LISTEN INC

**Transforming Sound into Knowledge**

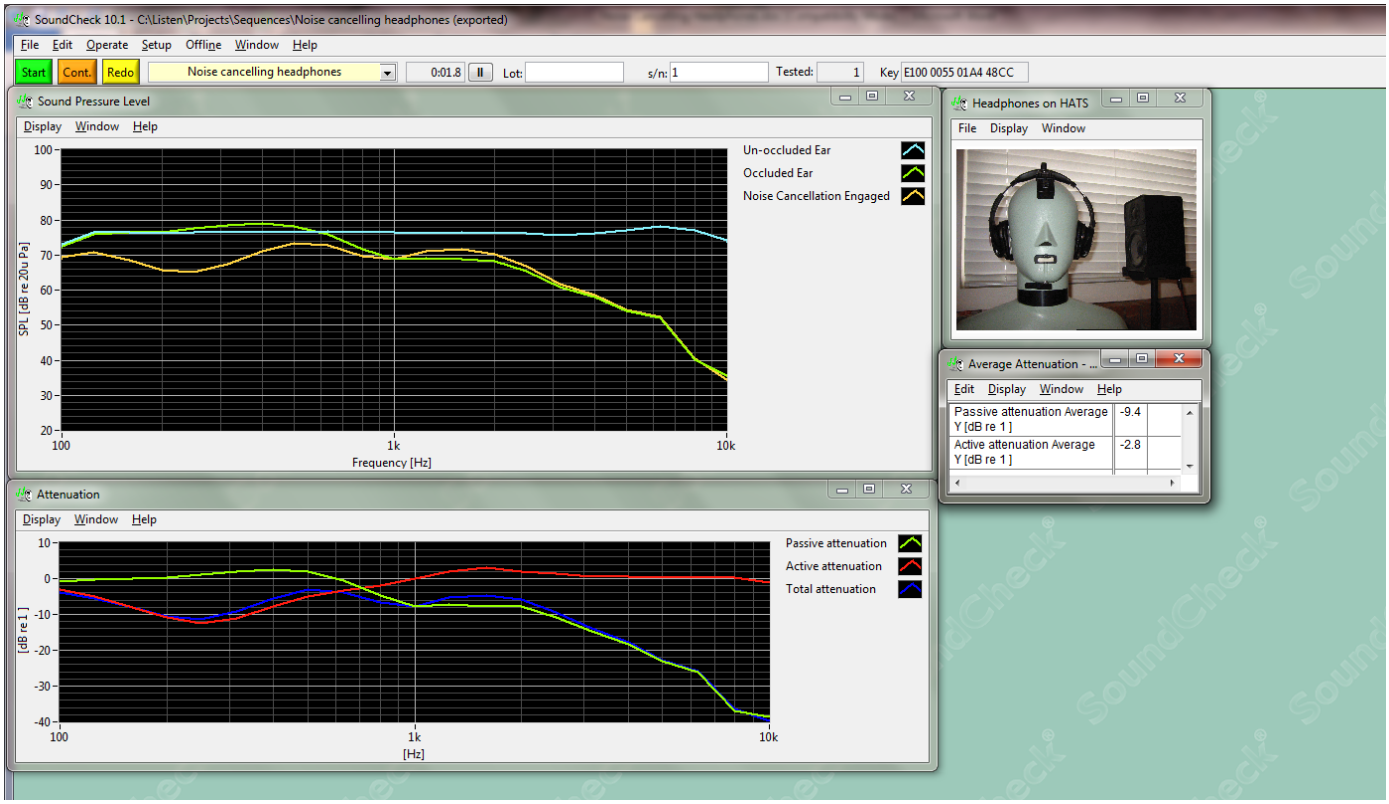
Sequence Note

# Noise Cancelling Headphones

## Introduction

When measuring noise cancelling headphones there are three important pieces of data to generate. Passive Attenuation is the amount of noise that is reduced at the ear simply by the headphones being worn. Active Attenuation is the amount of noise that is further reduced by turning on the device's active cancellation feature. Lastly, Total Attenuation is the combined reduction in noise from passive and active sources, and is what the end user of the product will experience.

To calculate these metrics this sequence performs three separate measurements using a Head and Torso Simulator and a small speaker which serves as a noise source. The alternative to using the small speaker would be to develop a diffuse environment with multiple speakers playing uncorrelated noise. This is a far more complicated arrangement and would require additional steps in the sequence.




**Final Display for *Noise Cancelling Headphones* sequence**

The sequence begins with an option to load example data from disk. If the user selects 'No' a message will appear instructing the user to leave the HATS ears open with no headphones in place. A 10 second pink noise signal is played through the loudspeaker, and the signal at the HATS ear is analyzed with an RTA analysis step. This 1/3rd octave spectrum is called the Un-occluded ear measurement. Next the user is prompted to place the headphones on the HATS but leave the noise cancellation turned off. The pink noise signal is once again played, and the RTA spectrum is called the Occluded ear measurement. Finally the user is instructed to turn on the headphones' noise cancellation, and a third round of the pink noise is played. This final RTA spectrum is called Noise Cancellation Engaged.

These three measurements comprise the raw data in dBSPL versus frequency. Since the speaker has not been calibrated, these spectra will include the response of the speaker. This is not a problem, as the attenuation parameters are all relative calculations based on the three measurements. Passive attenuation is the difference between the occluded and un-occluded measurements. Active attenuation is the difference between the occluded ear and noise cancellation engaged measurements. And lastly, the Total attenuation is the difference between the un-occluded ear measurement and the noise cancellation engaged measurement.

Two graphs are displayed at the end of the sequence showing both the three original measurements and the three calculations derived from the measurements. A table also displays the average of the passive and the active attenuation curves.

## Requirements

*Software:*

- SoundCheck 10.1 or newer
- p/n 2017 – Stimulus editor
- p/n 2005 – RTA
- p/n 2004 – Post Processing

*Hardware:*

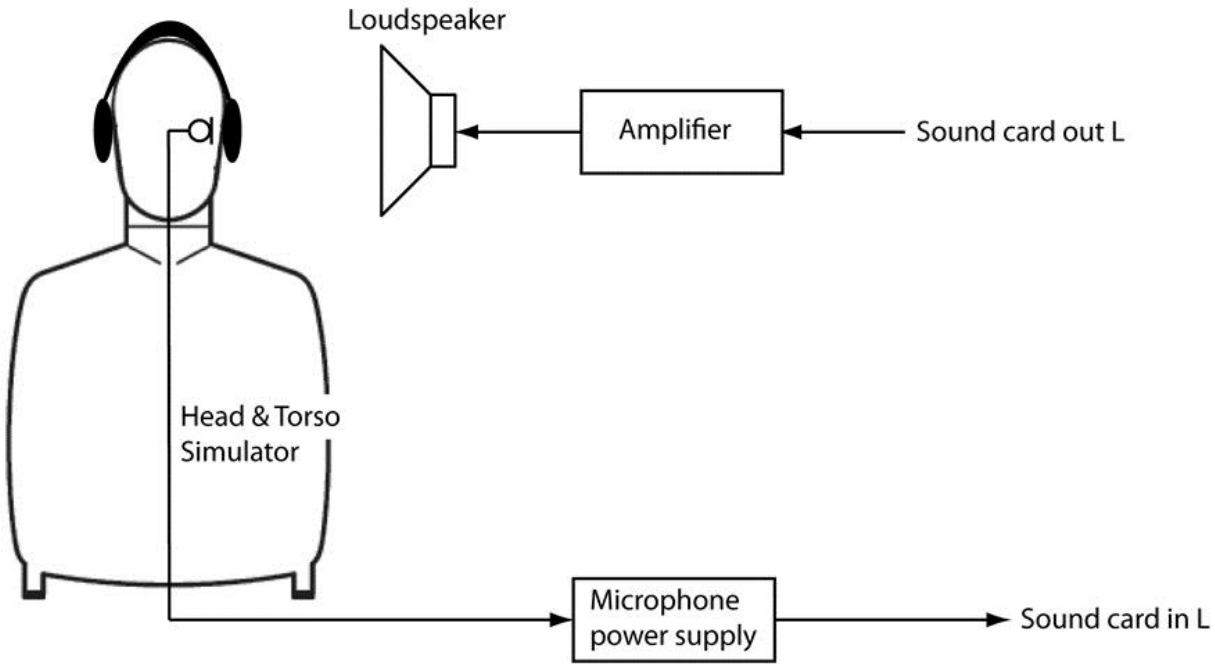
- HATS (B&K 4128 or equivalent)
- Small full range loudspeaker
- p/n 4020 – Listen SoundConnect microphone power supply
- Crown D-45 power amplifier (or equivalent)

## Hardware Setup & Calibration

1. Calibrate the amplifier that the loudspeaker will be connected to as instructed in the SoundCheck manual.
2. Calibrate the HATS ear instructed in the SoundCheck manual.
3. Connect the channel 1 (or Left) output of your soundcard to the input of the amplifier.
4. Connect the output of the amplifier to the loudspeaker.
5. Position the loudspeaker about 1 foot away and pointed directly at the HATS' left ear
6. Connect the output of the mic supply to the channel 1 (or Left) input of your soundcard.

You are ready to start the sequence.

## System diagram



## Sequence Logic

| Type | Step Name | # | Out | In | |
|---|---|---|---|---|---|
| | (Overall sequence) | | | | |
| Har | Hardware Default | | | | |
| Cal | HATS | | | | |
| Mes | Recall data | 1 | | | |
| | display step | | | | |
| | jump on fail to # 3: Unoccluded ear | | | | |
| | overwrite curves | | | | |
| Rec | Recall curves | 2 | | | |
| | jump on pass to # 15: Curve division | | | | |
| Mes | Unoccluded ear | 3 | | | |
| Sti | Pink Noise | 4 | Noise Speaker | | |
| Acq | Play & Record | 5 | Noise Speaker | HATS Ear L | // Measures un-occluded ear |
| Ana | RTA | 6 | | | |
| Lim | Test for Signal | 7 | | | |
| Mes | No Acoustical Signal | 8 | | | |
| Mes | Occluded ear | 9 | | | |
| Acq | Play & Record | 10 | Noise Speaker | HATS Ear L | // Measures occluded ear |
| Ana | RTA | 11 | | | |
| Mes | Noise cancelling circuit on | 12 | | | |
| Acq | Play & Record | 13 | Noise Speaker | HATS Ear L | // Measures with Active Noise Cancellation engaged |
| Ana | RTA | 14 | | | |
| // The post processing steps below calculate | | | | | |
| // the attenuation parameters from either the | | | | | |
| // recalled data or the measured data. | | | | | |
| Pos | Curve division | 15 | | | // Calculate Passive Attenuation |
| Pos | Curve Average | 16 | | | |
| Pos | Curve division | 17 | | | // Calculate Total Attenuation |
| Pos | Curve division | 18 | | | // Calculate Active Attenuation |
| Pos | Curve Average | 19 | | | |
| Dis | Noise cancelling headphones | 20 | | | |

## Further sequence development

Ways in which you could modify or further develop the sequence include:

- If the loudspeaker serving as the noise source has a relatively flat output, you could calibrate the speaker itself and equalize the noise so that the RTA spectrum at the ear is flat for the un-occluded measurement.
- The entire setup could be modified to work with a diffuse, multi-speaker configuration.
- In a diffuse environment or with two speakers, both ears could be measured at the same time.