

What is a 40 Hz response?

The 40 Hz response is an event related evoked potential similar to middle latency responses. It is usually considered to be a steady state response due to its periodic repetition. The response resembles a sinusoid with 25 millisecond duration and, when successfully recorded, it is usually robust in nature; usually having amplitudes larger than 1 μ V.

Definition of the parts of the auditory system that contribute to this response is still unclear. Although still in question, it has been speculated that the response originates within the polysensory areas of the thalamus and/or in the auditory cortex.

The large amplitude of the response and its close relationship to behavioral thresholds make the procedure an ideal candidate for hearing threshold search, without the need of patient response. However, the presence of the response is related to patient state; the response is not found in patients that have been sedated, taking medications, or that are not in an alert state. In addition, young patients may have a response at slower rates, making the acquisition parameters age dependant. All this variability has made the recording of 40 Hz responses unreliable, especially when testing young children.

At this time, there are no widely used markings or nomenclature for the acquired recordings; the common goal is simply to look for the presence of a response. The responses are usually acquired using clicks or tone bursts; and displayed on a 100 millisecond scale, which allows the display of 4 stimulus cycles.

Electrode Usage

Surface electrodes are sufficient for acquiring 40 Hz recordings. Clean and prepare electrode pacing sites in order to reduce the impedance and acquire a clearer recording. You must use pediatric electrodes with infants.

Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient sits up on a comfortable chair. The patient must be instructed to remain alert during testing. It is recommended that the patient avoid stimulants or any prescription drugs before testing. For 40 Hz acquisition, electrodes may be placed in the following configuration:

- **Inverting (-)** : Red electrode positions to their corresponding mastoids or ear lobes.
- **Non-Inverting (+)** : joined Blue electrode positions to high forehead, or vertex, using a Y-adapter.
- **Ground**: low forehead.

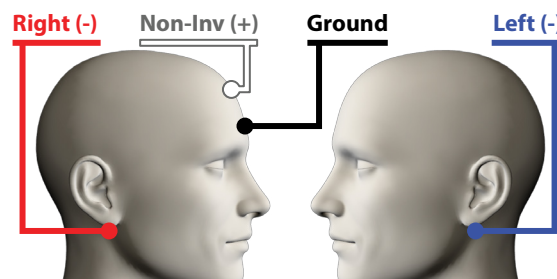


Fig.1 - Dual channel setup for Duet.

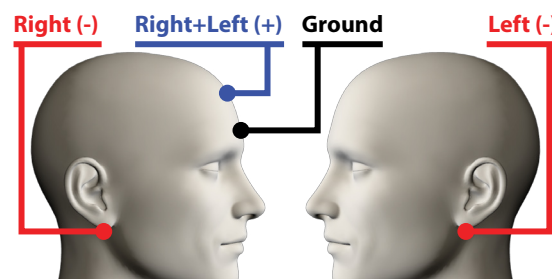


Fig.2 - Dual channel setup for USB and USB Jr.

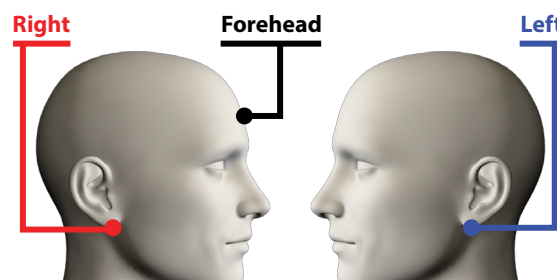


Fig.3 - Single channel setup for USB and USB Jr.

Acquiring 40 Hz with SmartEP

40 Hz response acquisition is a built-in standard function of SmartEP. A few clicks of the mouse will allow you to start 40 Hz acquisition. You may load a pre-existing settings file by clicking the **[LOAD SETTINGS]** button from the control panel; or complete the following steps to set the parameters manually:

1. From the SmartEP main menu, select **[PROTOCOL > MODALITY > AUDITORY > MLR]**. This option will apply the necessary settings and scales to start acquisition.
2. Click on the **[AMPLIFIER]** button from the SmartEP side panel and set the low pass filter, high pass filter, notch filter, desired amplification and artifact rejection ratio and region for each channel, as necessary.
3. Click on the **[STIM]** button on the SmartEP control panel and click on "File", choose the file named "40HZRESP" from the "Stim_EP" folder. Click **[OK]** to close the window and confirm the stimulus settings.
4. On the control panel, set the rate, phase, mode and sweeps as needed.
5. Click on the **[ACQUIRE]** button on the control panel to start acquiring for the selected ear.

For tone burst stimulus, choose one of the other available 40 Hz files in the 'Stim_EP' folder. Make sure to carefully select your filter settings in the EEG and Amplifier dialog box. Lack of filtering may result in excessive artifact, while excessive filtering may result in waveforms that are too smooth to assess. EEG and Amplifier settings may not need to be adjusted more than once. To acquire rates other than 40 Hz, you will need to create your own stimulus files using the Stimulus Generation Utility.

Recommended Test Settings

Use these settings as a guideline for acquisition. It is recommended to run the test 2 to 4 times.

- **Stimulus:** 40Hzresp file that was provided with the system.
- **Rate:** Around 10/sec. The stimulus file contains four clicks with a 25 millisecond repetition.
- **Polarity:** rarefaction.
- **Transducers:** insert earphones.
- **Intensity:** From 70 dB HL and down for threshold search.
- **Masking:** none.
- **Filters:** 10 to 1500 Hz for structured waveforms, 10 to 300 Hz for smoother waveforms.
- **Notch Filter:** OFF, ON only when there is excessive electrical noise.

- **Amplification:** 100K.
- **Sweeps:** 512.
- **Electrode Montage:** Ipsilateral Array
- **Plot Start and End:** From 0 to 100 milliseconds, start earlier to see pre-stimulus region.

Analysis

The cursors built into SmartEP can be helpful to identify the structure of the response. To turn on the cursors, from the main menu choose **[SHOW > CURSORS]**; then using the small round handle at the bottom of the cursor, drag them to the observed peaks. Once both cursors are in place, the right most one will show the difference between the markers including a Hz value in parenthesis (see Fig.4). This value should be close to 40 Hz, reflecting a response to the presented stimulus.

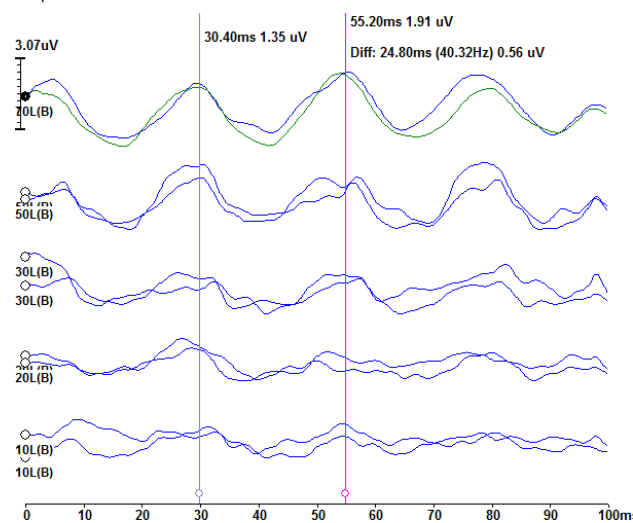


Fig.4 - Sample 40 Hz responses.

You may label on the recently acquired recording for your convenience. To do so:

1. Right click at the point of the recording where the label is to be placed.
2. From the popup menu, select the "Mark Other Peak" option.
3. Select an existing label or enter a new label marker.
4. Once placed, drag the top and bottom markers of the labels to the desired placement.

Select "Print Pages" or "Print Page" from the SmartEP main menu to print a report of the currently displayed signals. See the SmartEP manual for other report generation options. All results must be evaluated by an audiologist or medical professional trained in 40 Hz acquisition and evaluation techniques.