

## Specifications for Data Acquisition System, Transducers and Analysis Software for Physiological Signals

### Specifications of Data Acquisition System

The desired specifications for data acquisition system for reliably acquiring physiological signals are:

- **Analog Inputs**
  - **Channels** : 16-channels or more
  - **A/D Resolution** : 16 bits or higher
  - **Accuracy** : 0.5% or higher
  - **Input Impedance** : 1 Mega Ohms or more
- **Analog Outputs**
  - **Channels** : 2-channels or more
  - **D/A Resolution** : 16 bits or higher
  - **Accuracy** : 0.5% or higher
  - **Output Impedance** : 200 Ohms or less
- **Digital I/O Channels** : 16 or more
- **CMRR (Common Mode Rejection Ratio)** : 90 dB (50/60 Hz) or higher
- **Sampling and Buffer**
  - **Sampling Rate** : Maximum of 100 Kilo samples/sec or more
  - **Internal Buffer** : Should have a buffer to support at-least 15 seconds of data.
- **Data Connectivity**
  - **Data transfer rate** : 4 Mega samples/sec or higher.
  - **Interface software** : The acquisition system should export time-stamped output through a user programmable API/SDK. Documentation about the data acquisition system should provide details about the API/SDK. Additional options to connect with standard bridge platforms such as Imotions and/or e-prime should be explicitly mentioned. It is

required to mention about the bridge platforms in the documentation.

- **Connectivity with sensors** : The system should be able to connect readily with various wireless and wired physiological sensors available in the market. In this regard, the following table should be filled.

**Table 1: Make and Models of wireless and wired sensors that can connect readily with the data acquisition system**

Serial Number	Physiological measurement	Wireless Sensor (Make and models)	Wired sensor (Make and models)
1.	Electrocardiography (ECG)		
2.	Electromyography (EMG)		
3.	Electroencephalography (ECG)		
4.	Galvanic skin resistance (GSR)		
5.	Photoplethysmography (PPG)		
6.	Thoracic expansion and contraction while breathing		
7	Electrooculogram (EOG)		
8	Skin temperature		
9	Electrogastrogram (EGG)		

- **Operating Conditions**
  - **Temperature** : 5° – 45° Celsius
  - **Humidity** : 0 – 90 %
- **Operating System** : Windows 10 or higher
- **Power Options** : Powered via external source using AC power adapter. The AC power adapter, if provided, should be compatible to standard

Indian power system specification (230 V AC, 50 Hz frequency).

- **Safety Certification** : Should comply with standard IEC 60601-1. Details of the certification should be provided.
- **Documentation** : A detailed document providing information about dimension, weight, power consumption, connectors, power options and processing (such as buffers, sampling rate, channels etc.,) should be provided.
- **Accuracy and Precision** : Detailed documentation establishing the accuracy and precision of the system should be provided.
- **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace (like in industries, nuclear plants, pilots, air traffic controllers etc.,).

### **Transducer for measuring galvanic skin resistance (GSR)**

The desired specifications of the transducer (including electrodes and amplifier) for measuring galvanic skin resistance are:

- **Resolution** : 0.5% after connecting the transducer with the data acquisition system (specification of the acquisition system is provided above)
- **Bandlimits** : up-to 5 Hz or higher
- **Accuracy** : 5% or higher
- **CMRR (Common Mode Rejection Ratio)** : 90 dB (50/60 Hz) or higher
- **Filter** : Should have filter options to performing filtering of data
- **Zeroing and Offset** : Automatically controlled by software or other means

- **Accessories** : The transducer should include necessary accessories such as wireless transmitter, wireless receiver, electrodes, clips, gels etc., (if required) for use with the transducer
- **Connectivity** : Should be compatible and have wireless connectivity with the data acquisition system (specifications of the data acquisition system is mentioned above). The range of wireless system used should at-least support reliable data transmission within a standard room of size 15 ft x 15 ft. Documentation on wireless connectivity along with range should be provided
- **Data transfer rate** : Should be able to communicate with the data acquisition system (specifications mentioned above) at 1000 Hz or higher
- **Operating Conditions**
  - **Temperature** : 5° – 45° Celsius
  - **Humidity** : 0 – 90 %
- **Operating time** : Should support continuous operation of 12 hours or more
- **Safety** : Should comply with IEC60601 standards. Details of the certification should be provided
- **Documentation** : A detailed document providing information about dimension, weight, power consumption, connectors, power options and processing (such as buffers, sampling rate, channels etc.,) should be provided.
- **Accuracy and Precision** : Detailed documentation establishing the accuracy and precision of the system should be provided.
- **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace (like in industries, nuclear plants, pilots, air traffic controllers etc.,).

## Transducer for photoplethysmography (GSR)

The desired specifications of the transducer (including electrodes and amplifier) for photoplethysmography (PPG) are:

- **Resolution** : 0.5% after connecting the transducer with the data acquisition system (specification of the acquisition system is provided above)
- **Bandlimits** : up-to 5 Hz or higher
- **Accuracy** : 5% or higher
- **CMRR (Common Mode Rejection Ratio)** : 90 dB (50/60 Hz) or higher
- **Filter** : Should have filter options to performing filtering of data
- **Zeroing and Offset** : Automatically controlled by software or other means
- **Accessories** : The transducer should include necessary accessories such as electrodes, clips, gels etc (if any) for use with the transducer
- **Connectivity** : Should be compatible and have wireless connectivity with the data acquisition system (specifications of the data acquisition system is mentioned above). The range of wireless system used should at-least support reliable data transmission within a standard room of size 15 ft x 15 ft. Documentation on wireless connectivity along with range should be provided
- **Data transfer rate** : Should be able to communicate with the data acquisition system (specifications of the data acquisition system is mentioned above) at 1000 Hz or higher
- **Operating Conditions**
  - **Temperature** : 5° – 45° Celsius
  - **Humidity** : 0 – 90 %
- **Operating time** : Should support continuous operation of 12 hours or more
- **Safety** : Should comply with IEC60601 standards. Details of the certification should be provided
- **Documentation** : A detailed document providing information about dimension, weight, power consumption, connectors, power options and processing (such as buffers, sampling rate, channels etc..) should be provided.

- **Accuracy and Precision** : Detailed documentation establishing the accuracy and precision of the system should be provided.
- **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace (like in industries, nuclear plants, pilots, air traffic controllers etc.,).

### **Transducer for Electrocardiography (ECG)**

The desired specifications of the transducer (including electrodes and amplifier) for electrocardiography (ECG) are:

- **Resolution** : 0.5% after connecting the transducer with the data acquisition system (specification of the acquisition system is provided above)
- **Bandlimits** : up-to 100 Hz or higher
- **Accuracy** : 5% or higher
- **CMRR (Common Mode Rejection Ratio)** : 90 dB (50/60 Hz) or higher
- **Filter** : Should have filter options to performing filtering of data
- **Zeroing and Offset** : Automatically controlled by software or other means
- **Accessories** : The transducer should include necessary accessories such as electrodes, clips, gels etc (if any) for use with the transducer
- **Connectivity** : Should have a wireless connectivity with data acquisition system. The range of wireless system used should at-least support reliable data transmission within a standard room of size 15 ft x 15 ft. Documentation on wireless connectivity along with range should be provided
- **Data transfer rate** : Should be able to communicate with the data acquisition system (specifications mentioned above) at 1000 Hz or higher

- **Operating Conditions**
  - **Temperature** : 5° – 45° Celsius
  - **Humidity** : 0 – 90 %
- **Operating time** : Should support continuous operation of 12 hours or more
- **Safety** : Should comply with IEC60601 standards. Details of the certification should be provided
- **Documentation** : A detailed document providing information about dimension, weight, power consumption, connectors, power options and processing (such as buffers, sampling rate, channels etc.,) should be provided.
- **Accuracy and Precision** : Detailed documentation establishing the accuracy and precision of the system should be provided.
- **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace like in industries, nuclear plants, pilots, air traffic controllers etc.,).

**Transducer for measuring extremely rapid respiratory effort variations**

The desired specifications of the transducer (including electrodes and amplifier) for measuring extremely rapid respiratory effort variations are:

- **Resolution** : 0.5% after connecting the transducer with the data acquisition system (specification of the acquisition system is provided above)
- **Bandlimits** : up-to 5 Hz or higher
- **Accuracy** : 5% or higher
- **CMRR (Common Mode Rejection Ratio)** : 90 dB (50/60 Hz) or higher
- **Filter** : Should have filter options to performing filtering of data

- **Zeroing and Offset** : Automatically controlled by software or other means
- **Accessories** : The transducer should include necessary accessories such as electrodes, clips, gels etc (if any) for use with the transducer
- **Connectivity** : Should have a wireless connectivity with data acquisition system. The range of wireless system used should at-least support reliable data transmission within a standard room of size 15 ft x 15 ft. Documentation on wireless connectivity along with range should be provided
- **Data transfer rate** : Should be able to communicate with the data acquisition system (specifications mentioned above) at 1000 Hz or higher
- **Operating Conditions**
  - **Temperature** : 5° – 45° Celsius
  - **Humidity** : 0 – 90 %
- **Operating time** : Should support continuous operation of 12 hours or more
- **Safety** : Should comply with IEC60601 standards. Details of the certification should be provided
- **Documentation** : A detailed document providing information about dimension, weight, power consumption, connectors, power options and processing (such as buffers, sampling rate, channels etc..) should be provided.
- **Accuracy and Precision** : Detailed documentation establishing the accuracy and precision of the system should be provided.
- **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace (like in industries, nuclear plants, pilots, air traffic controllers etc..).

## Software for analyzing data from physiological sensors

The specifications of the analysis software to analyze data from various physiological sensors are:

- **GSR and PPG Analysis** : The analysis software should be able to acquire GSR and PPG signals from the data acquisition system and contain automated routines to perform the following:
  - Identify skin conductance resistances
  - Construct Phasic GSR Waveform from Tonic Waveform
  - Event related GSR analysis. Should allow to perform multiple stimuli analysis. Markers should also be inserted by stimulus presentation programs such as E-Prime or SuperLab
  - Provide PPG data
  - Provide real-time view of raw and filtered GSR and PPG data
- **ECG analysis** : The analysis software should be able to acquire ECG signal from the data acquisition system and contain automated routines to perform the following:
  - Identify ECG complex boundaries
  - Perform ECG waveform boundary detection for human
  - Locate QRS complex
  - Should allow to perform multiple stimuli analysis. Markers should also be inserted by stimulus presentation programs such as E-Prime or SuperLab
  - Identify the type of heartbeat event (such as normal or abnormal)
  - Calculate Heart rate variability. Option to choose software filters (such as Hamming, Hanning etc.,) should be provided.
  - Provide real-time view of raw and filtered ECG data
- **Respiratory data analysis** : The analysis software should be able to acquire respiratory data from the data acquisition system and contain automated routines to perform the following:
  - Pulmonary resistance and pulmonary compliance
  - Should allow to perform multiple stimuli analysis. Markers should also be inserted by stimulus presentation programs such as E-Prime or SuperLab

- Basic airflow measures
  - Pulmonary airflow analysis
  - Identify the type of heartbeat event (such as normal or abnormal)
  - Calculate Heart rate variability
  - Provide real-time view of raw and filtered respiration data
- **Time synchronization** : The analysis software should allow for time synchronization of GSR, PPG, ECG and respiration data. It should also allow for analysis of data from these transducers (GSR, PPG, ECG and respiration data) based on common events.
  - **Provision for performing analysis of other physiological signals** : It is desirable to have a software that can analyze various physiological signals mentioned in Table 1 apart from ECG, GSR, PPG and respiratory data.
  - **Validity of License** : The analysis software should have a validity of 10 years of more.
  - **Documentation** : A detailed document providing information about the software use for acquiring various signals, data processing along with information about routines used should be provided.
  - **Prior Expertise** : Vendors must have sufficient experience in supplying this data acquisition system to reputed Indian organizations for research purpose. Details of the Purchase Order (P.O.), contacts of the organization along with performance certificate from the end users (reputed Indian Organizations) for the system (if available) should be provided. We will reserve the right to speak to the customers in order to confirm their experience with respect to the performance of the equipment. Experience of the end users will also be used as a criterion for the selection of bids that meet technical requirements. Specifically, we expect details about deployment of the system for use of monitoring humans in their workplace (like in industries, nuclear plants, pilots, air traffic controllers etc.,).