Electronics

External Audience Protocol (EAP) - Headphones

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Headphones Test Protocol:

Headphones allow consumers to privately listen to music, TV programs, movie soundtracks, and audiobooks via portable devices (such as smartphones, tablets, and laptops) or home audio systems. Depending on the headphone and the audio source device, headphones can be connected by a wire, or wirelessly via Bluetooth or some other means. Some headphone models offer an electronic noise cancellation feature that can be used to reduce the amount of ambient noise heard by the wearer in high noise situations, such as airline travel. The noise cancellation can be used with or without an audio program playing in the headphones. Headphones in today’s market come in many styles; some place a high priority on size for ease of portability, possibly at the expense of sound quality, while others focus on sound quality, possibly at the expense of portability.

The purpose of this project is to aid the consumer in finding the best headphones for their application. To that end we evaluate the ability of headphones to accurately reproduce audio content, and in the case of types with a noise cancellation feature, the ability to reduce ambient noise. We also comment on design features that affect comfort and ease of use.

What industry standards are being used to guide the structure or content of this protocol?

Our tests are not patterned after any particular industry standard. However our listening and noise cancelation assessments do reflect some elements of an IEC and an ISO standard respectively. For our listening assessments that standard is IEC 60268-7 ed 3.0: Sound System Equipment Part 7 – Headphones and Earphones. Differences include the use of multiple reference samples to characterize different levels of sound quality, and the use of high quality wide band music and spoken word program material rather than a simulated program signal (a filtered pink noise signal as described in IEC [60268-1]) for listening assessments. For our noise cancelation assessments that standard is ISO 4869-1: Acoustics – Hearing Protectors – Part 1: Subjective Method for the Measurement of Sound Attenuation. Differences include the use of two panelists rather than sixteen, the use of a single wide band pink noise test signal played at a high volume level rather than seven or eight separate filtered pink noise test signals with different center frequencies played at high volume levels, and the use of a non-diffuse sound field test environment.

Group Procedure:

This Group Test Procedure consists of six individual Test Procedures that will contribute to generating headphone ratings. They describe the processes for cataloging features, evaluating specific scored attributes relating to performance, and evaluating specific non-scored attributes
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that will result in useful comments. The test procedures are as follows:

1. Pedigree

2. Listening Assessment

3. Noise Canceling Assessment

4. Fit/Use Assessment

5. Sensitivity

6. Wireless Range

Pedigree Procedure:

The pedigree is used to catalog headphone specifications and features. Specific headphone feature and specification information is recorded. This information is obtained from either the product instruction manual, product packaging, product inspection, product operation, or the manufacturer’s website. Some (but not all) of these specifications and features are listed and/or commented on in the ratings so that consumers can see which models have features that are of interest to them. This information is not scored.

Listening Assessment Procedure:

Listening assessments are conducted to describe and score headphone sound quality (ability to accurately reproduce audio content). Trained panelists perform listening assessments by comparing each test model to known reference models while listening to high quality music recordings with known sonic characteristics. The test model’s sonic characteristics are described, and its level of sound quality is scored with respect to the reference models. In cases where a headphone has more than one operational mode (example Bluetooth and cord connected), each mode is assessed.

Audio Quality Expectations

A system may have user-adjustable or non-adjustable audio controls. Some of these controls, such as bass and treble controls, tone presets, multi-band graphic equalizer, and/or a “direct” (circuit bypass and/or tone control bypass) setting, can be used to adapt the system to the listening environment to achieve the flattest frequency response or theoretically provide the clearest sound possible for that system; they can also be used to adjust the system frequency response to user taste. Other controls, such as DSP reverberant field effects, stereo to multi-channel matrixing, simulated surround sound, and 3-D sound, can be used to add enhancement to the original audio program which users may, or may not desire.
At CR, the audio test process is designed to determine the baseline fidelity of audio reproduction to the original source for a given audio system. This means turning off, if possible, all audio enhancement modes, and, if needed, using any provided frequency response adjustment controls (which includes any “direct” setting switch) to achieve the best combination of clearest sound and flattest frequency response for the system under test in our test environment. The systems under test are sequentially compared to reference audio systems that represent various standards of quality. The characteristics that we look for when assessing audio quality are as follows:

- **Clarity and detail** - Ideally notes should be distinct and clean, there should be a sense of space between instruments and voices, complex musical lines and vocal harmonies shall maintain their richness and detail and should not sound homogenized, and the recording site ambience should be clearly evident and unique - different recordings should have distinctly different ambient sounds.

- **Frequency response** - Ideally the reproduced frequency response should be flat throughout the entire audible frequency range. Bass should be extended (no low bass roll-off), and should have a solid quality that is not thumpy, boomy, thuddy, etc. The midrange should be full and smooth, and should not sound nasal, thin, gritty, etc. Treble should be extended (no high frequency roll-off) and smooth, and shall not sound peaky, sizzly, etc.

- **Spatial image placement (vertically, laterally, and depth)** - Ideally the system should provide a stereo sound stage that has a reasonable sense of height, width, and depth; The placement of instruments and voices in the sound stage shall be realistic and consistent with the placement found with the betterreference systems.

- **Dynamics** - The dynamics of the audio program shall not be noticeably compressed or exaggerated.

- **Freedom from obvious distortion at reasonable volume levels** - This includes electrically based distortions (such as clipping, intermodulation, etc.) and mechanically based distortions (such as voice coil rubbing, speaker cabinet buzzing, etc.).
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Audio Tests

Subjective Audio Tests:

Select tracks from commercially available uncompressed audio CD quality (44.1kHz/16 bit) or higher program material are used in testing. Each “test track” has particular audio content (i.e. deep bass with a resonate quality, detailed delicate treble, midrange with complex instrumental and vocal layering, natural recording site ambience, artificially added echo, dry multi-tracked recording space, complex sound mix, etc.) that is used to characterize the test system’s performance and rank it in comparison to the reference systems. A group of trained listeners assesses the audio performance of the systems for the test tracks based on the characteristics listed under the Audio Quality Expectations section above.

Noise Canceling Assessment Procedure:

Noise canceling assessments are only conducted on models that have an active noise-canceling feature. This assessment is used to describe and score an active noise-canceling headphone’s ability to reduce ambient (extraneous environmental) noise. Trained panelists perform ambient noise reduction assessments by comparing the test model to reference models while in a controlled high volume-level wideband ambient noise environment. The test model’s ambient noise reduction characteristics are described, and its level of ambient noise reduction is scored with respect to the reference models. In cases where a headphone has more than one noise canceling mode (example: high, medium, and low), the highest noise canceling mode is assessed.

Fit/Use Assessment Procedure:

Fit/use assessments are conducted to find and describe potential fit and use issues. Panelists with a wide range of head, pinna (outer ear), concha (ear bowl), and ear canal sizes use the test model and check for specific problems with fit and stability, and for any major difficulties with use. Fit, and when necessary, use comments are provided so that consumers can see what models may be problematic for them. These findings are not scored.

Sensitivity Procedure:

The sensitivity test is used to assess perceived cord connected and cord connected transmitter based wireless headphone volume at a given audio source output level. Trained panelists
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compare the volume level of test models that are cord connected, or are wireless but have cord connected transmitters, to the volume level of a reference cord connected headphone when they are connected to a specific audio source with a specific output level that is playing specific audio program material. As a practical matter, sensitivity is not an issue with Bluetooth connected headphones, cord connected headphones used with AC powered equipment, or typical portable audio devices. It may pose a problem in situations where low sensitivity headphones are used with very low power portable devices. Sensitivity comments are provided for informational purposes but are not scored.

Wireless Range Procedure:

The wireless range measurement is used to verify a wireless test model's claimed wireless operating range. For wireless headphones the wireless transmitter, which is connected to an audio source, transmits (broadcasts) to the headphones. Bluetooth wireless headphones generally do not come with their own transmitter, so for these models a specified Bluetooth compatible audio device is used as the transmitter. Line-of-sight measurements are taken between the transmitting devices and the wireless test headphone while it is receiving audio program material; a tester notes whether or not any degradation in the audio program sound quality or any problems with transmissions from the headphone (such as control signals like volume up/down) occur within the claimed transmission range. In the case of a Bluetooth model where no operating range is claimed, the tester checks for glitch-free operation up to at least the Bluetooth Class 2 range specification (10 meters). A comment indicating whether or not the headphone met the claimed/Bluetooth specification wireless range is provided, but the measurement results are not scored.