manual intended for?

The current manual is intended for physicians, medical experts and users working in the field of psychological and neurological research. (For details, see section "Intended use" on page 14).

Conventions used in the manual

The manual uses the following typographical conventions:

Italic	Italic text is used to identify menus, menu commands, dialog boxes, options, the names of files and folders and the labels on the products. Italic font is also used to highlight portions of running text.
Underscore	Underscored text indicates a cross-reference or a web address.
●	The blue dot indicates the end of a chapter.

The manual also uses the following symbols to help you find your way around:

The *Personal injury* symbol indicates that incorrect use of the products may result in a health hazard to the test subject, the user and/or a third-party. Incorrect use means non-adherence to the stipulations set out in this manual.

The *Damage to property* symbol indicates that the incorrect use of the products may bring about a risk of damage to property.

The *Stop* symbol indicates that you should not carry out a particular action.

A *note* draws your attention to important (technical) information.

A *cross-reference* refers to another section or an external document that has a bearing on the running text at this point.

A *tip* gives you advice, recommends a particular approach or draws your attention to an interesting aspect.

Revision history

Page	*Status*	*Change*
17	new	Requirements for the computer
59	modified	Product identification (CE marking)

Reporting errors and support

We would ask you to report to us without delay any error you find in this manual, any fault in the products or any malfunction that you observe when operating the products and any event where a test subject, user or third party has been injured, however slightly, or could have been injured. To do so, contact your dealer who can also advise you about general questions relating to these products.

Preface

The BrainAmp and BrainAmp MR amplifier series

The BrainAmp and BrainAmp MR amplifier series are easy to use, compact and robust. The BrainAmp series is made up of the BrainAmp Standard, BrainAmp DC and BrainAmp ExG and the MR series comprises the BrainAmp MR, BrainAmp MR plus and BrainAmp ExG MR.

Our amplifiers rigorously meet the requirements for reliability, data quality and trouble-free use. There is a huge variety of applications for these amplifiers, ranging from traditional acquisition of EEG and ERP signals, through DC acquisition, and right up to the acquisition of polygraph signals such as EMG, ECG and EOG under field conditions encountered in a neurophysiological research laboratory.

Together with their accessories, the amplifiers form a complete, integrated system. When used correctly, according to the *Correct use*, the amplifier system guarantees excellent data quality and the very highest level of comfort and safety for users and subjects alike.

The BrainAmp Standard, BrainAmp DC, BrainAmp MR and BrainAmp MR plus use a referential (i.e. unipolar) measurement principle and are intended for acquiring EEG data with electrode caps.

The BrainAmp ExG and BrainAmp ExG MR use a differential measurement principle and are intended for the bipolar measurement of electrical potentials at the surface of the body (EMG, ECG) as well as for non-electrical measurements (respiration, blood circulation) using electrode input boxes and sensors.

The amplifiers of the MR series can be used in the MR scanner while the scanner is in operation. Only those accessories that have been explicitly approved for this purpose by Brain Products are permitted for use in an MR environment.

You will find detailed notes on the use of the amplifiers of the MR series for combined EEG-fMRI measurements in the separate BrainAmp MR Operating and Reference Manual, which are available for download from our website under the link http://www.brainproducts.com/downloads.php.

Intended use

The components of the BrainAmp family are intended to be used for acquiring neuro-/electrophysiological signals (e.g. EEG, EMG, ECG, EOG or signals from other approved sensors) in the context of non-medical applications in order to carry out fundamental or applied research on the basis of neurophysiological methodology and data.

In particular, the acquisition of invasive EEG signals is permitted if

- the acquisition is performed outside the MR environment,
- the BrainAmp components are powered by the PowerPack (rechargeable battery),
- no other product is electrically connected with the test subject at the same time, and
- no simultaneous electrical stimulation is used.

Invasive electrodes must not be used for recording ECG signals and polygraphic signals with the BrainAmp components.

The components of the BrainAmp family are not medical devices. Use for diagnosis, therapy, monitoring of vital physiological processes (such as cardiovascular functions) or other medical purposes is expressly forbidden.

Correct use

The components of the BrainAmp family are permitted to be used by users in the psychological and neurophysiological research area as well as physicians and medical experts for non-medical applications.

The components of the BrainAmp family are not permitted to be used by unqualified persons (e.g. laymen), persons who cannot read (e.g. due to visual impairment) or understand (e.g. due to a lack of language skills) the manual.

The components of the BrainAmp family are permitted to be used in the following environments: hospitals, clinics, other medical environments, research institutes and other non-medical environments (e.g. at home), provided that all the other stipulations regarding the correct use are met and that the products are used in accordance with its intended use.

The components of the BrainAmp family are not permitted to be used in the following environments:

- 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 the components of the BrainAmp family (e.g. under shower, under water-tap).

The components of the BrainAmp family are permitted to be used for healthy and sick adults, children and animals.

Irrespective of any liability on the part of the manufacturer, the relevant national stipulations for operators and other relevant national legislation must be observed.

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

Use together with other products and components

The components of the BrainAmp family may be combined with the following products and components:

For use in and outside of MR scanner rooms:	
Product	**Manufacturer**
GSR-MR Module	Brain Products GmbH
RespirationBelt MR	Brain Products GmbH
3D Acceleration Sensor	Brain Products GmbH
ExG AUX Box	Easy Cap GmbH
BrainCap MR (passive Ag/AgCl EEG electrodes/caps for MRI)	Easy Cap GmbH
Electrode gel or paste	Easy Cap GmbH (others on request)
MR scanner[a]	Siemens, GE, Philips, Bruker

a. MR scanner room only.

Not for use in MR scanner rooms	
Product	**Manufacturer**
Passive Ag/AgCl EEG electrodes/caps that are not designed for use in MRI (e.g. Multitrodes/BrainCap)	EasyCap GmbH (others on request)
actiCAP active EEG electrodes (incl. SplitterBox and ControlBox)	Brain Products GmbH
Electrode Input Box EIB 64 (32 and 64 referential channels)	Easy Cap GmbH
ExG Input Boxes (with 16 bipolar ExG channels)	Easy Cap GmbH
MOVE (transmitter and receiver)	Brain Products GmbH
StimTrak	Brain Products GmbH
Temperature sensor	Becker Meditec
TriggerBox & TriggerBox Extension	Brain Products GmbH
Photo sensor	Brain Products GmbH

Software (on a computer [not to be located in MR scanner room])	
Product	**Manufacturer**
BrainVision Recorder	Brain Products GmbH
BrainVision RecView	Brain Products GmbH
actiCAP ControlSoftware	Brain Products GmbH

Requirements to the computer (not to be located in MR scanner room)
The computer to which you connect the amplifier (via the USB adapter) must fulfill the IEC 60950-1 or EN 60950-1.

In addition to this general overview of the permitted combinations, users must also check that all the conditions applicable to the product in question (e.g. relating to MR compatibility) are fulfilled for the specific combination and specific application (definition of purpose and intended use).

If users combine products other than those listed here then they are responsible for ensuring the safety of test subjects, operating personnel and the environment. If the product data does not immediately make it clear that products can be combined (connected) without danger then the user must contact the relevant manufacturers to ensure that the required safety of all the products involved is not compromised by the intended connection.

Chapter 1 Installation

On the one hand, this chapter describes those installation steps you must perform irrespective of whether you want to use the amplifier system under laboratory conditions or in an MR environment.

On the other hand, it describes those installation steps which are only relevant if the amplifier system is to be used in a laboratory.

The installation steps which only need to be performed if you intend using the amplifiers of the BrainAmp MR series in the context of combined EEG-fMRI measurements are described in the separate BrainAmp MR Operating and Reference Manual. This manual is available for download from our web site: http://brainproducts.com/downloads.php.

1.1 General installation of the amplifier system

The amplifiers are operated using the BrainVision Recorder recording software. Make sure that the most recent version of the Recorder is installed on your computer. If you need it, the most recent version can be found on our web site at http://www.brainproducts.com/downloads.php.

The following elements are located on the front panel of all the amplifiers (see Figure 1-1):

- the *Power* LED
- the *Electrode Input* socket for connecting electrode caps and electrodes (see Section 1.1.6 as of page 33)

Figure 1-1. (From bottom to top): Front view of the BrainAmp MR, BrainAmp MR plus and BrainAmp ExG MR amplifiers, "Power" LED and electrode connector

Figure 1-2. BrainAmp ExG MR 16 with additional power output

Note that only the BrainAmp ExG/BrainAmp ExG MR with 16 channels is fitted with a power output. The BrainAmp ExG/BrainAmp ExG MR with 8 channels does not feature this output. This power outlet was intended for the connection of the ExG AUX Box (for details, see page 36).

The pinouts of the power output of the BrainAmp ExG 16 and BrainAmp ExG MR 16 are described in Appendix B on page 69 and on page 64 respectively.

The following elements are located on the rear panel of the amplifiers (see Figure 1-3 and Figure 1-4):

- the *Power* switch for switching the amplifier on and off
- a 2-way connector for fiber optic plugs with locks and protection against polarity reversal
- the *No Sync.* LED

Figure 1-3. Rear view of an amplifier with battery compartment

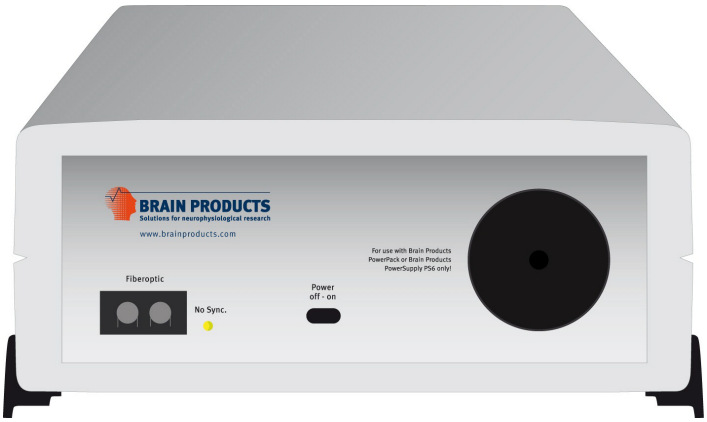
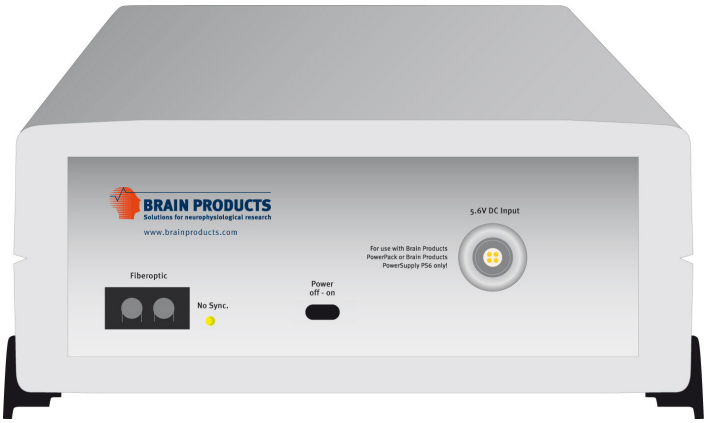


Figure 1-4. Rear view of an amplifier with integrated 4-way screw-lock power socket, without battery compartment (as of 2011)



There are two different interfaces for connecting the amplifier to the computer used for recording the EEG data: either USB 2.0 or PCI 2.1.

You will find instructions on installing the Recorder in the relevant User Manual.

To use the interfaces, first install the BrainVision Recorder recording software. When the software has been installed, all the required drivers will be located on your computer.

There are also two ways of powering the amplifier system: You can either use the PowerPack or the PS6 wr V-0 power supply unit[1]. The PS6 wr V-0 is not suitable for use in an MR environment. Rather, it is only intended for EEG acquisition under laboratory conditions.

For information on setting up the power supply using the PS6 wr V-0, refer to Section 1.2.1 as of page 41.

The following sections provide details on using the interfaces, setting up the power supply using the PowerPack and connecting general accessories.

If you intend using the MR series amplifiers for combined EEG-fMRI measurements, you must perform the following steps outside the MR environment.

1.1.1 Connecting the amplifier using the USB2 Adapter (BUA)

Application in an MR environment – Caution! The USB2 Adapter is not suitable for use in an MR environment. You must therefore always use it outside of the scanner room.

Note that your computer must be equipped with a USB 2.0 port. The USB2 Adapter does not work with a USB 1.0 or USB 1.1 port.

Two versions of the USB2 Adapter are available: The BUA64 for up to 64 channels or a maximum of two amplifiers (see Figure 1-5) and the BUA128 for up to 128 channels or a maximum of four amplifiers.

1. Not available in the USA and Canada.

Figure 1-5. USB2 Adapter for up to 64 channels (top view)

You have the option of combining two USB2 Adapters and thus using up to eight amplifiers in your experimental setup. There are two ways of combining the adapters (see Table 1-1). Please note that it is not possible to combine two BUA64s. Use one BUA128 if you wish to use a total of four amplifiers.

Table 1-1. Possible combinations of two USB2 Adapters in an experimental setup

First USB2 Adapter	Second USB2 Adapter
BUA128	BUA64
BUA128	BUA128

Proceed as follows if you want to use the USB interface:

1. Install the BrainVision Recorder software as described in the User Manual for the Recorder.
2. Connect the USB2 Adapter to the computer. *Use only the supplied USB cable to do this.*

   If you wish to use two USB2 Adapters, you also need the supplied dualBUA Adapter Cable (see Figure 1-6) in addition to the USB cable. Proceed as follows:

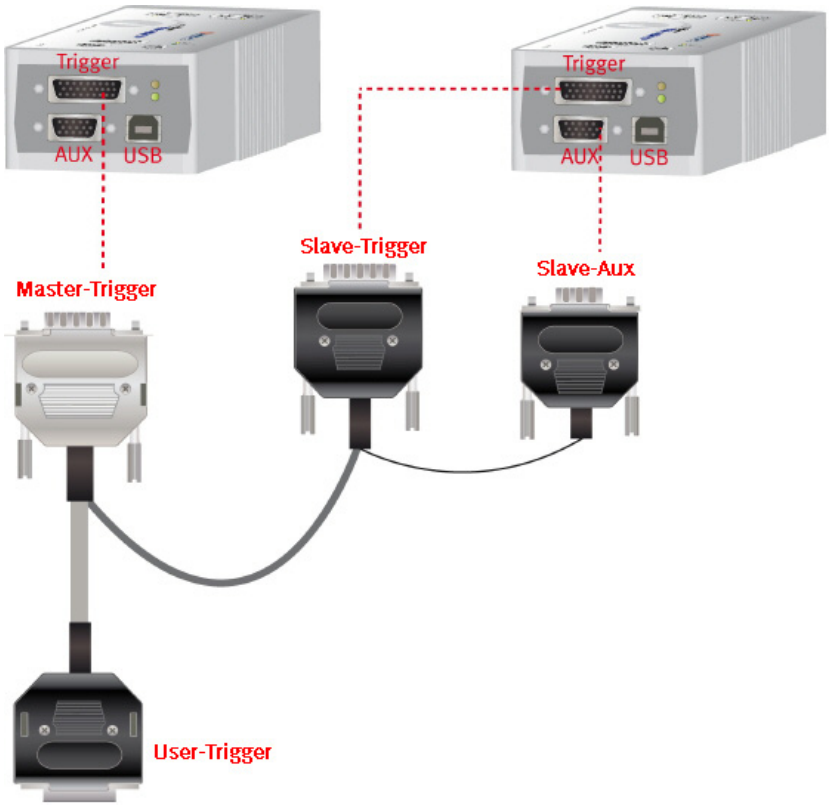
   a. Connect the dualBUA Adapter Cable to the relevant trigger connection (see Figure 1-7) of each of the first and second USB2 Adapters.

   b. Then connect the dualBUA Adapter Cable to the AUX connection of the second USB2 Adapter.

   c. Tighten the securing screws on all the connectors of the dualBUA Adapter Cable.

   d. Then connect the two USB2 Adapters to your computer using the supplied USB cables.

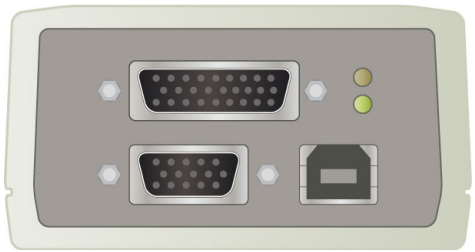
Figure 1-6. Connecting two USB2 Adapters using the dualBUA Adapter Cable



You will find the pinout for the trigger socket on the USB2 Adapter in Appendix C as of page 75.

You will find a description of the AUX connection pinout in Appendix D on page 77.

Figure 1-7. USB2 Adapter (side view), 26-pin HD D-Sub socket for the trigger cable (top), "AUX" port (bottom left) and "USB" port (bottom right)



3 The computer will inform you that a new hardware component has been detected and will then install the driver for the USB2 Adapter.

Note that Windows® requires that the driver is re-installed for each USB port the first time that the USB2 Adapter is used on a different port.

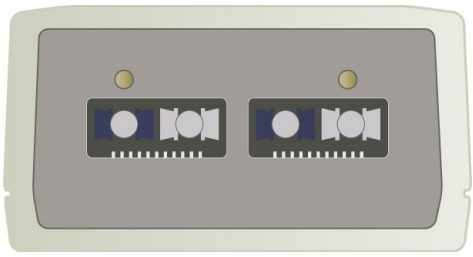
4 Connect the amplifier power supply.

If you are using the PowerPack as the power supply, you must charge it first. Disconnect the PowerPack from the charger before connecting it to the amplifier.

Refer to Section 1.1.3 as of page 28 for detailed information on setting up the power supply using the PowerPack, and to Section 1.2.1 as of page 41 for detailed information on setting up the power supply using the PS6 wr V-o.

5 Connect the amplifiers to the relevant connections on the USB2 Adapter using the supplied fiber optic cables (see Figure 1-8). On the BUA64, these are the connections marked *Fiberoptic 1* and *Fiberoptic 2* and on the BUA128, they are the connections marked *Fiberoptic 1 to Fiberoptic 4*.

Figure 1-8. USB2 Adapter (side view), 2-way connectors for fiber optic plugs with locks and protection against polarity reversal and "no Sync." LEDs



If you are using two USB2 Adapters in your experimental setup, you must ensure that all the fiber optic connections on the first USB2 Adapter are occupied before you connect the amplifiers to the second USB2 Adapter. If you do not do this, the Recorder will issue a warning.

If, for instance, you wish to use six amplifiers in your experimental setup, it is not possible to connect three amplifiers to the first USB2 Adapter and the other three amplifiers to the second USB2 Adapter. Instead, you must connect the first four amplifiers to the first USB2 Adapter and the remaining two amplifiers to the second USB2 Adapter. The fiber optic connections (and hence the channels) are counted in ascending sequence, as illustrated by Table 1-2:

Table 1-2. Assignment of the channels to the USB2 Adapters in an experimental setup with six amplifiers, one BUA128 and one BUA64

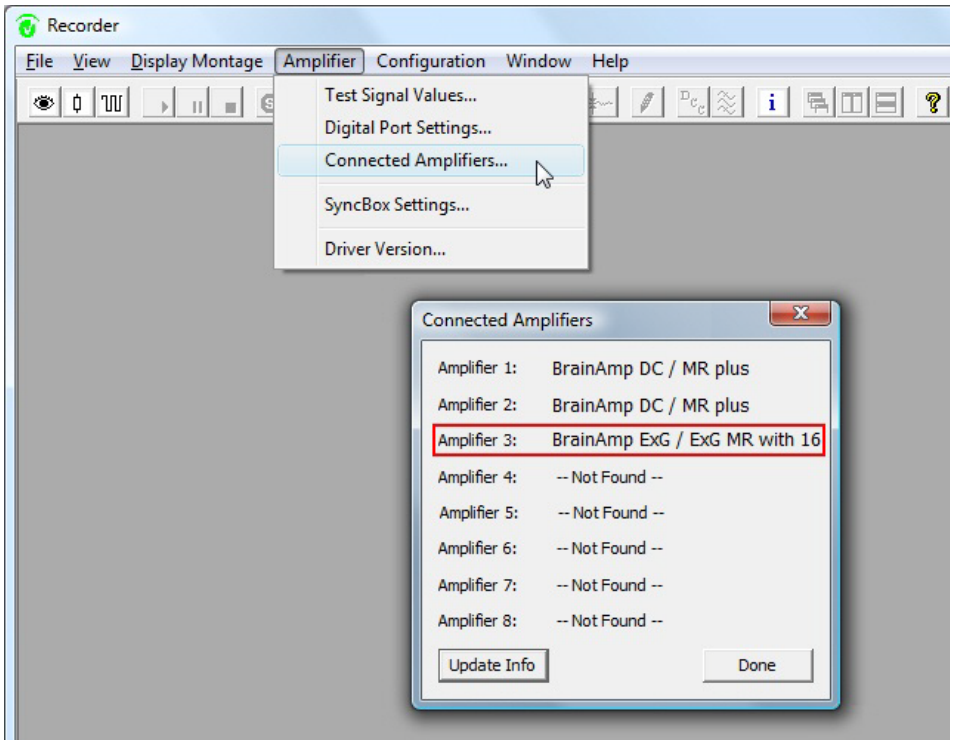
BUA no.	Fiber optic connection	Channel numbers
1	*Fiberoptic 1*	1 to 32
	Fiberoptic 2	33 to 64
	Fiberoptic 3	65 to 96
	Fiberoptic 4	97 to 128
2	*Fiberoptic 1*	129 to 160
	Fiberoptic 2	161 to 192

6 After you have connected the amplifier(s) to the USB2 Adapter, switch on the amplifier(s) using the *Power* switch on the back of the amplifier. The *Power* LED lights up on the front of the amplifier.

7 After you have connected the components to each other, start the Recorder. If the system is working correctly, the *No Sync.* LED located on both the USB2 Adapter and the amplifier goes off. If the LED lights up during the measurement, this indicates that no synchronization has been detected while data is being received and sent. There is either a problem with the fiber-optic cables or their plugs or with the sockets on the USB2 Adapter or the amplifier. Extreme attenuation on the fiber optic cables (if these are too long, for instance) can also result in a failure to detect synchronization.

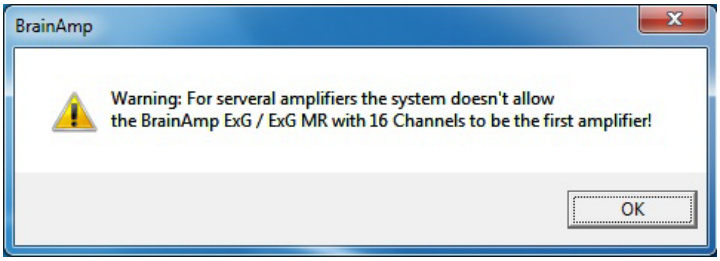
If you are using both unipolar (BrainAmp Standard/BrainAmp DC/BrainAmp MR/MR plus) and bipolar (BrainAmp ExG/BrainAmp ExG MR) amplifiers, always connect the bipolar amplifiers to the USB2 Adapter after the unipolar amplifiers. If, for instance, you are using two BrainAmp MR plus and one BrainAmp ExG MR 16 amplifier, first connect the BrainAmp MR plus amplifiers to the *Fiberoptic 1* and *Fiberoptic 2* inputs of the BUA128. Then connect the BrainAmp ExG MR amplifier to the *Fiberoptic 3* input. The *Amplifier › Connected Amplifiers…* menu item in the Recorder will then list the connected amplifiers as follows (see Figure 1-9).

Figure 1-9. Listing of the connected amplifiers in the Recorder



A warning message is issued if you have connected the bipolar amplifiers in the wrong sequence (see Figure 1-10).

Figure 1-10. Warning message if the BrainAmp ExG MR/BrainAmp ExG MR amplifier has been connected in the wrong sequence



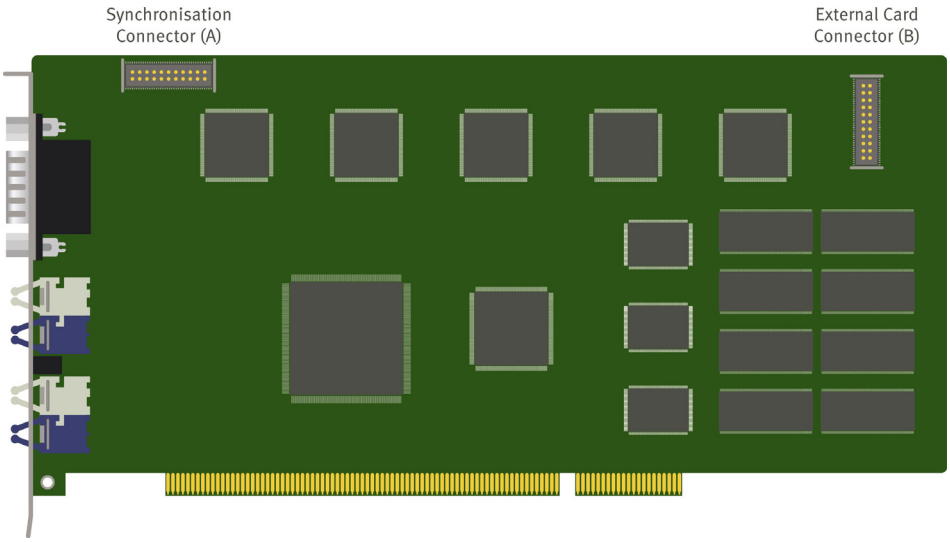
1.1.2 Connecting the amplifier using the PCI adapter card

Note that the mainboard of your computer must support PCI Version 2.1 (5 V 32-bit).

It does not make sense to use the PCI Adapter Card for combined EEG-fMRI measurements, as it does not support the SyncBox.

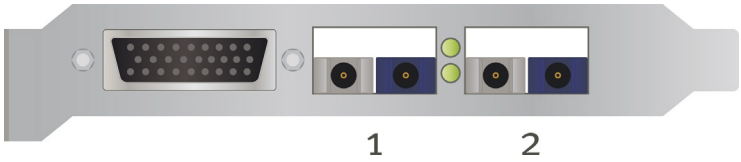
You can find information on installing the PCI Adapter Card as part of an experimental setup with more than 128 channels in Appendix G as of page 83.

Figure 1-11. PCI Adapter Card (top view)



You will find the pinout for the trigger socket on the PCI Adapter Card in Appendix C as of page 75.

Figure 1-12. PCI Adapter Card (side view), 26-pin HD D-Sub socket for the trigger cable and ports 1 and 2 for fiber optic cables, "no Sync." LEDs



Proceed as follows if you want to use the PCI interface:

1. Install the BrainVision Recorder software as described in the User Manual for the Recorder.
2. Shut the computer down, switch it off and unplug the power cord from the power supply.
3. Insert the PCI Adapter Card (see Figure 1-11) in a free PCI slot in the computer. The PCI Adapter Card is installed automatically. No additional drivers are required.
4. Connect the PCI Adapter Card to the amplifier using the fiber optic cable.
5. Switch the amplifier on with the *Power* switch on the rear of the amplifier. The *Power* LED lights up on the front of the amplifier.
6. Start the Recorder. If the system is working correctly, the *No Sync.* LED located on both the PCI adapter card and the amplifier goes off. If the LED lights up during the measurement, this indicates that no synchronization has been detected while data is being received and sent. There is either a problem with the fiber-optic cables or their plugs or with the sockets on the amplifier. Extreme attenuation on the fiber optic cables (if these are too long, for instance) can also result in a failure to detect synchronization.

If you are using both unipolar (BrainAmp Standard/BrainAmp DC,/BrainAmp MR/BrainAmp MR plus) and bipolar (BrainAmp ExG/BrainAmp ExG MR) amplifiers, always connect the bipolar amplifiers to the PCI Adapter Card after the unipolar amplifiers.

If, for instance, you are using two BrainAmp MR plus and one BrainAmp ExG MR 16 amplifier, first connect the BrainAmp MR plus amplifiers to the *1* and *2* ports of the PCI Adapter Card (see Figure 1-12 on page 28). Then connect the BrainAmp ExG MR to port *3*. The *Amplifier › Connected Amplifiers...* menu item in the Recorder will then list the connected amplifiers accordingly (in the same way as described in Section 1.1.1, see Figure 1-9 on page 26). A warning message is issued if you have connected the bipolar amplifiers in the wrong sequence (as described in Section 1.1.1, see Figure 1-10 on page 27).

You will also find instructions on how to set up the power supply on our web site under the link www.brainproducts.com/downloads.php (document "How to Set-Up the BrainAmp System").

1.1.3 Powering the amplifier using the PowerPack

The PowerPack (see Figure 1-13 f) has a rechargeable battery.

Figure 1-13. PowerPack, front view

Figure 1-14. PowerPack, rear view

Charging the PowerPack before initial operation

Only use the suppled Charger V9 for charging the PowerPack.

Application in an MR environment – Caution! The PowerPack is also intended for use in the MR environment. ***The Charger V9 is, however, not suitable for use in an MR environment. You must therefore always charge the PowerPack outside the MR environment.***

It is possible to charge the battery at temperatures between 10 °C and 30 °C. You should ideally charge the battery at room temperature.

Proceed as follows:

1. Connect the Charger V9 to the blue socket on the front of the PowerPack.
2. Connect the Charger V9 to the line power supply. Only use power sources which match the specifications of the charger.

- ▷ The *Power* LED (green) shows that power is being supplied to the PowerPack.
- ▷ The *Charge* LED (yellow) glows when the PowerPack is charged.

3 As soon as the rechargeable battery is fully charged, the yellow *Charge* LED goes out. (Empty batteries may take up to 17 hours to fully charge.)

4 Disconnect the Charger V9 from the PowerPack. (Note that for safety reasons, it is not possible to use an amplifier while the charger is connected.)

Damage to property

If you are charging several PowerPacks at the same time, do not stack them on top of each other in order to prevent them from overheating.

If you do not use the PowerPack immediately after you have charged it, leave it in the charger or charge the PowerPack even when you are not using it. The PowerPack can be trickle charged and cannot be overcharged. The mandatory maintenance charge required prevents harmful deep discharge and has no negative impact on the overall service life of the PowerPack.

Rechargeable batteries wear out over time and therefore take longer to charge. The PowerPack is designed for a service life of around 4,000 hours.

Connecting the PowerPack to the amplifier

To use the PowerPack, connect it to the amplifier as follows:

1 Screw the PowerSupply Adapter (PSA) into the battery compartment on the rear of the amplifier (see Figure 1-15). Note that on newer versions of the amplifier (as of 2011) a PowerSupply Adapter is already integrated in the amplifier and that there is no battery compartment (see Figure 1-4 on page 21).

For detailed information on positioning the amplifier and the PowerPack in the scanner room, refer to the separate BrainAmp MR Operating and Reference Manual.

2 Set up the amplifier(s) and the PowerPack in the location you require.

3 Connect the gray socket on the rear of the PowerPack with the PowerSupply Adapter using the PowerPack Cable. The green *Operate* LED on the rear of the PowerPack indicates that a supply voltage is present. The PowerPack is now ready to be used.

Figure 1-15. Rear of the amplifier showing the open battery compartment into which the cylindrical PowerSupply Adapter is screwed

When fully charged and with two amplifiers connected, the battery life of the PowerPack is around 15 hours, doubling to around 30 hours if only one amplifier is connected. If the operating voltage falls below the permitted minimum voltage of the amplifier, the green *Operate* LED on the rear of the PowerPack goes off.

Using and storing the PowerPack

You can use the PowerPack at temperatures of between 10 °C and 40 °C. To get the best performance from the rechargeable battery, you should always use the PowerPack at room temperature.

Damage to property

Do not expose the PowerPack to temperatures below 0 *°C or above* 40 *°C or to bright sunlight.* If the PowerPack is exposed to a temperature of above 40 °C, allow it to cool slowly to its operating temperature. At temperatures below 0 °C, the electrolyte can freeze, which will destroy the battery.

Damage to property

Under no circumstances use third-party accessories, as these can destroy the rechargeable battery. Only use original chargers and accessories from Brain Products.

Personal injury

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

1.1.4 Simultaneous recording of trigger signals via the computer interfaces of the amplifier

You will find a description of the digital port pinout in Appendix C as of page 75.

Refer to the Recorder User Manual for information on configuring the digital port.

Both computer interfaces (USB2 Adapter or PCI adapter card) have a 16-bit digital port for the simultaneous recording of trigger signals. The trigger signals are recorded as markers by the Recorder. The interfaces are designed as 26-pin HD D-Sub sockets.

The digital port is configured from the Recorder. The length of the trigger pulse that is required depends on the sampling rate selected in the Recorder and must be greater than the length of the sampling interval, otherwise it is not possible to write any markers. (At a sampling rate of 5 kHz, the length of the trigger pulse must be > 200 µs.)

Note that the digital port only supports pulse mode. Toggle mode is not supported. Also note that the digital port only accepts TTL input signals. Serial input signals on the other hand are not supported.

Damage to property

Trigger pulse voltages must comply with the TTL specification. *Voltages above the permitted pulse voltage will destroy the digital port.*

Brain Products supplies standard trigger cables with the amplifier system. You can connect the standard trigger cables to the parallel port of the computer on which the stimulation software is running and in this way record stimulation markers, for instance. *In this context, note that it is not sensible to install and use the stimulation software on the computer that is used to record the EEG data.*

Personal injury

The digital port of the amplifier system is designed only to receive triggers. *Never connect the USB2 Adapter or the PCI Adapter Card to the trigger input of stimulation equipment using the trigger cable.*

The standard trigger cables can include an additional BNC interface for an additional trigger output (e.g. volume trigger or TMS trigger) and a trigger pulse stretcher.

You will find information on recording volume triggers during combined EEG-fMRI measurements in the separate BrainAmp MR Operating and Reference Manual.

1.1.5 Use of fiber optic cables between the amplifier and the computer interface

The amplifier and the computer interface are galvanically isolated by means of duplex fiber optic cables.

Ensure that the fiber optic cables are firmly plugged into the amplifier and the interfaces.

In order to ensure trouble-free operation, make sure that you route long (20 m) fiber optic cables in particular permanently in cable ducts (in the case of combined EEG-fMRI measurements: in the scanner room).

Take great care when handling fiber optic cables. *Damaged cables impact negatively on the operational safety of the system.*

Damage to property

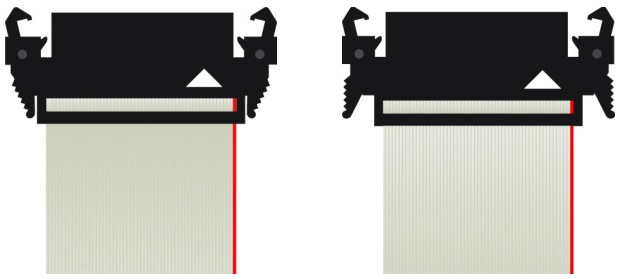
- Avoid sharp bending radiuses (< 25 cm) when storing and using the cables.
- Make sure that you do not tread on or run over fiber optic cables that are lying on the floor (office chair).
- Do not touch the exposed ends of the cables in order to avoid soiling and degrading correct operation of the cables.
- We recommend that you do not exceed a maximum cable length of 20 m between the USB2 Adapter and the amplifier or between the computer and the amplifier.

1.1.6 Connecting electrode caps and electrode input boxes

The front panel of the amplifier has a socket marked *Electrode Input* for connecting electrode caps or electrode input boxes. These are connected using the supplied ribbon cables. The plugs on the ribbon cables are fitted with clamps and are self-locking. Ensure that the clamps are open before you insert the plug (see Figure 1-16, left). As soon as you push the plug into the socket, the clamps automatically engage to prevent the plug from becoming disconnected inadvertently, e.g. if the ribbon cable is pulled.

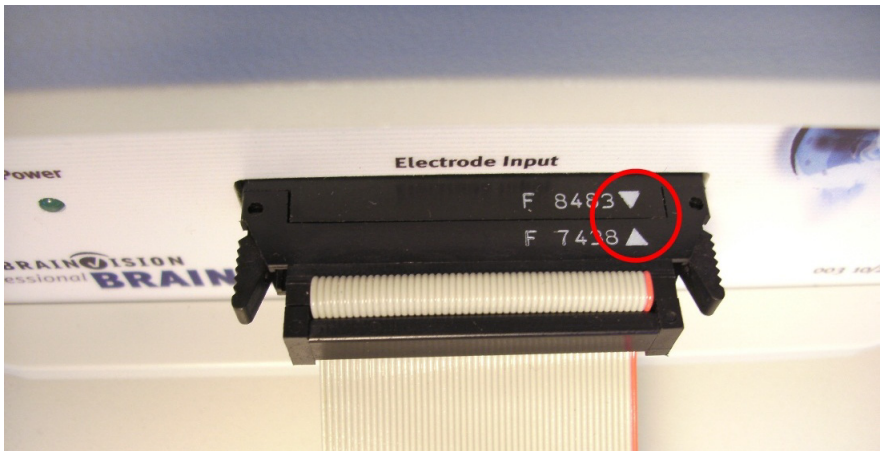
Always ensure that the plug is pushed home fully: The clamps must be engaged and point outwards (see Figure 1-16, right). To remove the plug from the socket, press both clamps at the same time. The plug is released automatically.

Figure 1-16. Open (left) and engaged (right) clamps on the ribbon cable connectors



Furthermore, the connectors on the ribbon cables feature arrows which indicate the orientation with which the connector must be plugged into the socket. Ensure that the arrow on the plug is aligned with the arrow on the *Electrode Input* socket (see Figure 1-17).

Figure 1-17. Arrow on the plugs of the ribbon cables and on the amplifier socket



Electrode caps

You can connect electrode caps to the amplifier in two different ways: Either using multi-way plugs (e.g. BrainCap, BrainCap MR and actiCAP) or using individual plugs (e.g. EasyCap) in combination with an electrode input box.

If you wish to use bipolar amplifiers (BrainAmp ExG/BrainAmp ExG MR with 8 or 16 channels each), you need connection boxes which are connected to the amplifier using the supplied ribbon cable.

You can connect electrode caps of the BrainCap (MR) type (see Figure 1-18) directly to the unipolar amplifiers using the supplied ribbon cable. The actiCAP (see Figure 1-19) is connected to the amplifier using the actiCAP ControlBox. When you do so, make sure that you connect the multi-way plugs to the amplifier in the correct sequence (i.e. 1 through 32 to amplifier 1, 33 through 64 to amplifier 2, etc.).

Figure 1-18. BrainCap, front and rear views

Figure 1-19. actiCAP

Electrode Input Box EIB64-A

You can only use electrode caps with individual plugs in combination with the Electrode Input Box EIB64-A. You will find detailed information on using the EIB64-A in Section 1.2.2 as of page 42.

ExG AUX Box

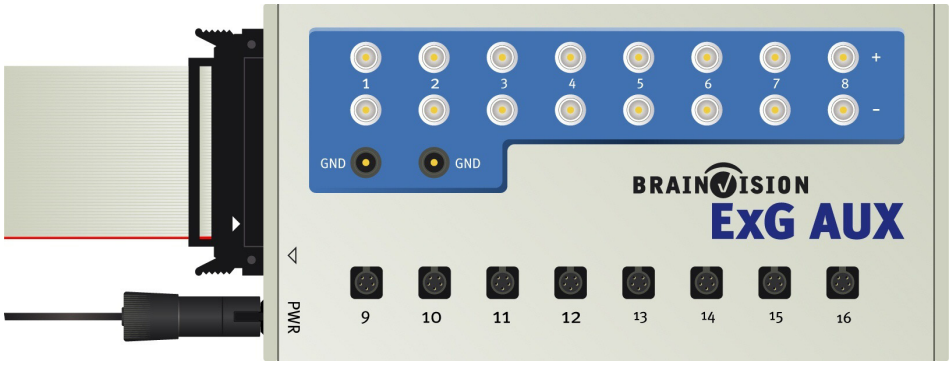
If you wish to use sensors (such as the GSR MR module), you require the ExG AUX Box (see Figure 1-20), which has 8 bipolar and 8 AUX channels.

Note that it is only possible to use sensors with the BrainAmp ExG/BrainAmp ExG MR 16, and not with the BrainAmp ExG/BrainAmp ExG MR 8.

You will find instructions for configuring the AUX inputs in the Recorder User Manual.

You will find a description of the pinouts of the sensor connections and the *PWR* connector of the ExG AUX Box in Appendix B on page 65.

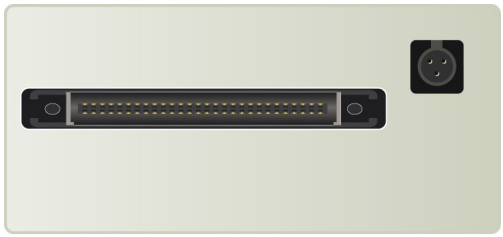
Figure 1-20. ExG AUX Box (top view) with 8 bipolar inputs (1 through 8) and 8 AUX inputs (9 through 16)



The pinouts of the power output of the BrainAmp ExG 16 and BrainAmp ExG MR 16 are described in Appendix B on page 69 and on page 64 respectively.

To supply the sensors with power, connect the *PWR* input of the ExG AUX Box (see Figure 1-21) to the power output of the BrainAmp ExG/BrainAmp ExG MR 16 bipolar amplifier using the supplied 3-way power cable. The power output is marked *4.5 V DC Output*.

Figure 1-21. ExG AUX Box (side view), connection for ribbon cable (left) and "PWR" input for the power supply (right)



1.1.7 Recording polygraphic signals using the PolyBox

Application in an MR environment – Caution! The PolyBox is not suitable for use in an MR environment. You must therefore always use it outside of the scanner room.

The PolyBox (see Figure 1-22 f) makes it possible to record up to eight sensor channels in addition to the channels of the amplifiers connected to the BUA64 or BUA128.

Note that the PolyBox cannot be used alone but must be operated in combination with an amplifier of the BrainAmp family.

The pinouts of the sensor ports on the PolyBox are described in Appendix B on page 71.

Figure 1-22. PolyBox with eight 5-way Binder type sockets and one "AUX" HD D-Sub socket (top view)

Figure 1-23. PolyBox with connection socket for the USB2 Adapter (side view)

The PolyBox is not isolated from the computer power supply unit as required by IEC 60601-1. Only use it directly with sensors that are electrically isolated from the test subject in accordance with IEC 60601-1. (We can provide you with a variety of compatible sensors on request.)

Connecting the PolyBox to the amplifier

Proceed as follows to connect the PolyBox:

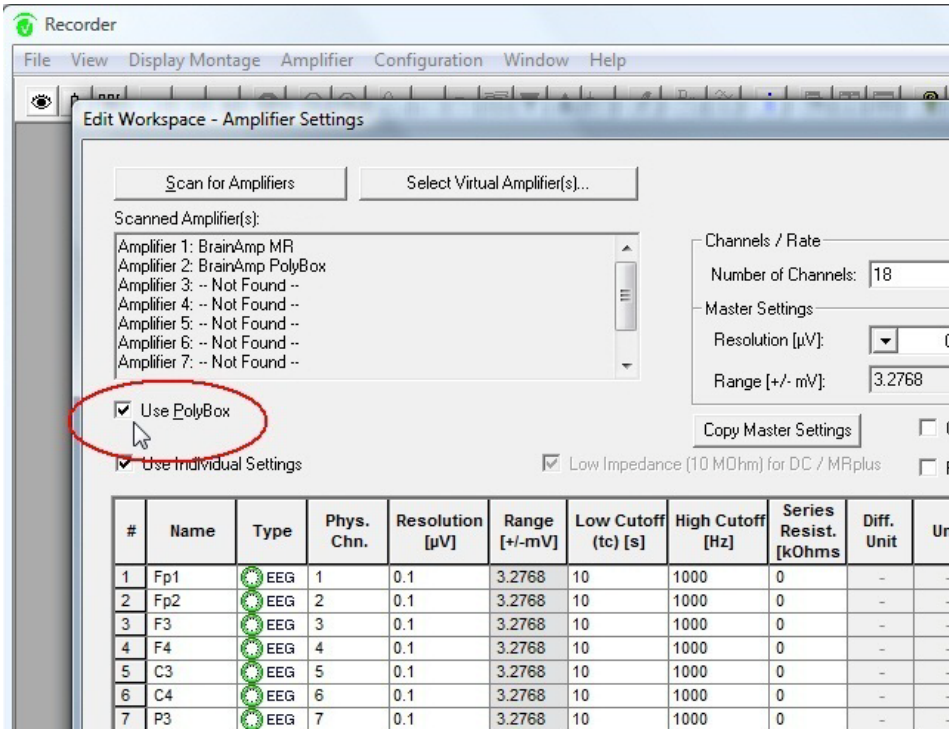
1. Connect the amplifier and the USB2 Adapter prepared for operation to the computer you will be using to record the data as described in Section 1.1.1 as of page 22.
2. Connect the PolyBox to the AUX input of the USB2 Adapter using the PolyBox connection cable.

3 Connect your sensors to ports *IN1* through *IN8* of the PolyBox.

4 Now activate the PolyBox in the Recorder workspace (see Figure 1-24). If you cannot do this, make sure that you are using the most recent version of the Recorder (minimum requirement: BrainVision Recorder 1.10 with BrainAmp Module 1.03.0004).

You will find details on how to configure the workspace in the Recorder User Manual.

Figure 1-24. Activating the PolyBox in the Recorder workspace



1.1.8 Checking the installation on operating system level

In order to check whether installation has been successful on Windows® level, open the Device Manager from the Control Panel.

The USB2 Adapter appears as the *Brain Amp USB Adapter* in the *Universal Serial Bus controllers* section in the Device Manager (see Figure 1-25). The PCI adapter card appears as the *BrainAmp (MR) Hostadapter* in the Device Manager (see Figure 1-26).

Figure 1-25. Windows® Device Manager, showing the USB2 Adapter

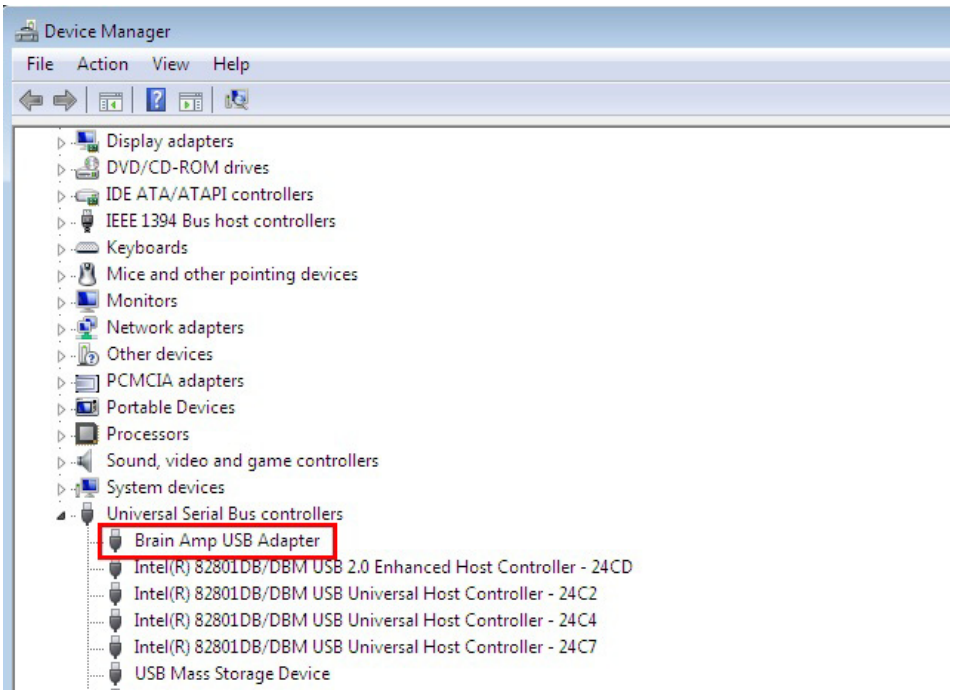
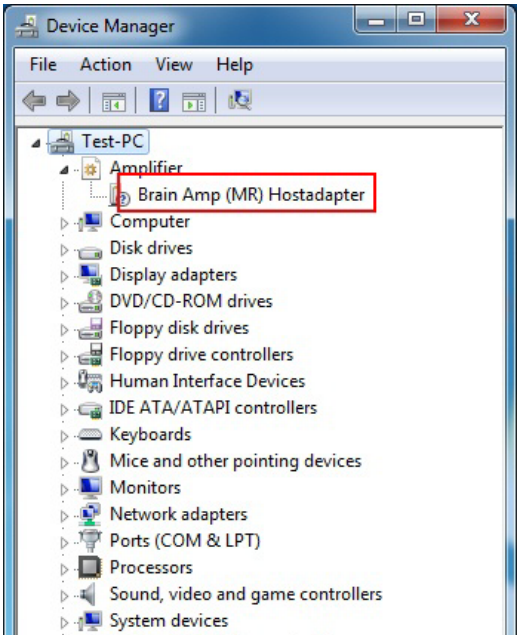


Figure 1-26. Windows® Device Manager, showing the PCI Adapter Card



1.1.9 Checking the installation at the level of the recording software

In order to check whether the connected amplifiers are detected correctly by the Recorder and are ready for operation, proceed as follows:

1. Connect the amplifier(s) to the USB2 Adapter.
2. Connect the USB2 Adapter to your computer (see Section 1.1.1 as of page 22).
3. Switch on the amplifier(s). The *Power* LED on the front panel of the amplifier lights up (green).
4. Choose *Amplifier › Connected Amplifiers...* from the menu (see Figure 1-27).
5. The *Connected Amplifiers* menu in the Recorder lists the amplifiers which are connected and ready for operation (see Figure 1-28).

Figure 1-27. Opening the list of connected amplifiers

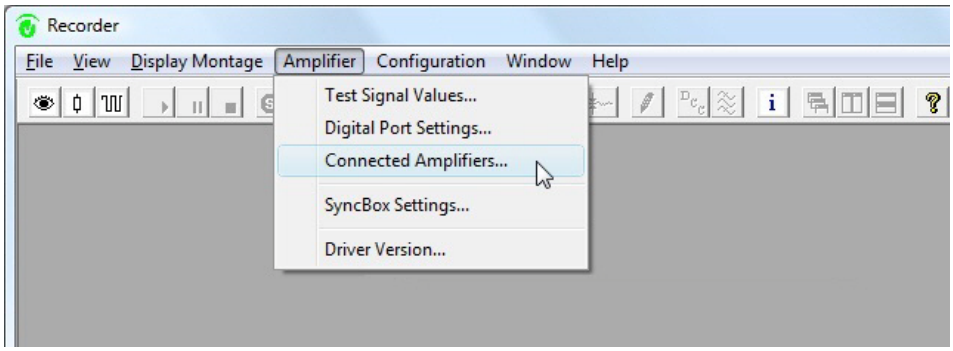
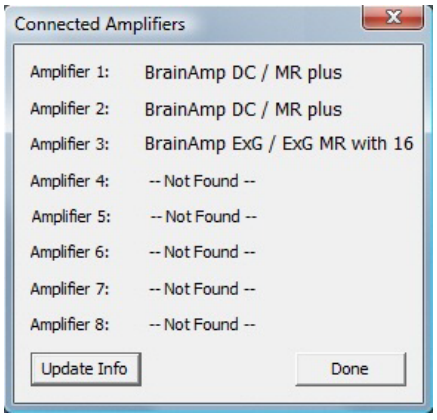


Figure 1-28. List of amplifiers that are ready for operation



1.2 Installation for exclusive use of the amplifier system in a laboratory environment

This section describes those installation steps you must perform if you want to use the amplifier system in a laboratory environment.

These laboratory-specific installation instructions cover those components that are *only intended for acquiring data under laboratory conditions*.

1.2.1 Powering the amplifier using the PS6 wr V-opower supply unit[2]

The PS6 wr V-o power supply unit is designed only for acquiring EEGs under laboratory conditions. If you intend using the MR series amplifiers for combined EEG-fMRI measurements, use the PowerPack to power the amplifiers.

The PS6 wr V-0 power supply unit (see Figure 1-29 f) allows the amplifier to be powered from the line power supply. It guarantees isolation from the line power supply as laid down in IEC 60601-1.

To reduce the danger of electric shock, only connect the amplifier and its accessories to a power supply with a protective conductor (grounded power outlet).

Personal injury

Never use any other power supply unit to power the amplifier.

Damage to property

You should also note that interconnecting electrical equipment to a multi-way socket outlet can result in a reduced safety level. The relevant requirements set out in IEC 60601-1 must be correspondingly adhered to.

Proceed as follows to connect the PS6 wr 0 power supply unit:

You will also find instructions on how to set up the power supply using the PS6 wr V-o on our web site under the link www.brainproducts.com/downloads.php (document „How to Set-Up the BrainAmp System“).

1. Connect the power cord to the PS6 wr V-0 power supply unit.
2. Screw the PowerSupply Adapter (PSA) into the battery compartment on the rear of the amplifier (as described in Section 1.1.3, see Figure 1-15 on page 31).

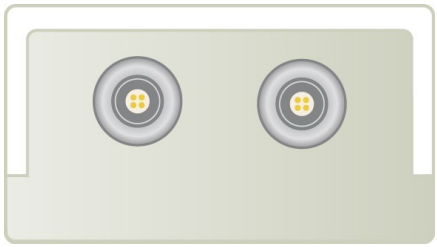
   Note that on newer versions of the amplifier (as of 2011) a PowerSupply Adapter is already integrated in the amplifier and that there is no battery compartment.
3. Connect the PowerSupply Adapter to the PS6 wr V-0 power supply unit using the PSC cable supplied. Avoid routing the connection cable to the amplifier alongside other cables.
4. Connect the PS6 wr V-0 power supply unit to a grounded power outlet.

2. Not available in the USA and Canada.

Ensure that the PS6 wr V-0 power supply unit is always easily accessible. The unit does not have a power switch. To isolate the power supply – even in the event of an emergency – remove the power plug from the socket of the power outlet.

Figure 1-29. PS6 wr V-0 power supply unit for two amplifiers with cables connected (top view)

Figure 1-30. PS6 wr V-0 power supply unit with 5.6 V DC ERNI outputs (side view)

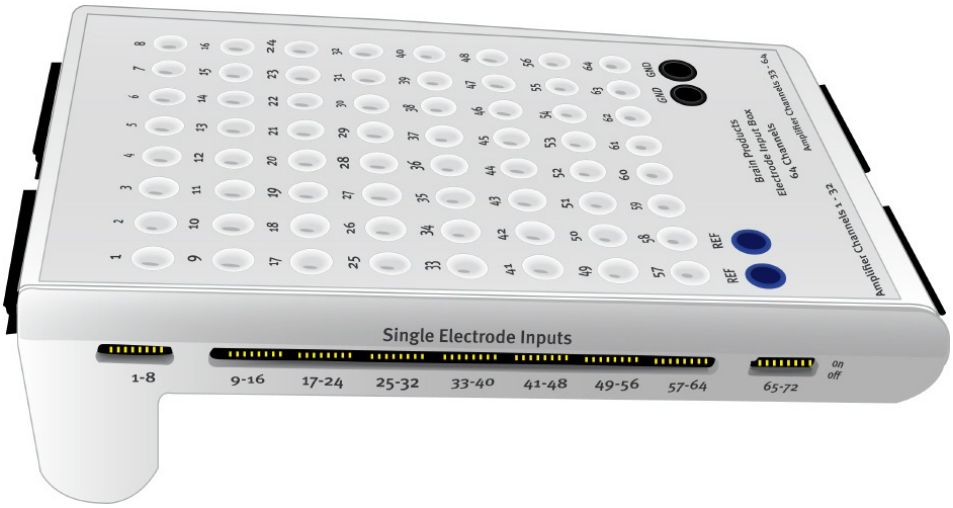


1.2.2 Electrode Input Box EIB64-A

The Electrode Input Box EIB64-A is designed only for acquiring EEG signals under laboratory conditions. You must therefore never use it in the context of combined EEG-fMRT measurements.

The Electrode Input Box EIB64-A (see Figure 1-31) allows you to connect not only individual electrodes, but also electrode caps with multi-way plugs to the amplifier.

Figure 1-31. Electrode Input Box EIB64-A



The individual electrodes are plugged into the corresponding 64 individual inputs provided.

Individual electrodes

You should use only standard commercially available individual electrodes with safety socket connectors (1.5 mm touchproof connector in accordance with DIN 42802).

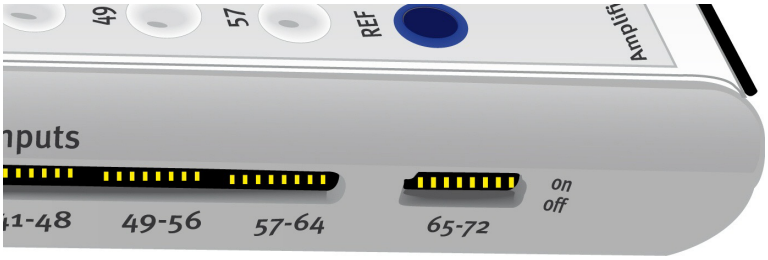
Damage to property

You connect electrode caps with multi-way plugs to the inputs marked *Cap Electrodes 1 – 32* and *Cap Electrodes 33 – 64*.

Electrode caps with multi-way plugs

There are DIP switches located on the side of the box (see Figure 1-32). These are used to select the signal from the electrode connected through the multi-way plug for each channel individually. The *off* position denotes that both the individual electrode and the electrode connected using the multi-way plug are used. The *on* position denotes that only the signal from the individual electrode is used (factory setting).

Figure 1-32. DIP switches on the Electrode Input Box



If you do not wish to use the electrodes connected using the multi-way plug, you must switch the DIP switch for the relevant electrode to *on*. Choose this setting in order to disable a faulty electrode in the cap that is connected using the multi-way plug and to make measurements for this channel using an individual electrode.

Connection to the amplifier

The supplied ribbon cable is used to connect the Electrode Input Box EIB64-A to the amplifier: Connect the cable to the *Electrode Input* socket on the amplifier and then connect the amplifier to the *Amplifier Channels 1 – 32* output of the Electrode Input Box EIB64-A. The *Amplifier Channels 33 – 64* output is for use with the optional second amplifier.

If you require more than 64 channels or more than two amplifiers for your experimental setup, and therefore need to use several EIB64-A boxes, you must ensure that the boxes are assigned to the amplifiers correctly and connect the two reference electrodes to each other and the two ground electrodes to each other (see Figure 1-33 f.).

Figure 1-33. Two EIB64-A Electrode Input Boxes with the reference and ground electrodes connected to each other (top view)

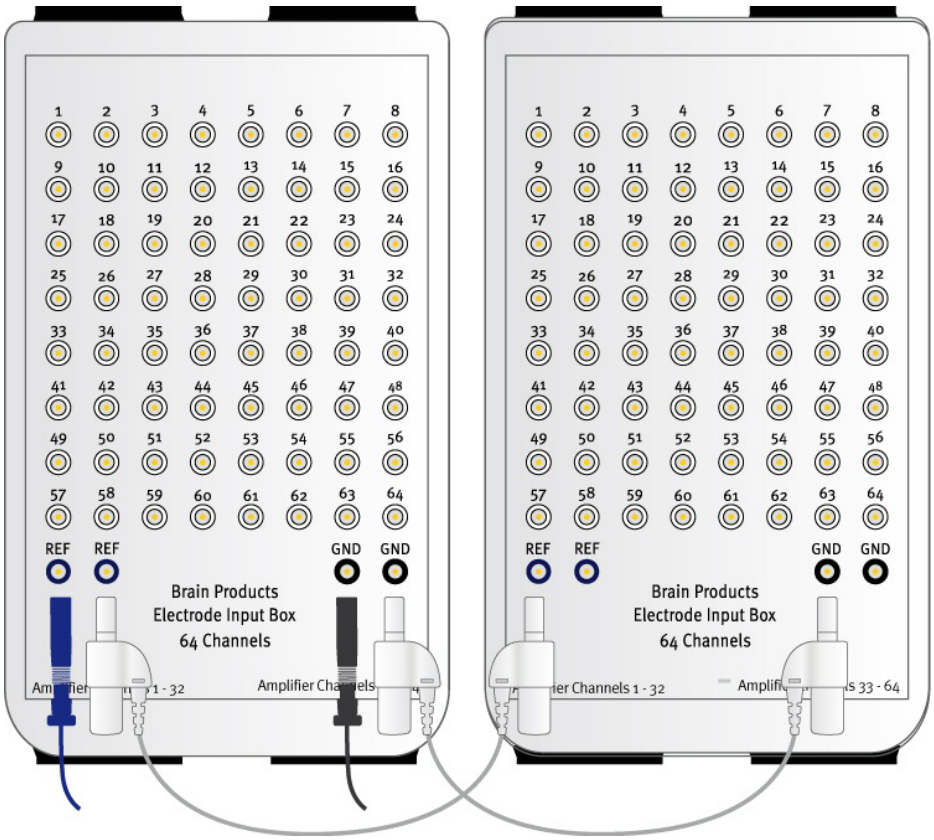
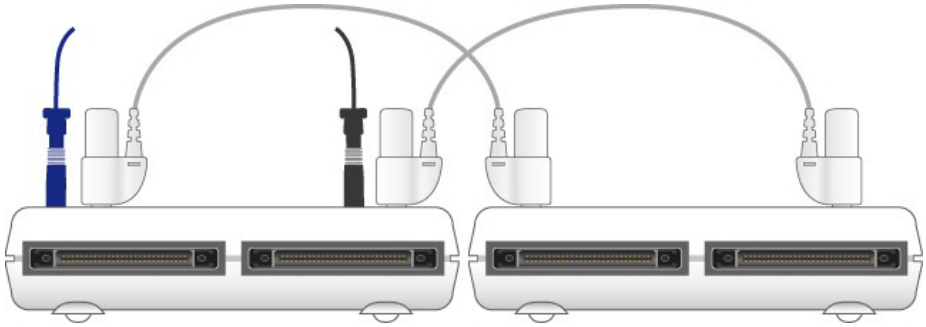


Figure 1-34. Two EIB64-A boxes with the reference and ground electrodes connected to each other (side view)



1.2.3 ExG Input Box

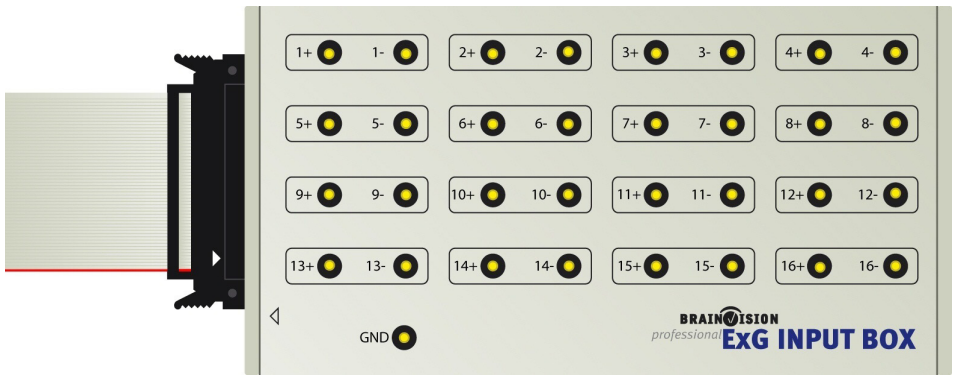
> ***The ExG Input Box is designed only for acquiring EEG signals under laboratory conditions. You must therefore never use it in the context of combined EEG-fMRT measurements.***

The ExG Input Box (see Figure 1-35) allows you to connect individual electrodes to the BrainAmp ExG/BrainAmp ExG MR amplifier. Connect the ExG Input Box to the amplifier using the ribbon cable supplied.

You should use only standard commercially available individual electrodes with safety socket connectors (1.5 mm touchproof connector in accordance with DIN 42802).

Damage to property

Figure 1-35. ExG Input Box



1.2.4 Interface for transcranial magnetic stimulation (TMS)

TMS trigger signals

If you are recording EEGs during TMS, you should record the trigger signals of the TMS stimulator.

TMS stimulators generally provide these trigger signals as TTL trigger pulses at BNC outputs. The length of the TTL trigger pulses must be longer than the sampling interval of the EEG recording. (At a sampling rate of 5 kHz, the length of the trigger pulse must be > 200 µs.) For further information refer to the user documentation provided with your TMS stimulator.

If the trigger pulse is of sufficient length, you can use the trigger cable. On the one hand, this allows an HD D-Sub connector on the digital port of the USB2 Adapter to be connected to the BNC output of the TMS stimulator. On the other hand, it allows stimulation systems to be connected to the parallel port of the computer.

Note that the digital port of the amplifier system is designed only to receive triggers.

⚠ **Personal injury**

Never connect the USB2 Adapter or the PCI adapter card to the trigger input of stimulation equipment using the trigger cable.

If the length of the TTL trigger pulses from the TMS stimulator is shorter than the sampling interval of the EEG recording, you must use the trigger stretcher cable that stretches the TTL pulses to an adequate length.

It is possible to block the amplifier input for the duration of the TTL trigger pulses. You can use this method for simultaneous acquisition of TMS and EEG data. In order to do so, you require a special trigger cable. In this event, please contact our technical support team. You will find the contact details for our technical support team on page 11.

TMS synchronization

You can phase synchronize the clock signals of the TMS stimulator and the EEG amplifier using TMS stimulators of the type "PowerMag Research". For details, refer to the PowerMag user documentation. ●

Chapter 2 Operation of the amplifier system in a laboratory environment

The amplifier and its accessories have been tested for electrical safety as per IEC 60601-1. Nevertheless, conductive parts of the electrodes and their connectors, including the neutral electrode, must not come into contact with other conductive parts including ground.

If several components are connected to each other, additional hazards may arise, for instance as a result of the accumulation of discharge currents. If you connect our products together with other products – including non-medical devices – this results in a new overall system. The responsibility for error-free and safe operation lies with you as the operator of the overall system.

If you have any questions about setting up the system or about particular combinations of products, you can contact your dealer or our technical support team at any time. You will find the contact details for our technical support team on page 11.

2.1 Shutting down the amplifier under normal conditions

Proceed as follows to shut down the amplifier:

1. Switch off the power supply to the amplifier.
2. Disconnect the electrode cap from the amplifier.
3. Remove the electrode cap from the person's head. To do this, hold the loop of the chinstrap and pull the cap backwards over the person's head.

2.2 Shutting down the amplifier in emergencies

If you need to break off acquisition due to an emergency, proceed as follows:

1. Disconnect the electrode cap from the amplifier.
2. Remove the electrode cap from the person's head. To do this, hold the loop of the chinstrap and pull the cap backwards over the person's head.

You should also pay attention to the BrainCap Operating Instructions or the user documentation for the electrode caps which you use. ●

Chapter 3 Maintenance, cleaning and functional testing

3.1 Safety checks and maintenance

We do not oblige the operator to undertake regular safety-related checks of our equipment in accordance with applicable national regulations.

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

In principle, the amplifier is completely maintenance-free. However, it is recommended that you apply the test signal at regular intervals (approx. once a month) in order to ensure that the product is functioning correctly.

We recommend that you have the manufacturer service the amplifier and check its measurement precision every three years.

If any pins or connections on the products are dirty or if you should notice any damage on the products, return them to Brain Products. You will find the contact details for our technical support team on page 11.

3.2 Function check

Application in an MR environment – Caution! The signal tester is not suitable for use in an MR environment. You must therefore always use it outside of the scanner room.

You can use the supplied signal tester and test signal mode in the Recorder recording software to check whether any channels are no longer functioning correctly.

Note that there is a separate signal tester for the BrainAmp/BrainAmp DC/BrainAmp MR/BrainAmp MR plus and for the BrainAmp ExG/BrainAmp ExG MR (see Figure 3-1 and Figure 3-2). The signal tester for the BrainAmp ExG/BrainAmp ExG MR is explicitly labeled *ExG*. Always use the appropriate signal tester for testing the amplifier.

Figure 3-1. Signal tester for BrainAmp Standard, BrainAmp DC, BrainAmp MR and BrainAmp MR plus

Figure 3-2. Signal tester for BrainAmp ExG and BrainAmp ExG MR

During the signal test, a test signal is injected into all input channels of the amplifier using the signal tester. If the representation of individual channels in the Recorder deviates from that of the rest, you should check whether the settings for these channels differ from those used for the other channels in the workspace you are using. For detailed information on configuring

workspaces, refer to the Recorder User Manual. If you have any questions in this regard, please contact our technical support team. You will find the contact details on page 11.

If you are not fully convinced of the results of the functional test using the signal tester in test signal mode in the Recorder, record the data delivered by the signal tester and send it to our technical support team.

Prepare recording of the test signal as follows:

1 Set up a test workspace as described in the User Manual for the Recorder and make the following settings in the workspace:

   a *Number of Channels* text box: 32 channels for the unipolar amplifiers BrainAmp Standard, BrainAmp DC, BrainAmp MR and BrainAmp MR plus (see Figure 3-3) or 8 or 16 channels for the BrainAmp ExG (MR) 8 or BrainAmp ExG (MR) 16 (see Figure 3-4).

Figure 3-3. Specifying the number of channels in the Recorder workspace for the BrainAmp MR amplifier test

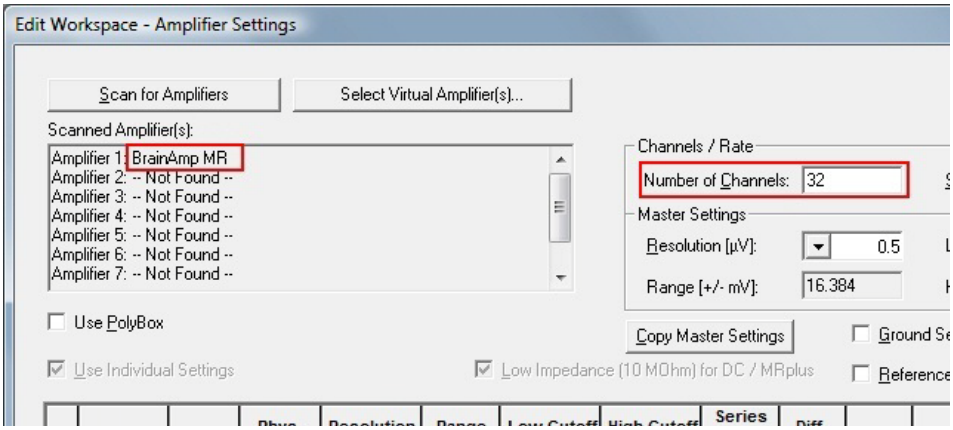
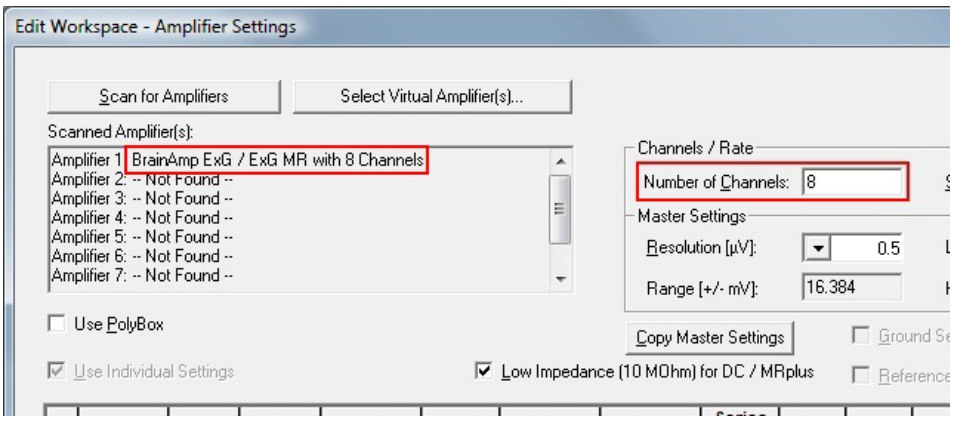


Figure 3-4. Specifying the number of channels in the Recorder workspace for the BrainAmp ExG MR 8 amplifier test



b *Sampling Rate [Hz]* = 5000 Hz

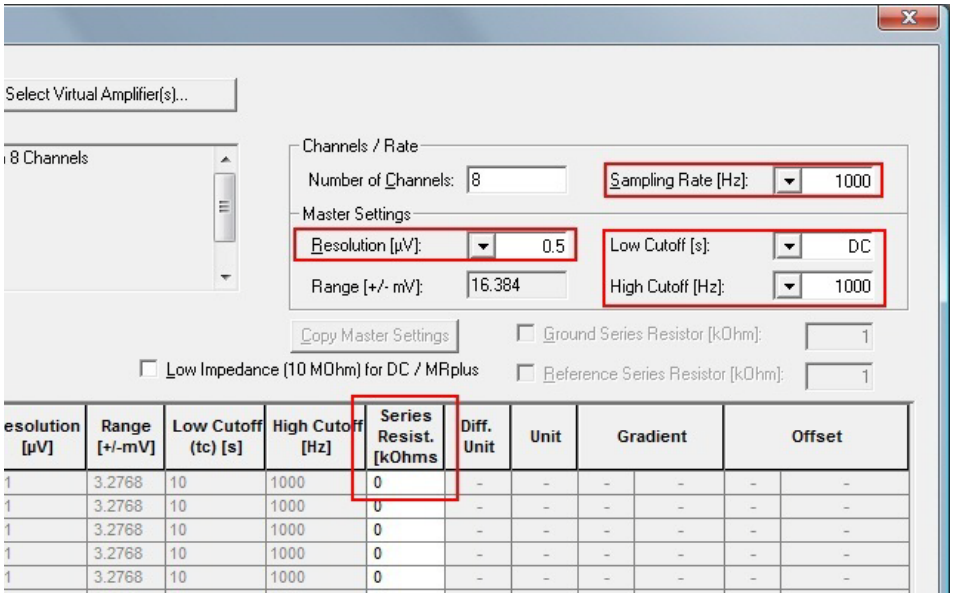
c *Low Cutoff [s]* = DC

d *High Cutoff [Hz]* = 1000 Hz

e *Resolution [µV]* = 0.5

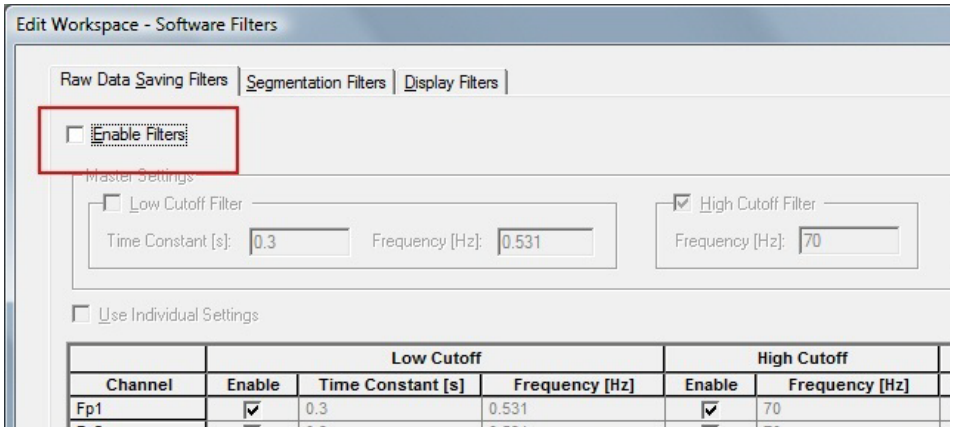
f Series resistors (EEG, REF, GND) = 0 kOhm

Figure 3-5. Settings in the Recorder workspace for the sampling rate, filter, resolution and series resistors



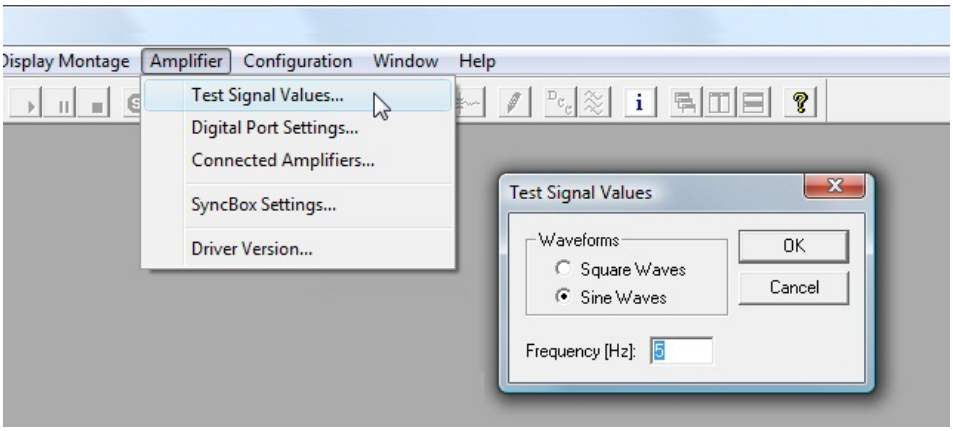
g Disable the *Raw Data Saving Filter* option (see Figure 3-6).

Figure 3-6. Disabling the "Raw Data Saving Filters" option



2 Choose Sine Waves as the test signal form and 5 Hz as the frequency (see Figure 3-7).

Figure 3-7. Specifying the form and frequency of the test signal



3 Only ever connect one amplifier at a time to the computer port.

4 Use the ribbon cable to connect the signal tester to the amplifier's *Electrode Input* socket.

Note that there is a separate signal tester for the BrainAmp Standard/BrainAmp DC/BrainAmp MR/BrainAmp MR plus and for the BrainAmp ExG/BrainAmp ExG MR (see Figure 3-1 and Figure 3-2 on page 50).

5 Start the Recorder in test signal mode. Check that all channels are receiving a signal. The test signal has a voltage of approximately 100 μV_{pp} in sinusoidal mode and approximately 50 μV_{pp} in square-wave mode. It is recommended that you check these values on a regular basis.

The test signal is not calibrated. It can only be used for a global function test but not to check the specified measurement precision of the product.

6 Record data for 30 seconds. Use the serial number of the amplifier as the name of the EEG file. (You will find the serial number on a label on the amplifier.)

To make the results of the signal test available to our technical support team, proceed as follows:

1 Create one ZIP archive file for each amplifier (containing the files with the following extensions: .vhdr, .eeg, .vmrk).

2 To ensure that your firewall does not block the archive file, change the file name extension to .piz.

3 Send the archive files to our technical support team together with a description of the problem.

3.3 Cleaning

3.3.1 Amplifier, accessories and connection cables

Personal injury

Never clean the products when the test subject is connected to them or when they are connected to the power supply.

You can clean the amplifiers and accessories with a damp cloth and domestic detergent. If necessary, you can also use compressed air to clean out the plugs and sockets of the products.

Damage to property

Do not, however, bring the plugs and sockets into contact with moisture (never wipe them with a damp cloth).

Damage to property

Never clean the amplifier and its accessories under running water. Do not use any alcohol, any other cleaning agents or any sterilization methods.

3.3.2 Electrode caps and electrodes

Store the electrodes in a dry, dark place.

Clean the cap and electrodes under running water using a toothbrush. If the water in your region is hard, you should then rinse the electrodes in distilled water. Dry the electrodes and cap gently by wrapping them in a towel. Any residual dampness can dry in the air. Avoid washing the chest and chin straps and the contact surfaces of the cable connectors each time, as this will reduce their service life.

If you wish to disinfect the cap and the electrodes, soak them for approximately 15 minutes in a 5 % Sekusept-PLUS solution. Then rinse them under running water.

If the Ag/AgCl pellet in the electrodes has come into contact with greasy material (e.g. perspiring fingers), you can clean it using alcohol.

A brown oxidation film can form on the Ag/AgCl pellet of electrodes that have been inadequately cleaned or that are only used rarely. Carefully brush or rub the film off using a non-metallic material (abrasive paste, fine emery paper). The sinter pellet is solid and 1 mm thick, which means that the surface can be restored several times without detriment. Then clean the electrodes as described.

The sinter electrodes are not particularly suitable for ultrasound cleaning. You should therefore use this method as rarely as possible.

Damage to property

Do not use any hot sterilization methods (e.g. autoclave) since this may damage the electrode cable insulation.

Chlorination of the electrodes is unnecessary and has a detrimental effect on their function.

The electric cables have been designed for limited tension forces. *Avoid any other stresses such as knotting and crushing.*

If you have significant difficulties achieving acceptable resistances when you place the electrodes, replace the affected electrode with a different one.

Chapter 4 Disposing of the amplifier and accessories

As soon as the products and their 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 will accept return of the equipment and handle disposal on request.

Appendix A Product identification

Names of the products in the BrainAmp family:	BrainAmp Standard, BrainAmp DC, BrainAmp ExG, BrainAmp MR, BrainAmp MR plus, BrainAmp ExG MR, USB 2 Adapter (BUA), SyncBox, PolyBox, PowerPack, PowerPack Charger V9, Power supply PS6 wr V-0 (not available in the USA and Canada), Signaltester, Signaltester ExG, DualBUA, Optical fiber cable, BAC cable
Manufacturer:	Brain Products GmbH Zeppelinstraße 7 82205 Gilching Germany Phone: +49 8105 73384 - 0 Fax: +49 8105 73384 - 505 Web site: http://www.brainproducts.com Email: techsup@brainproducts.com
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.
Electrical safety according to IEC 60601:	Protection class II (not: Power supply PS6 wr V-0)
Warranty	The terms of warranty can be found on our web site at: www.brainproducts.com/contact.php

Appendix B Technical data

Common characteristics of all amplifiers

Amplitude accuracy:	± 2%
Bit width of the A/D converter (EEG and AUX):	16 bit
Sampling rate:	5 kHz per channel
DC offset tolerance:	± 300 mV
Signal transmission:	Optically coupled using duplex fiber optic cables
Operating time between charges:	Typically 30 hours with one amplifier, 15 hours with two amplifiers
Power consumption:	≤ 150 mA in operation (see individual amplifiers); typically 7 mA in standby mode
Dimensions (H x W x D):	Approx. 68 mm x 160 mm x 187 mm for BrainAmp Standard, DC, ExG, MR, MR plus, ExG MR and PowerPack
Weight:	Approx. 1.1 kg for BrainAmp Standard, DC, ExG, MR, MR plus, ExG MR and PowerPack
Integrated impedance measurement:	Present; measurement includes ground electrode and reference electrode
Unlocking function:	Present
Locking of unused channels:	Present

Components suitable for the scanner room[1]

BrainAmp MR

Number of channels:	32
Channel type/reference:	Referential channels/acquisition of a reference using a single electrode (unipolar)
Input impedance:	10 MOhm (for DC)
Input noise:	≤ 1 μV_{pp}
Common-mode rejection (CMR):	≥ 90 dB
Low-cutoff frequency (high-pass)/time constant: Filter type:	0.016 Hz/10 s First-order filter with 6 dB/octave
High-cutoff frequency (low-pass): Filter type:	250 Hz Fifth-order Butterworth filter with 30 dB/octave
Measuring range:	± 16.384 mV
Resolution:	0.5 µV per bit
Power supply:	PowerPack (external rechargeable battery)
Suitability for use in the scanner room:	Yes

BrainAmp MR plus

Number of channels:	32
Channel type/reference:	Referential channels/acquisition of a reference using a single electrode (unipolar)
Input impedance:	Switchable: 10 MOhm/10 GOhm (for DC)
Input noise:	≤ 1 μV_{pp}
Common-mode rejection (CMR):	≥ 110 dB
Low-cutoff frequency (high-pass): Filter type:	0 Hz in DC mode or 0.016 Hz/10 s in AC mode; switchable between AC and DC modes First-order filter with 6 dB/octave

1. All components that are suitable for use in the scanner room can also be used outside the scanner room.

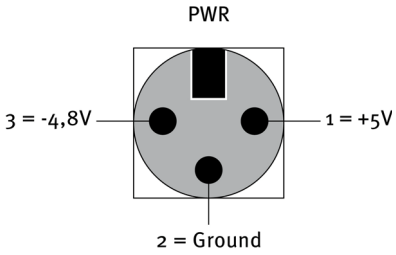
High-cutoff frequency (low-pass): Filter type:	1000 Hz/250 Hz (switchable for the resolutions 0.1 µV/0.5 µV per bit) Fifth-order Butterworth filter with 30 dB/octave
Measuring range:	± 3.28 mV/± 16.384 mV/± 327.68 mV (switchable)
Resolution:	0.1 µV/0.5 µV/10.0 µV per bit (switchable)
Power supply:	PowerPack (external rechargeable battery)
Suitability for use in the scanner room:	Yes

BrainAmp ExG MR

Number of channels:	8 or 16
Channel type:	8 bipolar or 8 bipolar + 8 AUX
Input impedance:	10 MOhm (for DC)
Input noise:	≤ 2 μV_{pp}
Common-mode rejection (CMR):	≥ 100 dB
Low-cutoff frequency (high-pass)/time constant: Filter type:	0 Hz in DC mode or 0.016 Hz/10 s in AC mode; switchable between AC and DC modes First-order filter with 6 dB/octave
High-cutoff frequency (low-pass): Filter type:	1000 Hz/250 Hz (switchable for the resolutions 0.1 µV/0.5 µV per bit) Fifth-order Butterworth filter with 30 dB/octave
Measuring range:	± 3.28 mV/± 16.384 mV/± 327.68 mV (switchable)
Resolution:	0.1 µV/0.5 µV/10.0 µV per bit (switchable)
Power supply:	PowerPack (external rechargeable battery)
Suitability for use in the scanner room:	Yes

Only for BrainAmp ExG MR 16 with additional power supply:

Figure B-1. BrainAmp ExG MR 16, connector for power supply (socket)



PowerPack

Number of amplifiers supplied:	1 or 2
Charging voltage:	9 V DC
Charging current	670 mA
Rated capacity:	6500 mAh
Dimensions (H x W x D):	Approx. 68 mm x 160 mm x 187 mm
Weight:	Approx. 1.9 kg
Output voltage:	5.6 V DC
Output current:	300 mA
Total operating time:	Approx. 4000 hours
Operating time for one amplifier:	> 30 hours (with a fully charged, new battery)
Operating time for two amplifiers:	> 15 hours (with a fully charged, new battery)
Charging:	Using external charger (Charger V9); only outside the scanner room
Charging time:	Approx. 17 hours (with empty battery at room temperature)
Rechargeable battery type:	Lead gel rechargeable battery
Charging temperature range:	10°C to 30°C
Electrical protection class:	II
Suitability for use in the scanner room:	Yes

ExG AUX Box

Number of channels:	8 ExG channels and 8 AUX channels
Channel type:	ExG: bipolar (for electrophysiological ExG signals); connection: touchproof in accordance with DIN 42802) AUX: bipolar (for sensors); connection: see Figure B-2
Use	Only with BrainAmp ExG and BrainAmp ExG MR. The lower 8 channels of the ExG amplifier are assigned to the 8 bipolar channels and the upper 8 channels are assigned to the 8 AUX channels in the ExG/AUX Box. The AUX channels are only available with the 16-channel ExG with power output.
Input voltage range of the 8 bipolar ExG channels:	Corresponds to the input impedance of the connected amplifier (passed through 1:1)
Input voltage range of the 8 AUX channels:	± 4.8 VDC
Input impedance of the 8 bipolar ExG channels:	See specifications for the input impedance of the connected ExG amplifier
Input impedance of the 8 bipolar AUX channels against ground: Differential input impedance of the 8 bipolar AUX channels:	Rev. 01: 23 kOhm (for DC), Rev. 02: 1000 kOhm (for DC)Rev. 01: 46 kOhm (for DC), Rev. 02: 2000 kOhm (for DC)
Supply voltage at the AUX channels:	+4.8 V,: 20 mA -4.8 V: 10 mA (maximum output current for all AUX channels)
Dimensions (H x W x D):	Approx. 137 mm x 70 mm x 38 mm
Weight:	Approx. 145 g
Suitability for use in the scanner room:	Yes

Figure B-2. ExG AUX Box, pinout of the sensor connectors (socket), type: Binder 719

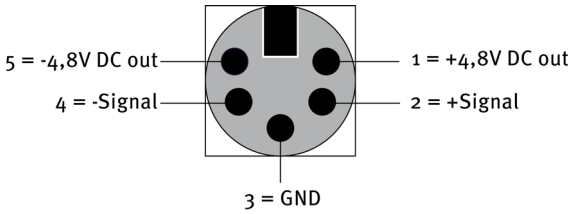
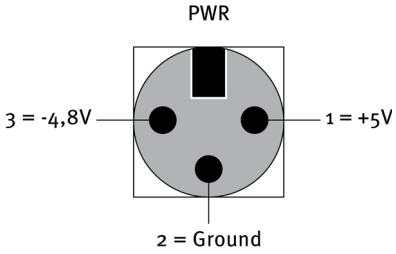


Figure B-3. ExG AUX Box, pinout of the power supply (socket), type: Binder 719



Components not suitable for the scanner room

BrainAmp Standard

Number of channels:	32
Channel type/reference:	Referential channels/acquisition of a reference using a single electrode (unipolar)
Input impedance:	10 MOhm (for DC)
Input noise:	≤ 2 μV_{pp}
Common-mode rejection (CMR):	≥ 90 dB
Low-cutoff frequency (high-pass)/time constant: Filter type:	0.016 Hz/10 s First-order filter with 6 dB/octave
High-cutoff frequency (low-pass): Filter type:	1000 Hz Fifth-order Butterworth filter with 30 dB/octave
Measuring range:	± 3.28 mV
Resolution:	0.1 µV per bit
Power supply:	PS6 wr V-o power supply unit or PowerPack (external rechargeable battery)
Power consumption:	Max. 110 mA
Suitability for use in the scanner room:	No

BrainAmp DC

Number of channels:	32
Channel type/reference:	Referential channels/acquisition of a reference using a single electrode (unipolar)
Input impedance:	Switchable: 10 MOhm / 10 GOhm (for DC)
Input noise:	≤ 1 μV_{pp}
Common-mode rejection (CMR):	≥ 110 dB
Low-cutoff frequency (high-pass)/time constant: Filter type:	0 Hz in DC mode or 0.016 Hz/10 s in AC mode; switchable between AC and DC modes First-order filter with 6 dB/octave
High-cutoff frequency (low-pass): Filter type:	1000 Hz/250 Hz (switchable for the resolutions 0.1 µV/0.5 µV per bit) Fifth-order Butterworth filter with 30 dB/octave

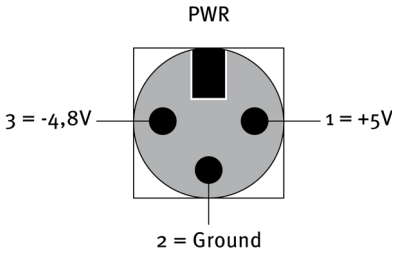
Measuring range:	± 3.28 mV/± 16.384 mV/± 327.68 mV (switchable)
Resolution:	0.1 µV/0.5 µV/10.0 µV per bit (switchable)
Power supply:	PS6 wr V-o power supply unit or PowerPack (external rechargeable battery)
Power consumption:	Max. 130 mA
Suitability for use in the scanner room:	No

BrainAmp ExG

Number of channels:	8 or 16
Channel type:	8 bipolar or 8 bipolar + 8 AUX
Input impedance:	10 MOhm (for DC)
Input noise:	≤ 2 μV_{pp}
Common-mode rejection (CMR):	≥ 100 dB
Low-cutoff frequency (high-pass)/time constant: Filter type:	0 Hz in DC mode or 0.016 Hz/10 s in AC mode; switchable between AC and DC modes First-order filter with 6 dB/octave
High-cutoff frequency (low-pass): Filter type:	1000 Hz/250 Hz (switchable for the resolutions 0.1 µV/0.5 µV per bit) Fifth-order Butterworth filter with 30 dB/octave
Measuring range:	± 3.28 mV/± 16.384 mV/± 327.68 mV (switchable)
Resolution:	0.1 µV/0.5 µV/10.0 µV per bit (switchable)
Power supply:	PS6 wr V-o power supply unit or PowerPack (external rechargeable battery)
Power consumption:	Max. 110 mA (8 channels)/120 mA (16 channels)
Suitability for use in the scanner room:	No

Only for BrainAmp ExG 16 with additional power supply:

Figure B-4. BrainAmp ExG 16, connector for power supply (socket)



SyncBox Main Unit

Input voltage:	5 V DC
Power consumption (via USB):	< 150 mA
Properties of the input signal:	0.4 V_{pp} to 5 V_{pp}, hysteresis approx. 150 mV
Frequency of the input signal:	Max. 30 MHz
Input impedance (on the scanner side):	50 Ohm, BNC socket
Required input signal shape:	Sine or square
Computer interface:	USB 2.0
Length of the connecting cable:	Max. 20 m
Suitability for use in the scanner room:	No, but can be used in the control room
Possibility to connect PolyBox:	Yes
Dimensions:	Approx. 132 mm x 70 mm x 30 mm (without connections)
Weight:	Approx. 160 g

SyncBox Scanner Interface

Power supply:	Via SyncBox Main Unit
Input (on the scanner side):	50 Ohm, BNC socket
Output:	50 Ohm, BNC socket
Galvanic isolation:	Yes, dielectric strength > 4 kV

Length of the connecting cable:	30 cm
Dimensions:	Approx. 90 mm x 45 mm x 25 mm
Weight:	Approx. 80 g

Charger V9 (charger for the PowerPack)

Input voltage range:	100 to 240 V AC, 50/60 Hz
Rated power consumption:	Max. 145 mA
Output voltage:	9 V DC
Output current:	Max. 670 mA
Suitability for use in the scanner room:	No, but can be used in the control room
Weight:	Approx. 130 g (without power adapter)

PS6 wr V-o power supply unit [2]

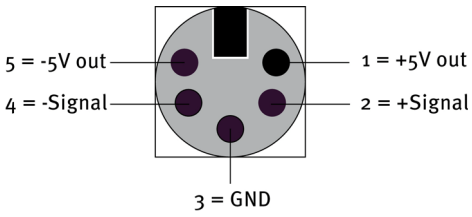
Electrical safety in accordance with IEC 60601-1:	Protection class II
Input voltage range:	100 to 240 V AC (wr = wide range), 50/60 Hz
Rated power consumption:	Max. 180 mA
Output voltage:	5.6 V DC
Output current:	300 mA
Suitability for use in the scanner room:	No
Dimensions:	Approx. 120 mm x 65 mm x 40 mm
Weight:	Approx. 300 g

2. Not available in the USA and Canada.

PolyBox[3]

Number of channels:	8
Amplitude accuracy:	± 4%
Bit width of the A/D conversion:	16 bit
Resolution:	152.6 µV per bit
Input voltage range:	± 5 V
Input impedance (to ground): Differential input impedance:	40.1 kOhm (for DC) 80.2 kOhm (for DC)
Sampling rate:	625 Hz per channel, multiplexed (underlying sampling rate of 5000 Hz over 8 channels)
Frequency adjustment in the ExG software:	Adjustment of the sampling rate from 625 Hz to the sampling rate of between 100 and 5000 Hz selected in the recording
Low-cutoff frequency (high-pass):	0 Hz (DC coupling)
High-cutoff frequency (low-pass):	100 Hz
Power consumption:	Approx. 20 mA without external sensors
Dimensions:	Approx. 135 mm x 70 mm x 30 mm
Weight:	Approx. 140 g
Suitability for use in the scanner room:	No

Figure B-5. PolyBox, pinout of the sensor connectors (socket), type: Binder 719



3. The PolyBox cannot be used in conjunction with the BrainAmp ExG/BrainAmp ExG MR.

Electrode Input Box EIB64-A

Number of channels:	64 (plus 2x ground, 2x reference)
Dimensions (H x W x D):	Approx. 67 mm x 102 mm x 175 mm
Weight:	Approx. 200 g
Suitability for use in the scanner room:	No

ExG Input Box

Number of channels:	16
Channel type:	Bipolar
Dimensions (H x W x D):	Approx. 137 mm x 70 mm x 38 mm
Weight:	Approx. 145 g
Suitability for use in the scanner room:	No

Interfaces for connecting the amplifiers to the computer

USB interface: USB2 Adapter (BUA)

Number of channels supported:	64 or 128 channels or two or four 32-channel amplifiers
USB port:	2.0
Power consumption with 64 channels:	Typically 280 mA
Power consumption with 128 channels:	Typically 400 to 500 mA
Trigger bit width:	16 bit (total for trigger inputs and outputs)
Trigger connection:	Via 26-pin HD D-Sub socket (see Appendix C as of page 75)
Amplifier connection:	Via duplex fiber optic cable
Dimensions:	Approx. 150 mm x 80 mm x 45 mm
Weight:	Approx. 260 g
AUX connection:	Via 15-pin HD D-Sub socket (see Appendix D on page 77)

USB interface: dualUSB2 Adapter (dualBUA)

The dualUSB2 Adapter comprises two USB2 Adapters and a dualBUA Adapter Cable.

Number of channels supported:	Up to 256 channels or up to eight 32-channel amplifiers
Trigger bit width:	16 bit (total for trigger inputs and outputs)
Trigger connection:	Via 26-pin HD D-Sub socket (see Appendix C as of page 75)
Amplifier connection:	Via duplex fiber optic cable
Dimensions:	Twice the size of a USB2 Adapter
Weight:	Approx. 520 g (two USB2 Adapters) + approx. 140 g (dualBUA Adapter Cable)

PCI interface: PCI Adapter Card

Number of channels supported:	64 to 256 channels or two to eight 32-channel amplifiers
PCI standard:	2.1
Hardware requirements:	One free PCI 2.1 (32-bit) slot for the first and second amplifiers. Additionally, one free slot blanking plate for the third and fourth amplifier. A further free PCI 2.1 (32-bit) slot for the fifth and sixth amplifiers. One additional free slot blanking plate for the seventh and eighth amplifier.
Trigger bit width:	16 bit (total for trigger inputs and outputs)
Trigger connection:	Via 26-pin HD D-Sub socket (see Appendix C as of page 75)
Amplifier connection:	Via duplex fiber optic cable

Appendix C Pinout of the trigger socket (digital port)

The trigger socket for the input of external synchronization pulses such as trigger and reaction time markers is located on the front of the USB2 Adapter (labeled *Trigger In*). On the PCI Adapter Card, this is located next to the first fiber optic socket. This is a 26-pin HD D-Sub connector. The input ports are TTL-CMOS ports.

Table C-1 shows the pinout and the assignment of the 16 digital inputs to stimulus information (S markers) and response information (R markers) as interpreted by the Recorder for positive logic. If several bits are set simultaneously at the stimulus input, their values are added together. For example, if D01 (S 2) and D05 (S 32) are set simultaneously, this results in the stimulus S 34. The same applies for combinations of response bits. You will find details on configuration in the Recorder User Manual.

The third and fourth columns show which contacts on the connectors (25-pin D-Sub/LPT and BNC connectors) of standard trigger cables are connected to which contacts of the trigger socket (digital port).

Table C-1. Pinout of the trigger socket (digital port) on USB2 Adapter and PCI Adapter Card

Pin on 26-pin HD D-Sub trigger socket (digital port)	Function	25-pin D-Sub/LPT on trigger cable	BNC connector on trigger cable
1	Ground	25	Ground
2	D01 (S 2)	3	
3	D03 (S 8)	5	
4	D05 (S 32)	7	
5	D07 (S128)	9	
6	D09 (R 2)		
7	D11 (R 8)		
8	D13 (R 32)		
9	D15 (R128)		Signal
10	Unused		
11	Unused		
12	VCC +3.3 V		
13	Unused		
14	D00 (S 1)	2	
15	D02 (S 4)	4	
16	D04 (S 16)	6	
17	D06 (S 64)	8	
18	D08 (R 1)		
19	D10 (R 4)		

Table C-1. Pinout of the trigger socket (digital port) on USB2 Adapter and PCI Adapter Card

Pin on 26-pin HD D-Sub trigger socket (digital port)	Function	25-pin D-Sub/LPT on trigger cable	BNC connector on trigger cable
20	D12 (R 16)		
21	D14 (R 64)		
22	Ground		
23	Block+		
24	Block-		
25	5 kHz out		
26	Unused		

Appendix D Pinout of the AUX socket on the USB2 Adapter

Table D-1. Pinout of the 15-pin AUX socket on the USB2 Adapter

Pin no.	Function
1	ADCLK
2	DASCLK
3	$\overline{\text{ADCS}}$
4	SDA
5	SCL
6	DIN
7	DADIN A
8	DADIN B
9	+5 V
10	Ground (GND)
11	UEXT
12	AUX 1
13	5 kHz (clock frequency for PLL)
14	DOUT
15	$\overline{\text{DACS}}$

Appendix E Ambient conditions

The following ambient conditions must be satisfied for operation, transport and storage:

Amplifier and accessories (*excluding PowerPack*):

Operation	Temperature range: 10 °C to 40 °C (50 °F to 104 °F) Relative humidity: 30 to 85 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa
Transport	Temperature range: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 30 to 85 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa
Storage	Temperature range: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 30 to 85 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa

PowerPack:

Operation	Temperature range: 10 °C to 40 °C (50 °F to 104 °F) Relative humidity: 30 to 70 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa
Charging	Temperature range: 10 °C to 30 °C (50 °F to 86 °F) Relative humidity: 30 to 70 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa
Transport	Temperature range: 0 °C to 60 °C (32 °F to 140 °F) Relative humidity: 30 to 75 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa
Storage	Temperature range: 0 °C to 40 °C (32 °F to 104 °F) Relative humidity: 30 to 85 %, non-condensing Atmospheric air pressure: 700 hPa to 1060 hPa

Appendix F Explanation of the markings on the products

Observe the manual.

These labels indicate that defective products must not be disposed of with household waste. Dispose of in accordance with national regulations or return the product and its accessories to the manufacturer.

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

Products with this mark meet the electrical safety requirements for the USA and Canada.

MR Unsafe: Products with this mark are not safe for use in an MR environment.

MR Conditional: Products with this mark are only suitable for use in an MR environment subject to certain conditions. Take note of the special application stipulations.

MR Safe: Products with this mark can be used safely in an MR environment.

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. ●

Appendix G Installing amplifier systems with more than 128 channels

Systems with more than 128 channels are connected to the computer via two PCI Adapter Cards and two expansion cards. To achieve this, you need two free PCI slots in your computer and space for one or two expansion cards.

Note that the mainboard of the computer used must support PCI Version 2.1 (5 V 32-bit).

One PCI Adapter Card is the master (see Figure G-1) and the other is the slave.

Proceed as follows to synchronize the master and the slave:

1. Connect the two cards to each other by plugging connection cable A (see Figure G-3) in the corresponding socket marked *A* (marked as the *Synchronisation Connector* in Figure G-1).
2. Then connect each PCI Adapter Card to an expansion card (see Figure G-2). Connection cables and sockets are marked *B* (labeled as *External Card Connector* in Figure G-1).

Shut the computer down, switch it off and unplug the power cord from the power supply. Now insert the cards in the computer in the following sequence:

1. Master (channels 1 through 64)
2. Expansion card for the master (channels 65 through 128)
3. Slave (channels 129 through 192)
4. Expansion card for the slave (channels 193 through 256)

The master card features an additional trigger input as well as the two fiber optic inputs.

Figure G-1. PCI Adapter Card (master)

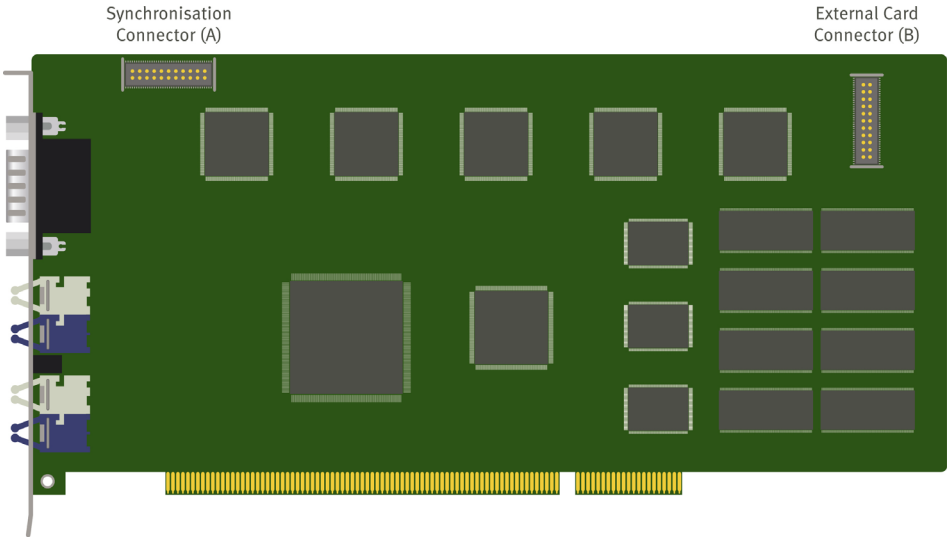


Figure G-2. Expansion card

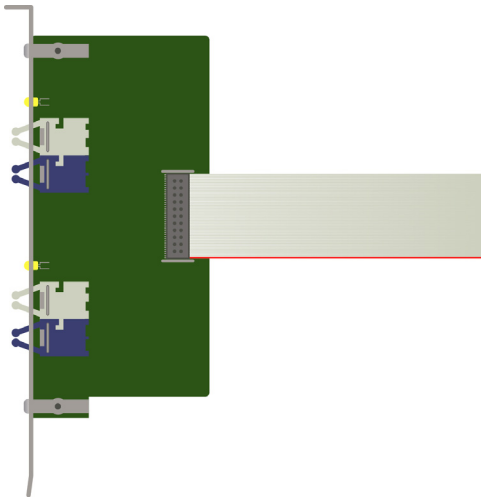
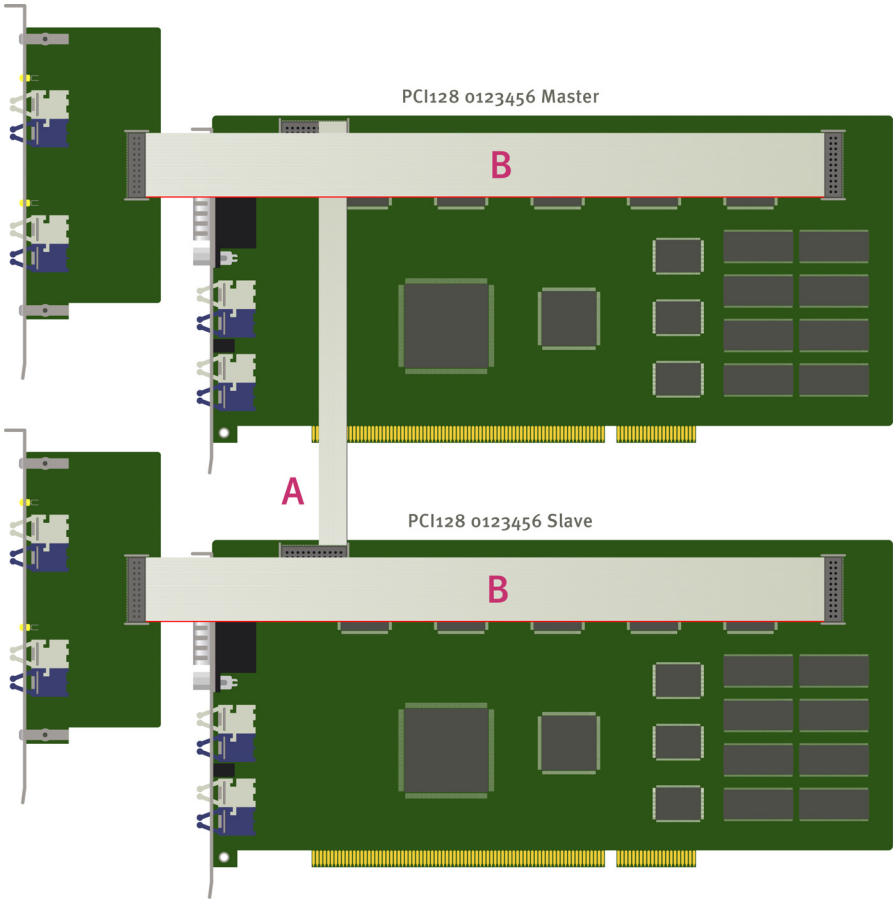


Figure G-3. Cards connected (master and slave)



Appendix H Note on the use of invasive electrodes

In accordance with electrical safety testing as per IEC 60601-1, the amplifier has been approved as protection class II, application type BF (body floating).

The tested discharge currents permit use of the amplifier under laboratory conditions in combination with specially authorized invasive electrodes on the central nervous system provided that:

- Power is supplied to the BrainAmp components by the PowerPack.
- No other product is simultaneously electrically connected to the test subject.
- No simultaneous stimulation is used (ERP).

Never use the invasive electrodes in an MR environment.

Personal injury

Under no circumstances use a defibrillator if the test subject feels unwell but is still connected to the invasive electrodes.

The invasive electrodes must not be used for recording ECG signals and polygraph signals with the BrainAmp components.

The approval of the electrodes used as a class III medical product must be notified to Brain Products on request.

Appendix I Legal notice for users of the BrainAmp MR/Brain MR plus in the USA

You should note that the use of our products other than for the intended use described in the present manual may represent an infringement of certain industrial property rights arising out of US patent number 5,445,162. You should therefore note that the following procedures for use must be observed:

Recording must be performed outside the scanner room. The PC or laptop used to record and store the signals must not be located in the scanner room. Brain Products GmbH accepts no liability in the event of any non-compliance with these instructions and the original intended use.

The manual or automatic triggering of the scanner based on the detection of special wave forms during the monitoring of inbound data may potentially result in the infringement of patent. Brain Products GmbH accepts no liability or responsibility in the event of the improper use of our products and/or software for such purposes.

The BrainAmp MR and BrainAmp MR plus amplifiers and the BrainVision Recorder recording software are not able to send triggers based on the detection of special wave forms in an EEG (e.g. spikes). You can find further information on the US patent office's web site at http://www.uspto.gov (patent number 5,445,162 and referral). Alternatively, please contact Brain Products GmbH directly.

Appendix J Ordering codes

Amplifier systems

BrainAmp Standard 32-channel amplifier system:	BP-01000
BrainAmp Standard 64-channel amplifier system:	BP-01010
BrainAmp Standard 96-channel amplifier system:	BP-01020
BrainAmp Standard 128-channel amplifier system:	BP-01030
BrainAmp Standard 256-channel amplifier system:	BP-01040
BrainAmp DC 32-channel amplifier system:	BP-01100
BrainAmp DC 64-channel amplifier system:	BP-01110
BrainAmp DC 96-channel amplifier system:	BP-01120
BrainAmp DC 128-channel amplifier system:	BP-01130
BrainAmp DC 256-channel amplifier system:	BP-01140
BrainAmp ExG 8-channel amplifier system:	BP-01350
BrainAmp ExG 16-channel amplifier system:	BP-01355
BrainAmp ExG 8-channel bipolar amplifier system:	BP-02682
BrainAmp ExG 16-channel bipolar amplifier system:	BP-02683
BrainAmp MR 32-channel amplifier system:	BP-01200
BrainAmp MR 64-channel amplifier system:	BP-01210
BrainAmp MR 96-channel amplifier system:	BP-01220
BrainAmp MR 128-channel amplifier system:	BP-01230
BrainAmp MR plus 32-channel amplifier system:	BP-01300
BrainAmp MR plus 64-channel amplifier system:	BP-01310
BrainAmp MR plus 96-channel amplifier system:	BP-01320
BrainAmp MR plus 128-channel amplifier system:	BP-01330
BrainAmp ExG MR 8-channel amplifier system:	BP-01370
BrainAmp ExG MR 16-channel amplifier system:	BP-01375
BrainAmp ExG MR 16-channel bipolar amplifier system:	BP-01355

Accessories and other products

64-channel USB2 Adapter:	BP-02040	
128-channel USB2 Adapter:	BP-02050	
dualBUA Kit:	BP-02070	
dualBUA Adapter Cable:	BP-02071	
Electrode Input Box EIB64-A:	BP-02200	
ExG AUX Box:	BP-02221	
PS6 wr V-o complete:	BP-02101	
PowerPack complete:	BP-02610	
Charger V9 for PowerPack:	BP-02630-EU/NA	
PolyBox 8-channel extension box for AUX/sensor inputs:	BP-02660	
ExG Input Box 16-channel:	BP-02220	
SyncBox frequency scaler:	BP-02675	
Clock output adapter cable for Siemens scanners:	BP-02680-SUB	
Signal tester:	BP-02060	
Signal tester for ExG:	BP-02061	
TriggerBox:	BP-210-9030,	
TriggerBox Extension:	BP-210-9040	
GSR Sensor MR:	BP 02810 MR	

List of abbreviations

AC ..... Alternating current

AUX ..... Auxiliary

BF..... Body floating

BNC ..... Bayonet Neill Concelman (type of high-frequency coaxial connector named after its inventors)

CMR..... Common-mode rejection

DC ..... Direct current

DIN ..... Deutsches Institut für Normung (German standards Institute)

EC..... European Community

EFTA ..... European Free Trade Association

ERP..... Event-related potential (evoked potential)

EU ..... European Union

fMRI..... Functional magnetic resonance imaging

LPT ..... Line printing terminal ("parallel port")

PSA ..... PowerSupply Adapter

PWR..... Power

TMS ..... Transcranial Magnetic Stimulation

TTL..... Transistor-transistor logic

VDE ..... Verband der Elektrotechnik Elektronik Informationstechnik e.V. (German Association for Electrical, Electronic and Information Technologies)

WEEE ..... Waste Electrical and Electronic Equipment Directive

Glossary

A

actiCAP active electrode system: Electrode system (including control software) from Brain Products featuring active electrodes which is used for acquiring EEG signals and can be combined with all amplifiers available from Brain Products.

D

DC offset: The average of the EEG signals. If this average is equal to zero, there is no DC offset. If analysis is negatively affected by too high a DC offset, it may be necessary to perform DC offset correction.

Digital port: Parallel interface over which data can be transferred between a computer and peripheral equipment.

G

GSR MR module: Sensor from Brain Products that can be used in MR scanners for recording and converting the electrical conductivity of the skin to a voltage that can be recorded by the amplifier. The GSR MR module is used in conjunction with a BrainAmp ExG MR and the ExG AUX Box.

H

High-cutoff filter (low-pass filter): Filter that reduces the amplitude of high-frequency digitized signals.

I

Impedance measurement: Amplifier operating mode for measuring the resistance of the electrodes.

L

Low-cutoff filter (high-pass filter): Filter that reduces the amplitude of low-frequency digitized signals.

M

Marker: Markers mark a point in time or a period within the EEG. A marker can be an item of stimulus information that is used to ascertain evoked potential. It can also mark a new segment or indicate that a DC offset correction was carried out at a certain time. Markers are used for orientation during segmentation.

Monitoring: Observation of the EEG signals on screen.

P

Polygraph recording: Simultaneous recording of different physiological signals such as EEG, breathing, ECG, eye movement, oxygen saturation, etc.

Potential: Frequently used as a synonym for "EEG wave".

R

Recorder: EEG recording software from Brain Products featuring extensive storage, filtering and display functions.

Resolution: Specifies the granularity with which the value range of the EEG signal is subdivided during digital acquisition. A higher resolution means finer granularity and more accurate acquisition of the original signal. Unit: µV.

S

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

SyncBox: Hardware accessory from Brain Products for the BrainAmp (ExG) MR/BrainAmp MR plus which makes it possible to synchronize the sampling rate of the amplifier with the clock rate of the scanner system.

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).

W

Workspace: Configuration file created by the Recorder (q.v.) in order to manage user-defined recording parameters, am-

plifier settings and other information. File name extension: .rwksp.

Subject index

T

U

W