INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

Powai, Mumbai 400076

For RFx No.6100000350 (PR No.1000014590)

Technical Specification for Research- Grade Multimodal Bio-signal Electroencephalography

I. **Research-grade multimodal bio-signal EEG amplifier:** The amplifier should have at least 64 channels (should work with the active wet electrodes, passive wet electrodes, and active dry electrodes) to acquire EEG, ECG, EMG, or EOG. And it should have additional 8 passive bipolar channels for bio-potential recording and physiological sensors to measure GSR, pulse, SpO2, respiratory flow, respiratory effort, temperature, snoring, NIBP, acceleration, limb movement, etc. All the necessary hardware, software, and accessories should be supplied to achieve the functionalities mentioned in the items and their descriptions below. At least 15 studies should have been published in reputed international journals by using the quoted amplifier model/version.

1. It should be possible to record 64 channels EEG or 64 channels EMG or in a combination of EEG, ECG, EMG, and EOG.
2. It should be possible to configure each active and passive channel either in unipolar (64 Ch) or in bipolar (32 Ch) configuration.
3. It should be possible to upgrade the amplifier to upgrade the amplifier to 160 channels or more (256 and higher channel count is preferred) for high-density EEG/EMG study.
4. Channel sensitivity should be less than 90 Nano Volts.
5. It should have at least 16 digital input channels and should be compatible to use with a pushbutton trigger, optical trigger sensor, microphone, trigger from TMS system, etc., interface.
6. It should be a real DC coupled amplifier.
7. It should have a USB interface for data transfer to the PC/Laptop.

8. It should have at least a 24-bit dedicated ADC with the sampling rate of at least 10KHz (15KHz and above is preferable) for each channel (in case of 64 Ch).
9. It should support EEG combined with brain stimulation e.g. TMS/tES/tDCS/tRNS/tACS etc.
10. The amplifier should be supplied with appropriate hardware (for active or passive electrodes) that minimizes the TMS artifacts and amplifier related artifacts during the simultaneous EEG and TMS recordings (e.g., discharge artifacts because of a strong electromagnetic field in EEG due to amplifier characteristics and skin/electrode impedance).
11. TMS artifact duration should be mentioned for passive and active electrodes with supporting evidence along with the various TMS pulse intensity.
12. Details on the signal to noise ratio (in RMS) must be provided in the specification sheet with verifiable data.
13. EEG cap must support continuous recording with stable impedance for at least 2 hours.
14. Preferably, the same cap should accommodate all the types of electrodes, such as active wet, passive wet, and active dry electrodes.
15. Both the cap and electrodes should be washable.
16. It should be possible to replace a single electrode if it becomes faulty.
17. It should be possible to access the real-time bio-signal raw data from the amplifier in the platforms such as C, .NET, MATLAB, and python using APIs in the future.
18. The recorded data format must be easily readable and analyzable with major EEG processing toolboxes such as EEGLAB, Fieldtrip, MNE-Python, BrainStorm, SPM, etc.
19. It should be supplied with the software/hardware solution for integrated impedance checks for each channel of active and passive electrodes.

20. It should be supplied with trigger cable from parallel port to digital-in port on the amplifier.
21. It should be supplied with a signal generator for calibration/troubleshooting purposes along with necessary hardware, software, and accessories.
22. It should support hyper-scanning and should be supplied with hardware, software, and accessories to collect data on 2 to 4 participants simultaneously (with supplied amplifier system).
23. It should be supplied with lithium-ion/Li-poly/etc. battery pack for the amplifier (minimum 4 hr backup) along with its charger and connecting accessories. Additionally, a medical-grade/research-grade AC power adapter for the amplifier should be supplied.
24. It should be supplied with 64 active wet electrodes with an additional 6 active wet electrodes for spare and maintenance purposes (Total:70 active wet electrodes) along with ground and reference electrodes.
25. It should be supplied with 64 passive wet electrodes with an additional 6 passive wet electrodes for spare and maintenance purposes (Total:70 passive wet electrodes) along with ground and reference electrodes.
26. It should be supplied with 2 sets of TMS compatible EEG adult caps. Each set should comprise of 3 different cap sizes that fit the head circumferences of small (50-54 cm), medium (54-58 cm), and large (58-62 cm). (Total 6 caps). Chin and chest fastening belts should be supplied.
27. It should be supplied with 1 set of TMS compatible EEG kids cap comprising of 3 different cap sizes that fit the head circumferences of small (32-36 cm), medium (37-43 cm), and large (44-48 cm). (Total 3 caps). Chin and chest fastening belts should be supplied.
28. The GSR physiological sensor should be supplied with the software, along with real-time raw data access.

29. The SpO2 and pulse physiological sensors should be supplied with the software, along with real-time raw data access.
30. The Respiratory Flow physiological sensor should be supplied with the software, along with real-time raw data access.
31. The Respiratory Effort physiological sensor should be supplied with the software, along with real-time raw data access.
32. One quantity of trigger interface hardware along with trigger interface cable (to connect with the amplifier's digital input channel) should be supplied.
    a) Trigger input hardware should accept the high-level inputs (e.g., pushbuttons, etc.), low-level inputs (e.g., microphones, optical sensors, etc.) with a sampling rate of at least 1KHz (1Hz/millisecond).
    b) Four quantities of pushbuttons and four quantities of optical trigger sensors should be supplied.
33. Onsite training and installation should be provided.

II. EEG Acquisition Software

1. The amplifier should be supplied with bio-signal data acquisition and review software with drivers, and necessary add-on components/block-sets to support all the hardware attached to the amplifier.
    a) The acquisition and review software should support the functionality of the software functionality of synchronized recording from camera/s (synchronized recording from multiple cameras is preferred) (USB/PoE).
    b) The acquisition and review software should provide a synchronized and integrated solution to capture EEG, ECG, EMG, GSR, SpO2, pulse, respiration, airflow, etc.
2. The amplifier should be supplied with a real-time processing software interface (SIMULINK/Python-based) with real-time access to bio-signal data acquired by the amplifier.

III. EEG Consumables

1. At least 500 pcs of double-sided adhesive washers should be supplied (to use with the supplied active/passive electrodes for ECG, EMG, and EOG recordings).
2. At least 500 grams of abrasive gel should be supplied (for skin preparation while using the active/passive electrodes for recoding).
3. At least 200 grams of water-soluble, non-abrasive, high viscosity gel should be supplied (for skin preparation while using the active/passive electrodes for recoding).
4. At least 5 Liters of water-soluble, non-abrasive, high viscosity gel should be supplied (for skin preparation while using the active/passive electrodes for recoding).
5. Two quantities of syringe should be supplied (will be used to fill the gel into the active/passive electrode).