

### What are ABRs?

Auditory Brainstem Responses are potential differences generated when a person's ear is stimulated with any kind of sound wave; stimulus that may be provided via air conduction or bone conduction. The potential difference originates in the VIII cranial nerve and the auditory brainstem system. These potential differences can be evoked using controlled stimulation, allowing acquisition of these differences by averaging the acquired signal over a specified period of time. The ABR response is commonly found between one and fifteen milliseconds from the time of stimulation.

The waveforms acquired will contain certain peaks and valleys. A standard ABR waveform will contain seven peaks, some more identifiable than others, peak five being the most prominent. The amplitudes, latencies, and relationship between those peaks and valleys can be used to diagnose certain pathological conditions. ABR responses are most commonly acquired using surface electrodes.

### Why use Bone Conduction?

Patients with certain auditory conditions, particularly those affecting the external and middle ear, may be difficult to test using standard air conduction stimulation. To bypass problems with external and middle ear, such as ear canal occlusion in newborns, it is necessary to use bone conduction. Vibration applied to the mastoid can deliver equivalent stimulation to that of the insert earphones. However, bone conduction is limited in the range of test frequencies and intensities that it can supply.

Bone Conduction testing can help determine the amount and type of hearing loss at specific frequencies, (i.e. hearing threshold), and the presence of any air-bone gap. ABR Bone Conduction testing can provide information about existing conductive hearing problems in the ear canal or middle ear.

### Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient lies down on a comfortable bed. It is recommended to have the patient relax or sleep to reduce the amount of artifact. Electrodes and Bone Conductor may be placed in the following configuration:

- **Inverting (-):** ipsilateral ear lobe.
- **Non-Inverting (+):** high forehead; joined using a Y-Adapter for 2 channel setups.
- **Ground:** low forehead.
- **Bone Vibrator:** high on the temporal bone, ipsilaterally.

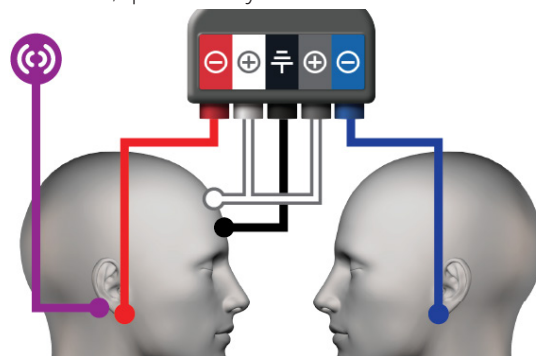


Fig.1 - Right ear test - 2 channel setup for Duet

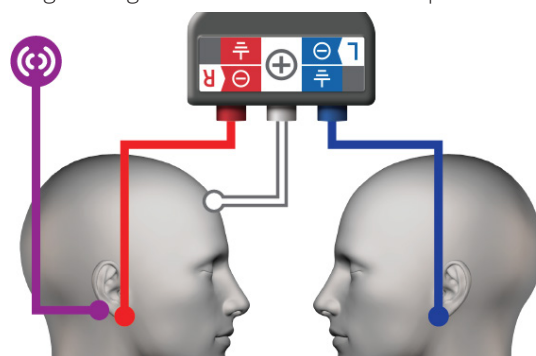


Fig.2 - Right ear test - 1 channel setup for Aria

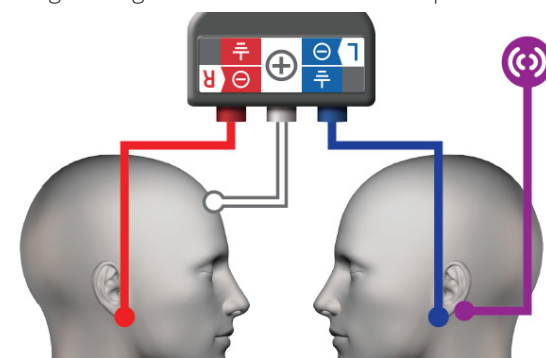


Fig.3 - Left ear test - 1 channel setup for Aria.

The Bone Vibrator unit must be switched between the left and the right temporal bone or mastoid. A contralateral offset masking, of usually 40 dB above stimulation level, may also be provided using insert earphones.

For the USB and USB Jr. platforms, follow the same dual or single channel setup for the Aria or Duet as applicable, keeping in mind the polarities of the electrodes.

## Electrode Usage

Surface electrodes are sufficient for acquiring ABR waveforms. Clean and prepare electrode pacing sites in order to reduce the impedance and acquire a clearer waveform. If testing an infant with small forehead using a two channel setup, you may place the ground electrode to one side, instead of Fpz.

## Setting up SmartEP

SmartEP from Intelligent Hearing Systems has built-in functionality to acquire Bone Conduction ABR. The software may be setup with a few clicks of the mouse. Complete the following steps in the order outlined, use the test settings that fit your testing requirements or use the recommended settings shown on the next section:

1. From the main menu, select [**PROTOCOL > MODALITY > AUDITORY > ABR**].
2. Click on the [**AMPLIFIER**] button in the side panel and set the filters, notch filter, artifact rejection ratio and region, and desired amplification for each channel, as necessary.
3. Click on the [**STIM**] button in the control panel and select the appropriate stimulus to be applied. Keep the window open.
4. Turn ON and set the desired masking level, if necessary, usually 40 dB above stimulus.
5. Select "Bone Vibrator" from the stimulator options and click [**OK**] to close the dialog box. You may save your settings for future use with the [**SAVE**] button on the Control Panel.

Carefully select your filter settings in the EEG and Amplifier dialog box. Lack of filtering may result in excessive artifact, excessive filtering may result in waveforms that are too smooth to assess correctly. EEG and Amplifier settings may need to be adjusted more than once.

## Suggested Parameters

This is a general guideline for acquisition of bone conduction responses. It is recommended to acquire 2 to 4 waveforms to properly assess repeatability of the response.

- **Stimulus:** Click or Blackman tone with a frequency of 500 Hz, 1 kHz, 2 kHz, or 4 kHz.
- **Duration:** 0.1 milliseconds for click; 5 cycles for tones.
- **Masking:** recommended; use a value of "40", set the level option to "tracking", and activate the "contralateral" check box.
- **Transducers:** bone conductor.
- **Masking Transducer:** insert earphones.
- **Rate:** 11.7 or 7.1 per second, use slower rate used to enhance wave I. Faster rates such as 39.1 per second can be used to speed up the acquisition.

- **Polarity:** alternating, to reduce stimulus artifact.
- **Intensity:** 55 to 60 dB HL.
- **Filters:** 100 - 3000 Hz for Adults, 30 - 3000 Hz for infants; can reduce the low-pass to 1500 Hz for smoother waveforms.
- **Notch Filter:** OFF; turn ON only when power line noise is present.
- **Amplification (gain):** 100K.
- **Time:** 50.0  $\mu$ s
- **Analysis Time window:** 0 - 25.6 milliseconds.
- **Sweeps:** 1024.
- **Electrode Placement:** ipsilateral array.

## Marking Peaks

To help you diagnose a condition accurately, you should first place the applicable labels on the recently acquired waveform in one of the following ways. Select the waveform and then, either:

- Click on the button corresponding to the label you wish to place from the SmartEP tool bar. The label button will turn red. Click again on the general area where the label is to be placed.
- Right click at the point of the waveform where the label is to be placed. From the pop-up menu, mouse over the [**MARK PEAK**] option. Then, select label to be placed (III, V, etc).

Once the label is on the waveform, drag the top marker of the labels to the appropriate place if needed. To obtain an amplitude, move the bottom marker to its appropriate location, usually the next peak or valley. Label markers may also be moved using keyboard shortcuts (see the SmartEP user manual for details)

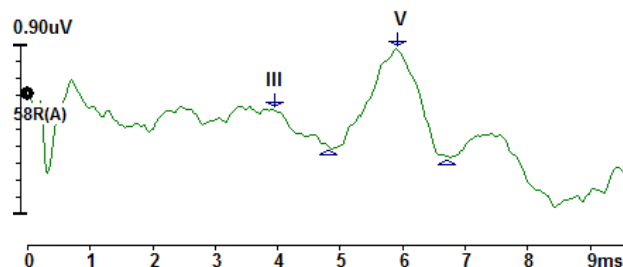


Fig.4 - Sample click bone conduction waveform

The graph shows suggested label placement for an acquired Bone conduction ABR.

## Analysis

Select [**PRINT PAGE**] or [**PRINT ALL PAGES**] from the SmartEP main menu to print a report of the currently displayed waveforms. See the SmartEP manual for other report generation options.

Since label placement is subjective, all results must be evaluated by an audiologist or medical professional trained in ABR techniques.