

eego™ amplifier EE-21x EE-22x



**eego amplifier EE-211, EE-212, EE-213, EE-214, EE-215 / version 1.2
 EE-221, EE-222, EE-223, EE-224, EE-225 / version 1.2**

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IMPORTANT NOTICES

Following the European Medical Device Directive 93/42/EEC Annex IX, **eego amplifier** is a CE class IIa medical device.



This User Manual only covers the EE-21x and EE-22x variants of the eego amplifier. Refer to dedicated User Manual for other variants.

For US customers only:

Rx only

Caution: Federal Law (USA) restricts this device to sale by or on the order of a physician.

DISCLAIMER

We have attempted to write this document as accurately as possible. However, mistakes are bound to occur, and we reserve the right to make changes to the products, which may render parts of this document invalid.

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1 GENERAL INFORMATION

1.1 ABOUT THIS DOCUMENT

With this document, we provide you with all information required to set up and start working with the **eego** amplifier.

If you encounter problems with the device that cannot be resolved using this document please contact us directly via **support@eemagine.com** for further help (please make sure to state the product ID and serial number of your amplifier in the Subject section of your email).

We will coordinate communication with your dealer in case you purchased the device locally.

1.2 INTENDED USE

The **eego** amplifier is intended to be used by or under the direction of a physician for acquisition of EEG signals and to transmit them digitally to a computer.

The device is intended for use on humans.

The device is intended for use in a clinical environment (e.g., hospital, physician's office, etc).

The device is not intended for use in life support systems.

1.3 TECHNICAL DATA AND FEATURES OVERVIEW

The **eego** amplifier has been designed as a mobile recording device for high-density EEG and other electrophysiological signals. It provides access to recorded data over a USB connection to external software over its signal driver interface. The eego amplifier comes with a built-in rechargeable battery for mobile applications and recordings of several hours.

This ultimate solution for mobile EEG recording provides maximum 64 channels of referential EEG and (optionally) synchronously recorded 24 bipolar input signals.

The **eego** amplifier is used in combination with the **eego** recording software, a 64-channel or 32-channel EEG headcap and other optional accessories.

The **eego** amplifier has one 8-bit trigger input channel accessible through high-density connectors. Impedance values can be measured for all referential electrodes as well as the reference and patient ground electrode. An active shielding technique protects the EEG inputs from grid interference noise. Sampling rate and gain can be set through the user interface of the control software.

Detailed technical specifications, environmental conditions, the available product variants and PC requirements are given in the APPENDIX D: Datasheet for **eego** amplifier.

1.4 SAFETY WARNINGS

The following warnings and cautions apply to the **eego** amplifier:



- Proper use of the **eego** amplifier depends on careful reading of all instructions and labels that come with or on the device inaccurate measurements may be caused by incorrect use of the device.
- Non-compliance with warnings and safety regulations may result in severe personal injury!

If you are uncertain or have any questions about operational safety or about any of the warnings and cautions, then do not hesitate to call or email:

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For warnings and safety regulations concerning **waveguard** EEG caps, please refer to the corresponding manual.

1.4.1 IMPORTANT INFORMATION

- There are no known side effects from the use of this equipment.
- **ONLY APPLICABLE TO THE USA:** Under federal law this apparatus may only be sold by or on the order of a physician or licensed practitioner. The apparatus may only be used under the constant supervision of or on the instructions of a physician or other authorized medical professional.

1.4.2 SAFETY MEASURES

- The only external power supply that may be used is the original device supplied together with the amplifier. **DO NOT** replace it with anything else. If any third-party type of power supply is used then patient safety is not guaranteed.
- Make sure that the wall socket is well earthed.
- Inspect the power cord on a regular basis for damages. Do not operate the device with a damaged power cord.
- The **eego** amplifier contains LITHIUM-ION BATTERIES. In case of damaged amplifier housing and to the battery cells inside the housing, metallic Lithium tends to spontaneous formation of flames when in air contact. Make sure to quarantine any amplifier with damaged battery cells and inform eemagine support immediately.
- Do not connect active sensors or electrodes to any of the inputs of the amplifier.
- Do not use the device with adapters, EEG caps or other devices not explicitly listed to be compatible with the device.
- Take care when arranging sensor cables to avoid risks of entanglement or strangulation.



- Reusable electrodes present a potential risk of cross-contamination. Please refer to the documentation that came with your electrodes for instructions on how to prevent this.
- Do not connect the device to a patient undergoing MRI, electro-surgery or defibrillation.
- Do not modify the equipment. Never attempt to unscrew any parts of the amplifier.
- Do not attempt to open the battery compartment of the amplifier.
- ELECTRICAL SHOCK HAZARD: Do not connect electrode inputs to earth ground. Connecting an earth ground might result in electrocution.
- Conductive parts of ELECTRODES and associated connectors for APPLIED PARTS, including the NEUTRAL/GROUND/REFERENCE ELECTRODE, should not contact other conductive parts including earth.
- ELECTRICAL SHOCK HAZARD: Servicing of the equipment is to be done by approved technicians only.
- Do not connect the amplifier device with other equipment via a multi socket outlet to the mains.
- Make sure the computer connected to the amplifier remains outside the patient environment.



1.4.3 PRECAUTIONARY MEASURES

- When the amplifier is not in use, please make sure to switch it off. The device will switch off automatically after the batteries are discharged below a given limit. With batteries completely discharged, the device can only be switched on while the power supply is attached.
- The amplifier needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in APPENDIX B: AMPLIFIER TECHNICAL SPECIFICATIONS (EMC); the use of accessories other than specified may result in increased emissions or decreased immunity of the **eego** amplifier.
- The **eego** amplifier should not be used adjacent to or stacked with other equipment; if this is still necessary, verify normal operation in the configuration in which it will be used. Do also not stack multiple **eego** amplifiers directly on top of each other. Allow for some spacing of several cm in between.
- The use of portable and mobile RF communications equipment can adversely affect the recording; do not use an operating cellular phone within 30 cm of the amplifier, the cables and the electrodes to avoid excessive noise on the signals. See also in APPENDIX B: AMPLIFIER TECHNICAL SPECIFICATIONS (EMC).
- Disposable electrodes which are used for electrophysiological measurements may pose a biohazard. Handle, and when applicable, dispose of these materials in accordance with accepted medical practice and any applicable local, state and federal laws and regulations.

1.4.4 WARNINGS

- Safety and performance of the device are not guaranteed when it is used together with accessories that were not explicitly listed as compatible.
- The device is not defibrillator-proof.
- The device is not suitable for use in an inflammable mixture of anesthetics and air, oxygen or nitrous oxide.
- No chemical agents are to be used with the device.
- The device is not to be immersed in any liquid and should not be exposed to rain.



- If any liquids or moisture penetrate the device or a part thereof, turn the device off, remove the plug from the wall socket and have the device checked by the manufacturer.
- Do not expose the device to direct sunlight, heat from a source of thermal radiation, excessive amount of dust, moisture, vibration, or mechanical shock.
- Do not wind the cables in a loop smaller than 5 cm or bend them sharply, as this may damage the cables.
- During operation with an active connection via USB to a compatible computer, do not connect other USB devices, and do not make changes to any connections.
- If the **eego** amplifier is upgraded or replaced for any reason, make sure to have the control software and interfacing computer checked for compliance by eemagine support before continuing to work with the device. Similarly have the **eego** amplifier checked for compliance when the control software or computer is upgraded or replaced.
- During operation place the device in such a way that connectors and cables are easily accessible.
- Do not use sharp objects such as pencil-points or pen-tips to manipulate the buttons on the control panel, as this may cause damage.
- Do not use the device whenever parts of it are damaged.
- The **eego** amplifier's soft-shell must be handled with care and must not be removed from the device. It may tear otherwise.

1.5 MAINTENANCE AND CLEANING

We would like to give a few general recommendations that may help to keep your equipment in good shape and ensure high quality of recordings.

The amplifier is mechanically robust – within limits. Try to protect the device as much as possible from falling and heavy mechanical shocks. Please take special care that the USB cable and the connectors on either side are not under mechanical stress. A broken USB connection may lead to expensive and time-consuming repair of the amplifier.

The EEG head-cap and trigger connectors may be attached to the amplifier with the available screws on the connector in case of expected movement of the patient/subject. The screws do not need to be extremely tight but just hold the connectors in place, so please tighten the screws gently.

The expected lifetime is 5 years.

There is no need for periodic testing of the device and accessories during the lifetime. After this, we recommend to test every year.

If the amplifier requires cleaning, please use a dry cloth to remove dirt (e.g. gel remainders). Do not use alcohol or cleaning chemicals.

1.6 DISPOSING OF WASTE EQUIPMENT

Various parts of the **eego** amplifier device bear the symbol for special waste disposal regulations (EU). The symbol means that the products must not be disposed of with regular waste. Instead, it is the user's responsibility to dispose of waste equipment by handing it over to a designated collection point for the



recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service, or the manufacturer.

1.7 PRODUCT VARIANTS

See the APPENDIX D: Datasheet.

1.8 PC REQUIREMENTS

See the APPENDIX D: Datasheet.

1.9 CONTACT INFORMATION

For more information and for reporting problems with **eego** amplifier, please contact eemagine at:

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2 THE EEGO AMPLIFIER, HARDWARE SETUP DESCRIPTION

2.1 THE EEGO AMPLIFIER

The **eego** amplifier device has been designed for ultra-mobile applications of high-density EEG and other electrophysiological signals. The compact electronic device is battery-powered and gives access to 64 referential input channels as shown in Figure 2-1 or only 32 channels as shown in Figure 2-2. Some variant restrict the number of channels to 16 but they still use the EEG IN 1 connector.

At the rear (Figure 2-3 and Figure 2-4) 24 additional bipolar input channels can be connected (optional, not for all amplifier types). Further a USB connector (plug type B, straight) provides access to data communication and hardware control.



Figure 2-1. The eego amplifier EE-211 amplifier shown from the front. The amplifier (white) is mechanically protected by the eego amplifier soft-shell (blue). Two high density connectors (EEG IN 1 and EEG IN 2) provide access to 64 shielded referential inputs, reference and ground. The openings allow securing the amplifier, e.g., on the table.

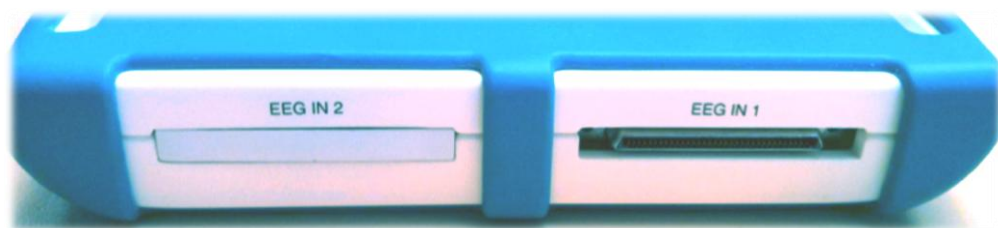


Figure 2-2. The eego amplifier EE-212 shown from the front. Only 32 shielded referential inputs are available.

Trigger input can be recorded from devices that deliver TTL output. The high-density connector at the back side, next to the USB connector, provides 8 independent input lines and a ground connection. The trigger ground and the trigger lines are electrically isolated from the other electrical parts of the

amplifier. The trigger adapter XS-230 allows to connect **eego** amplifier with DSUB25 compatible trigger sources.



Figure 2-3. The eego amplifier shown from the rear. The ON/OFF pushbutton to the left is the power button. The TRIGGER high density connector gives access to 8 electrically decoupled TTL lines for recording of synchronized trigger input. The USB 2.0 connector provides access to control the hardware and to stream data. The DC IN 12 V power input is compatible with the charger delivered with the device.



Figure 2-4. The eego amplifier shown from the rear with the optional bipolar channel high density connector (24 bipolar channels).



Figure 2-5. Side view of the eego amplifier with soft-shell. The LED light bars at the left and right sides work symmetrically and contain multicolor LEDs for DATA and POWER status.

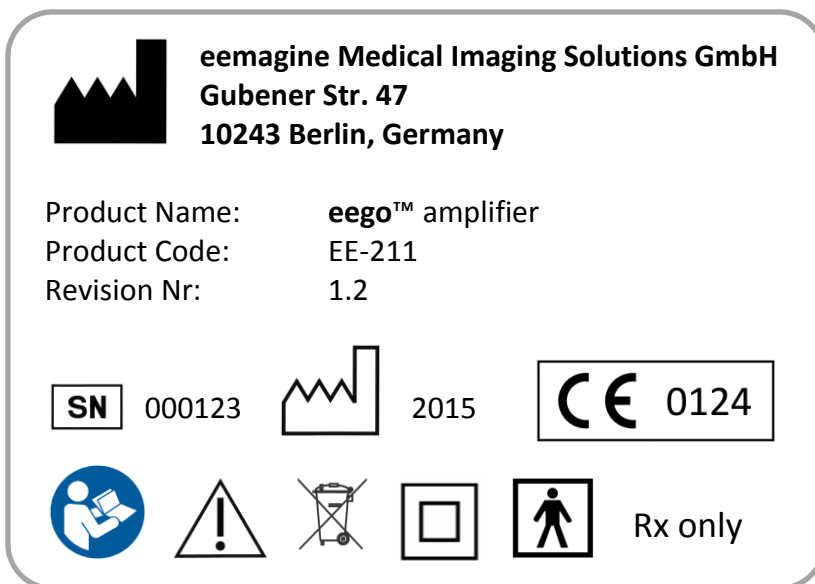



Figure 2-6. The product label at the bottom of the amplifier device shows manufacturer information, product name, code and revision, and serial number, year of production and CE marking. The symbols in the bottom row points are explained in Appendix C. The product code as shown, EE-211, will read EE-21x and EE-22x for corresponding different amplifier types. Amplifier revisions below 1.2 were delivered as type CF. For revision 1.2 and above type BF is the standard (man in box symbol). Type CF is still available on request. The manufacturer label for CF amplifiers looks slightly different (showing the hart symbol  and a product code with a CF extension).



Figure 2-7. Compatible waveguard cap CA-200, 64 electrodes plus GND (medium size shown). The white labels on the cable indicate product code, (and on other side of label) manufacturer information and serial number.

2.2 BIOSIGNAL AND IMPEDANCE MEASUREMENTS

Measurements of physiological parameters such as EEG require highest quality and fidelity of the electronic equipment and sensors used with it. The **eego** amplifier has been developed on the basis of latest state of the art core electronic components (integrated circuits). The modern chip-set allowed miniaturizing hardware without compromises in signal quality and keeping the power consumption at a minimum. The device weighs less than 500 grams and has a small form factor, as it should be for mobile use.

The input stage of the 64 referential input channels to the amplifier has been optimized for high-density EEG recorded with **waveguard** head caps. The preamplifier component implements active shielding, which greatly suppresses external noise effects that typically contaminate EEG signals. Active shielding works such that the buffered input signal (no amplification of signal amplitude but impedance transformation) is put on the coaxial shield of an electrode lead inside the **waveguard** cap. This way, electrical transmission of external noise through the coaxial shield into the lead is minimized due to the nearly perfect “shorting” (zero voltage difference) between the lead and its shield.

The input stage of the amplifier registers incoming signals against a common dedicated passive reference electrode. The measured voltages thus all depend upon the quality of the reference signal and it is highly recommended to pay attention to good preparation of the reference.

In order to measure physiological signals with high sensitivity, the human body acting as a source of voltage differences and the amplifier ground (the electrical zero-point from which the operating range is determined) have to be connected. This can be - for convenience - an electrode lead in the **waveguard** cap: the model CA-200 defines AFz to be the ground (GND) position. Nonetheless, any other accessible body part can be used to make the GND connection – with no effect on the measured signal amplitudes. For a good suppression of common-mode signals, it may actually be more suitable to place the GND at some distance from the scalp electrode. The cap therefore provides access to the GND with a microcoax socket in the cap cable near the neck (note that there is a second socket for connection of an EOG lead). See the cap datasheet and its user guide for more information.

The GND connection actually implements a driven ground, i.e. a small voltage of ca. 2.5 Volts relative to the internal amplifier ground is put on the human body. Electrical currents are kept well below limits defined for patient safety in medical devices and order of magnitude smaller than currents flowing in impedance measurements. The driven ground allows measuring signal amplitudes of the voltage of the driven ground without saturation effects, regardless of the polarity of the signal. The actual signal range is determined by the amplification factor of the input stage, which is programmable in steps.

With the **eego** amplifier you can record bipolar signals using a referential setup and by re-referencing in the **eego** software application. Please refer to corresponding documentation for more details how to prepare the configuration with the appropriate adapter (XS-260).

Further you can record true bipolar signals via the dedicated bipolar input ports at the rear of the housing. Two terminals per channel are available and must be connected.

Regardless of referential or bipolar recordings the amplified data stream of input signals is converted from analog (continuous in amplitude and time) to digital (discrete in amplitude and time). Both dimensions – voltage and time – are digitized in a way that the analog waveforms can be approximated without loss of quality in further review and analysis steps. The minimum step width is in the order of (less than) ms (milliseconds) and a few nV (nano Volts), depending on the selected sampling rate, signal range and resolution (see **eego** amplifier datasheet). Each signal is treated by its own converter, so that no multiplexing effects occur.

The digital data stream is then converted into a protocol suitable for computer communication (USB). Communication between computer and amplifier works in two ways: control commands sent by the application software make sure that the amplifier takes the requested actions, and the amplifier sends EEG data, trigger and status information in the respective operation mode.

The application software sets up communication with USB 2.0 (USB 3.0 is fully compatible with USB 2.0 standard) and provides user interfaces to display and record the measurements.

2.3 RECORDING TRIGGER INPUT

In case you want to record event-related activity, we assume you have available a PC with presentation software, which is able to deliver TTL pulses along a parallel port cable (DSUB 25 pin connector, male) with pinning compatible with the description in Appendix A.

WARNING: Make sure that the computer generating the trigger signals is compliant with IEC 60950.



To run an ERP experiment, please insert the trigger adapter XS-230 into the high-density trigger input of the amplifier. The DSUB connector at the other end of the adapter is connected with a parallel port cable that links with the DB25 port of the presentation PC (cable, presentation PC and software not provided with the **eego** amplifier).

The 8-bit trigger information is encoded in a decimal trigger code (from 1 to 255) in the recording software.

Please be aware that only rising flanks are detected as triggers and as high trigger bits! A trigger pulse should have a length of at least 2-3 times the reciprocal of the sampling rate. In between triggers the Low level must also be hold for 2-3 times the reciprocal of the sampling rate.

2.4 MOUNTING OPTIONS FOR THE EEGO AMPLIFIER

The **eego** amplifier can be used as a stationary device or as a mobile device.

When using **eego** amplifier as a stationary device, please make absolutely sure that the amplifier cannot drop from the table, e.g. when the patient is connected with the cap and tries to walk away or when the USB cable is dragged over the table sides. You can for example put a string through the mounting holes to fixate the amplifier box.

In mobile EEG applications, we strongly recommend to mechanically protect the amplifier with the **eego** amplifier soft-shell. Do not remove the soft-shell from the amplifier.

2.5 BATTERY AND CHARGER FOR THE EEGO AMPLIFIER

The **eego** amplifier comes with a built-in rechargeable Li-Ion battery. The battery provides several hours of operation time. The exact value may vary depending on the operation mode of the amplifier (more current is drawn from the battery in impedance measurement mode), operating temperature and aging effects of the battery similar to other battery-driven devices. The charging process takes usually less than 2 hours to complete.

The LED light-pipes at the side edges of the **eego** amplifier communicate POWER and DATA status as well as possible hardware problems. The two multi-color LED indicators at each side operate symmetrically.

The following table gives a description of the battery status as shown with the **POWER** LED.

POWER LED color*)	Battery Status	Description
Red	Low	Battery is in the low charging state. You should stop the recording and recharge the amplifier immediately.
Yellow	Medium	Battery is in medium state. At least 1 hour of operation time remains but the device should be recharged now. Do not start a new recording.
Green	High	Battery charging state is high.

Table 2-1 Display of battery status as shown with the POWER LEDs.

The POWER indicator light is *breathing*, i.e. brightness of the LEDs is oscillating slowly, when the battery is charged (supposing that the power supply is attached). Please remember that for best signal quality the power supply should not be attached while recording with the amplifier.

In case you experience drastically reduced battery operation times of the amplifier, please contact Support for options to check the device and possibly to exchange the battery.

WARNING: Do not attempt to open the amplifier or battery compartment yourself!



The battery charger for **eego** amplifier comes with a power cord and plug fit for a particular region. A green LED indicator in the power supply shows whether the device is turned on.

***) The LED indicators are not active when the amplifier is turned off. Nevertheless, the device will be charged when the power supply is connected. You can check the charging status by turning on the device.**

2.6 LED AND SOUND STATUS INDICATORS FOR THE EEGO AMPLIFIER

The LED light-pipes at the side edges of the **eego** amplifier communicate POWER and DATA status as well as possible hardware problems. The two multi-color LED indicators at each side operate symmetrically.

The **DATA** LED indicator can have the following states:

DATA LED color	Visual indication	Description
OFF	-	Amplifier is switched OFF
Green	Constant	Amplifier is ON , no data is acquired
Green	Breathing*	Data is acquired (streamed)
Yellow	Breathing*	Impedance data is acquired (streamed)
Red	Constant	Device error, restart device, contact support

Table 2-2 status as shown with the DATA LEDs. (* brightness of the LEDs is oscillating slowly)

A built-in **beep** indicates important changes of the status:

SOUND signal	Description
2 beeps	first low, second high Amplifier is switched ON
2 beeps	first high, second low Amplifier is switched OFF
3 beeps	Amplifier is fully charged

Table 2-3 Sound signals as relevant for power status.

The LED and sound indicators are not active when the amplifier is turned off. Nevertheless, the device will be charged when the power supply is connected. You can check the charging status by turning on the device.

APPENDIX A: CONNECTORS AND PINNING TABLES

EEG CONNECTORS (REFERENTIAL)

The **eego** amplifier has two EEG input connectors, EEG IN 1 and EEG IN 2. The 68-pin high-density, high-quality connectors give access to the 64 shielded referential inputs, the reference electrode and the patient ground, and are typically used according to the pinning tables below.

eego amplifier EEG IN 1 connector			
Channel Number	Electrode CA-200/201	Pin numbers, 68-pin high-density connector	
		active	shield
-	GND	34	68
Ref 1	Fp1	33	67
Ref 2	Fpz	32	66
Ref 3	Fp2	31	65
Ref 4	F7	30	64
Ref 5	F3	29	63
Ref 6	Fz	28	62
Ref 7	F4	27	61
Ref 8	F8	26	60
Ref 9	FC5	25	59
Ref 10	FC1	24	58
Ref 11	FC2	23	57
Ref 12	FC6	22	56
Ref 13	M1	21	55
Ref 14	T7	20	54
Ref 15	C3	19	53
Ref 16	Cz	18	52
Ref 17	C4	17	51
Ref 18	T8	16	50
Ref 19	M2	15	49
Ref 20	CP5	14	48
Ref 21	CP1	13	47
Ref 22	CP2	12	46
Ref 23	CP6	11	45
Ref 24	P7	10	44
Ref 25	P3	9	43
Ref 26	Pz	8	42
Ref 27	P4	7	41
Ref 28	P8	6	40
Ref 29	POz	5	39
Ref 30	O1	4	38
Ref 31	O2	3	37
Ref 32	EOG	2	36
-	REF	1	35

eego amplifier EEG IN 2 connector			
Channel Number	Electrode CA-200	Pin numbers, 68-pin high-density connector	
		active	shield
-	not connected	34	68
Ref 33	AF7	33	67
Ref 34	AF3	32	66
Ref 35	AF4	31	65
Ref 36	AF8	30	64
Ref 37	F5	29	63
Ref 38	F1	28	62
Ref 39	F2	27	61
Ref 40	F6	26	60
Ref 41	FC3	25	59
Ref 42	FCz	24	58
Ref 43	FC4	23	57
Ref 44	C5	22	56
Ref 45	C1	21	55
Ref 46	C2	20	54
Ref 47	C6	19	53
Ref 48	CP3	18	52
Ref 49	CP4	17	51
Ref 50	P5	16	50
Ref 51	P1	15	49
Ref 52	P2	14	48
Ref 53	P6	13	47
Ref 54	PO5	12	46
Ref 55	PO3	11	45
Ref 56	PO4	10	44
Ref 57	PO6	9	43
Ref 58	FT7	8	42
Ref 59	FT8	7	41
Ref 60	TP7	6	40
Ref 61	TP8	5	39
Ref 62	PO7	4	38
Ref 63	PO8	3	37
Ref 64	Oz	2	36
-	not connected	1	35

One of the connectors can also be used with the XS-260 bipolar adapter; see its datasheet for details.

BIPOLAR CONNECTOR

The **eego** amplifier has one bipolar input connectors, BIPOLAR IN. The 50-pin high-density, high-quality connectors give access to the 24 bipolar inputs and the patient ground. The patient ground is identical to the referential channel patient ground. Only one patient ground connection should be established and used when preparing a subject. Pin 50 on the connector is unused and reserved for internal use.

eego amplifier BIPOLAR IN connector		
Channel Number	Pin numbers, 50-pin high-density connector	
	negative	positive
BIP 1	1	26
BIP 2	2	27
BIP 3	3	28
BIP 4	4	29
BIP 5	5	30
BIP 6	6	31
BIP 7	7	32
BIP 8	8	33
BIP 9	9	34
BIP 10	10	35
BIP 11	11	36
BIP 12	12	37
BIP 13	13	38
BIP 14	14	39
BIP 15	15	40
BIP 16	16	41
BIP 17	17	42
BIP 18	18	43
BIP 19	19	44
BIP 20	20	45
BIP 21	21	46
BIP 22	22	47
BIP 23	23	48
BIP 24	24	49
GND	25	

TRIGGER CONNECTOR

The **eego** amplifier provides an 8-bit trigger input via the 36-pin high-density connector at the amplifier backside. The trigger connector is compatible with the XS-230 trigger adapter, which should be used whenever connecting the amplifier with a trigger source (TTL).

WARNING: The trigger source must be compliant with IEC 60950.



eego amplifier trigger connector (and pinning for XS-230)		
Pin numbers, 36-pin high-density connector	Pin numbers, 25-pin DSUB connector (XS-230)	Description
1	-	(not connected)
2	-	(not connected)
3	-	(not connected)
4	-	(not connected)
5	-	(not connected)
6	2	TTL Bit 1
7	3	TTL Bit 2
8	4	TTL Bit 3
9	5	TTL Bit 4
10	6	TTL Bit 5
11	7	TTL Bit 6
12	8	TTL Bit 7
13	9	TTL Bit 8
14	-	(not connected)
15	-	(not connected)
16	-	(not connected)
17	-	(not connected)
18	-	(not connected)
19	-	(not connected)
20	-	(not connected)
21	-	(not connected)
22	-	(not connected)
23	-	(not connected)
24	25	Trigger Ground
25	25	Trigger Ground
26	25	Trigger Ground
27	25	Trigger Ground
28	25	Trigger Ground
29	25	Trigger Ground
30	25	Trigger Ground
31	25	Trigger Ground
32	-	(not connected)
33	-	(not connected)
34	-	(not connected)
35	-	(not connected)
36	-	(not connected)

POWER AND USB CONNECTOR

The power connector of the **eego** amplifier is compatible with the DC output cable of the supplied battery charger. Do not connect any other power source to the amplifier!

The USB connector of the **eego** amplifier is typically connected with the USB port of a computer (USB plug type A). This cable is necessary for data transmission. It does not power the amplifier or battery but supplies the electrically isolated USB communication module. Please inspect the settings for the USB ports available at your computer, and make sure 'power saving' options are turned off for the USB ports.



Figure A-0-1. The label of the compatible power supply.


APPENDIX B: AMPLIFIER TECHNICAL SPECIFICATIONS (EMC)

The compliance in the tables below is valid for eego amplifier with following accessories:

Part	Cable length (m)
Power supply XP Power Model AFM45US12C2	1.9
USB cable	1.8
XS-230 trigger adapter DB25	0.3
CA-2xx waveguard caps (tests below performed with CA-200)	1.2
XS-260 adapter for 16 bipolar channels (connection equivalent to a set of 32 unipolar EEG inputs)	0.8











Guidance and manufacturer's declaration – electromagnetic emissions		
<i>The eego amplifier is intended for use in the electromagnetic environment specified below. The customer and/or user of the eego amplifier should ensure that it is used in such an environment.</i>		
Emission Test Compliance	Compliance	Electromagnetic Environment - guidance
RF Emissions CISPR 11	Group 1	The eego amplifier uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment. The eego amplifier is suitable for use in all establishments, including domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
RF Emissions CISPR 11	Class B	
Harmonic Emissions IEC 61000-3-2	Not applicable	
Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3	Not applicable	

Guidance and manufacturer's declaration – electromagnetic immunity			
<i>The eego amplifier is intended for use in the electromagnetic environment specified below. The customer and/or user of the eego amplifier should ensure that it is used in such an environment.</i>			
Immunity Test	IEC 60601 test level	Compliance level	Electromagnetic Environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV line(s) to line(s) ± 2 kV line(s) to earth	± 1 kV line(s) to line(s) ± 2 kV line(s) to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 s	<5 % U_T (>95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 s	Mains power quality should be that of a typical commercial or hospital environment.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer's declaration – electromagnetic immunity			
The eego amplifier is intended for use in the electromagnetic environment specified below. The customer or the user of the eego amplifier should assure that it is used in such an environment.			
Immunity test	IEC 60601 Test level	Compliance level	Electromagnetic environment – guidance
Conducted RF IEC 61000-4-6 Radiated RF IEC 61000-4-3	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	3 Vrms 3 V/m	<p>Portable and mobile RF communications equipment should be used no closer to any part of the eego amplifier, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p>Recommended separation distance</p> $d = 1.2 \sqrt{P}$ $d = 1.2 \sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 2.3 \sqrt{P} \quad 800 \text{ MHz to } 2.5 \text{ GHz}$ <p>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in metres (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,^{a)} should be less than the compliance level in each frequency range.^{b)}</p> <p>Interference may occur in the vicinity of equipment marked with the following symbol:</p> 
<p>NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.</p> <p>NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</p> <p>a) Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the eego amplifier is used exceeds the applicable RF compliance level above, the eego amplifier should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the eego amplifier.</p> <p>b) Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.</p>			

Recommended separation distances between portable and mobile RF communications equipment and the eego amplifier			
The eego amplifier is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the eego amplifier can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the eego amplifier as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter (W)	Separation distance according to frequency of transmitter (m)		
	150 kHz to 80 MHz $d = 1.2 \sqrt{P}$	80 MHz to 800 MHz $d = 1.2 \sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3 \sqrt{P}$
0.01	0.2	0.2	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23
<p>For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.</p> <p>NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.</p> <p>NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.</p>			

APPENDIX C: EXPLANATION OF SYMBOLS

	Manufacturer symbol: indicated with name, address
	Serial number
	Year of manufacture
	Conformité Européenne, CE mark, with number of Notified Body involved in the conformity assessment
	Follow the instructions for use (i.e., this user manual)
	Warning sign: warnings apply
	Special waste disposal regulations apply (EU)
	Safety according to class II electrical equipment (IEC 60601-1)
	Applied parts: type BF (IEC 60601-1)
	Applied parts: type CF (IEC 60601-1) <i>(only applicable if on device label)</i>
Rx only	Caution: Federal Law (USA) restricts this device to sale by or on the order of a physician.

APPENDIX D: DATASHEET



Manufacturer: eemagine Medical Imaging Solutions GmbH
Gubener Straße 47
10243 Berlin
Germany

Product Name: eego amplifier

Product Code: EE-211, EE-212, EE-213, EE-214, EE-215 / version 1.2
EE-221, EE-222, EE-223, EE-224, EE-225 / version 1.2

Classification: CE class IIa according to the MDD 93/42/EEC Annex IX

Description: The **eego** amplifier has been designed as a mobile recording device for high-density EEG and other electrophysiological signals. It provides access to recorded data over a USB connection to external software over its signal driver interface. The **eego** amplifier comes with a built-in rechargeable battery for recordings of several hours.

The device provides maximum 64 channels of referential EEG and (optionally) synchronously recorded 24 bipolar input signals.

The **eego** amplifier is used in combination with the **eego** recording software.

An SDK is available for direct amplifier communication.

The implemented active shielding technology protects the EEG inputs from grid interference noise.

Sampling rate and gain can be set through the user interface of the control software.

Product variants:

Product code	Description
EE-211	eego amplifier, 64ch referential, 2kHz
EE-212	eego amplifier, 32ch referential, 2kHz
EE-213	eego amplifier, 16ch referential, 2kHz
EE-214	eego amplifier, 32ch referential, 24ch bipolar, 2kHz
EE-215	eego amplifier, 64ch referential, 24ch bipolar, 2kHz
EE-221	eego amplifier, 16ch referential, 16kHz
EE-222	eego amplifier, 32ch referential, 16kHz
EE-223	eego amplifier, 32ch referential, 24ch bipolar, 16kHz
EE-224	eego amplifier, 64ch referential, 16kHz
EE-225	eego amplifier, 64ch referential, 24ch bipolar, 16kHz

Specifications:

Dimensions (width * depth * height)	160 * 205 * 22 mm
Weight	<500 g
Resolution and input stage	24 bit, true DC input for all channels, one A/D converter per channel
Number of referential channels	64 actively shielded inputs. Separate reference and patient ground
Number of bipolar channels (optional)	24
Input noise (referential)	< 1.0 μV_{RMS} (lowest sampling rate and signal range)
Input impedance (referential)	>1 G Ω
Input signal range (referential)	150 – 1000 mV _{PP} (programmable gain)
Common-mode rejection ratio (referential)	>100 dB
Maximum sampling rate (depends on amplifier type)	16384 Hz (16384/8192/4096/2048/1024/512 and 16000/8000/4000/2000/1000/500 Hz)
Trigger input	8 bit TTL, electrically separated from amplifier
USB output interface	USB, electrically separated from amplifier
Operation time (integrated battery)	up to 5h
Operating temperature	10°C to 40°C
Storage temperature	10°C to 40°C
Transport temperature	-10°C to 50°C
Humidity	30% to 75%
IP class	The enclosure protection class is IP20 according EN60529
Atmospheric pressure	70 kPa to 106 kPa

OS requirements	MS Windows 7 or 8.1 (32bit, 64bit), 32 bit applications only Debian 8.x with g++ 4.9 compiler (32bit, 64bit OS and applications) 2GB RAM working memory USB 2.0 connection for amplifier Control software must be compatible and designed for eego amplifier
PC Compliance	IEC 60950 Compliant EMC Directive 2014/30/EU, the Low Voltage Directive 2014/35/EU, the RoHS Directive 2011/65/EU, the Ecodesign Directive 2009/125/EC, and the Radio Equipment Directive 2014/53/EU where applicable.

Warning:



Proper use of the **eego** amplifier depends on careful reading of all instructions and labels that come with or are present on the device. Incorrect use of the device may cause inaccurate measurements. Non-compliance with warnings and safety regulations may result in severe personal injury and total loss of equipment.

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