In-Car Audio Measurements

Introduction

This sequence tests the impulsive distortion, frequency response, and maximum sound pressure level of a vehicle infotainment system to the methods outlined in the Audio Engineering Society Technical Committee on Automotive Audio (TC-AA) in-vehicle measurements white paper. This white paper aims to define repeatable and defined car audio system measurements and in addition to the measurement methods, contains information on standardized test configuration, for example microphone and seat positioning. Please contact the TC-AA for more information on this project. This test sequence may, of course, be used with your own in-house physical configuration if adherence to the TC-AA guidelines is not essential.

This sequence includes one master sequence, three subsequences, plus a level check subsequence for calibration. The three individual subsequence tests have also been included in a separate folder so they may be run standalone. The standalone sequences each have their own Bluetooth connect and disconnect steps.

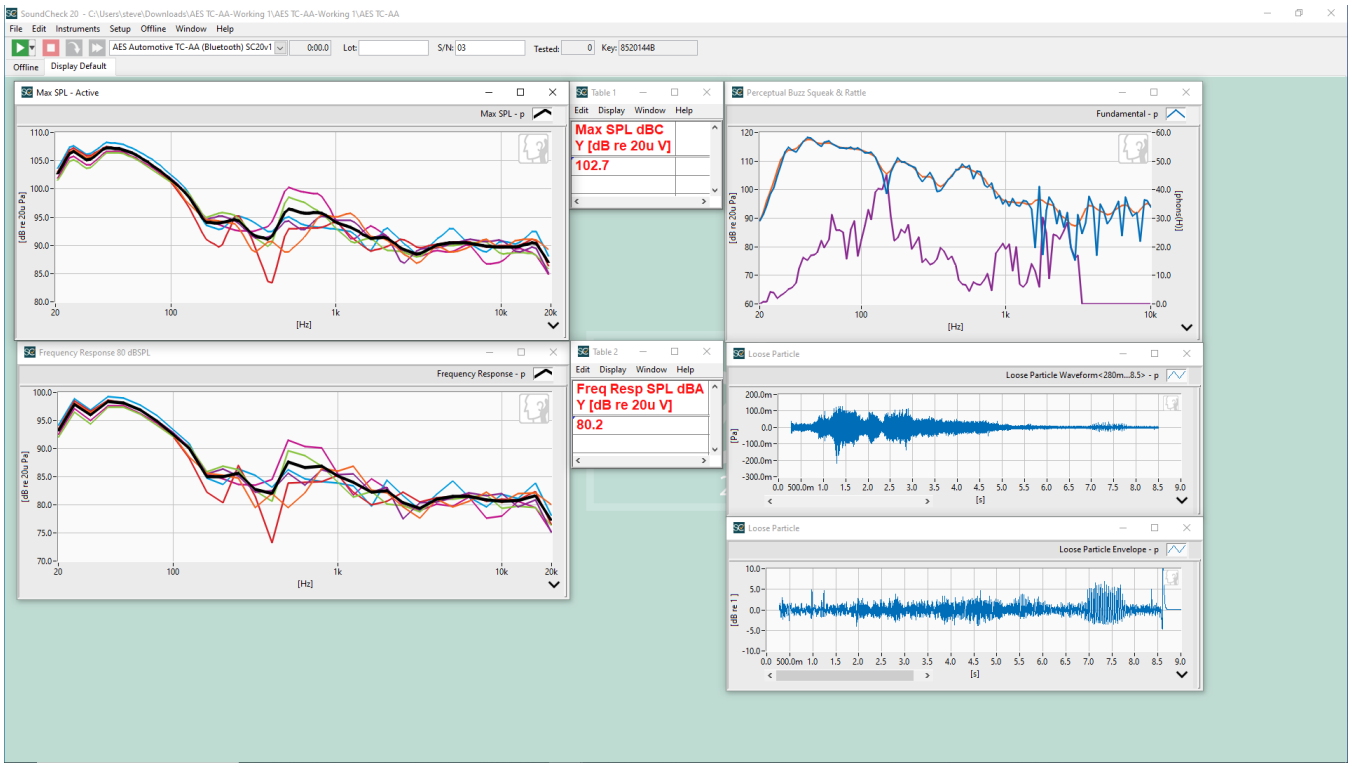


Figure 1 - Final display results of the measurements

Sequence Overview

The draft standard uses a six-microphone array placed in the driver's seat or passenger seat of the vehicle. The center of the array should be placed at the appropriate median head location for the specific vehicle under test. For details on microphone configuration and placement, please refer to the Microphone Array and Positioning section in the Appendix of the white paper.

The master sequence "AES Automotive TC-AA (Bluetooth)" begins with a prompt to configure the vehicle infotainment system to the specifications in the draft standard. The sequence will either pair the Bluetooth interface with the infotainment system, or the user can skip the pairing steps if a Bluetooth interface is already connected. The "Find Stim Level" step (#6) prompts the user to either find the stimulus level required for 80dBA in the Frequency Response measurement, or continue with the sequence measurements. Instructions on calibrating the 80dbA level are included below.

The first measurement taken is Impulsive Distortion, also known as buzz, squeak, and rattle, or Rub & Buzz. This test measures distortion caused by any rattling components in the car, such as loose molding and trim, incorrectly installed drivers, or components susceptible to vibration. The display step includes the fundamental frequency response, loose particles and recorded time waveform, ePRB measurement, and loose particle envelope before the sequence continues.

The second measurement is Frequency Response. This measures the frequency response of the vehicle's infotainment system at 80dbA. The prior calibration of the signal generator's level is used here. The display step includes six RTA curves, plus the frequency response curve shown on a graph, with the frequency response SPL value shown in a table before the sequence continues.

The third measurement is Max SPL. This test measures the maximum sound pressure level that a vehicle's infotainment system can produce. The display step includes six RTA curves, plus the Max SPL curve shown on a graph, with the Max SPL value shown in a table before the sequence continues.

When the three measurements are completed, the user is given the option of closing the Bluetooth connection or leaving it open. The final display step shows the results of the three measurements: Max SPL response and value, Frequency Response curve and SPL value, Perceptual Buzz Squeak & Rattle, and Loose Particles.

If you wish to run these sequences as individual tests outside of the master sequence, the three individual tests in standalone sequences are provided in the sequence folder. These sequences also include Bluetooth connectivity steps for standalone operation.

Calibration - 80dBA Calibration Bluetooth Subsequence Instructions

The sequence calculates the signal level needed for the car infotainment system to output 80dB A-weighted at the mic array. If this is previously calculated, the user can select "No" and proceed with the measurements.

The subsequence "80dBA Calibration Bluetooth" uses a signal generator and multimeter to establish the level required to achieve 80dBA at the microphone array position. The user must adjust the signal generator level until the multimeter records 80dbA, then press enter to display a table with the signal generator level. This level must be noted outside of SoundCheck before proceeding.

The user should then enter this value into the signal generator level in the Frequency Response subsequence (step 11-1). Once the level is correctly updated in the Frequency Response sequence, the user may proceed with the measurements when prompted in step 6 of the master sequence.

Software Requirements

- SoundCheck Plus Version 20 or later Part #1102
- RTA Analyzer Part #2005
- 8 channel acquisition module Part #2024

Hardware Requirements

- Interface with 6 inputs - Listen AmpConnect 621 or similar Part #4046
- Bluetooth interface - Portland Tool & Die BTC/BQC or similar Part #5816
- 6 SCM Microphones with holder* or similar. Part #4012

*Please reference the Microphone Array and Position section of the standard for specific requirements

Software Configuration

Your SoundCheck Calibration may not include the Signal Paths used in these sequences. Before opening the sequence for the first time, please take the following steps to import the Signal Paths and associated calibrated device files.

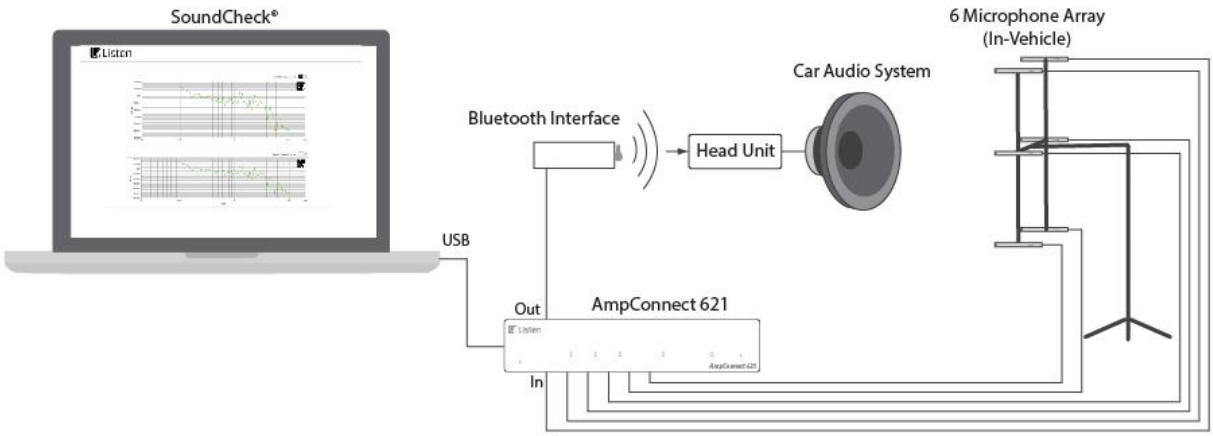
1. Go to Setup > Calibration and press the Import button
2. Browse to the Calibration folder included in the sequence distribution folder, select the system.cal file and click OK
3. When prompted to import calibrated device files, select Yes
4. When prompted to overwrite existing calibrated device files, select No

Hardware Setup & Calibration

1. Connect the microphones to input 1-6 of your audio interface
2. Calibrate the microphones as instructed in the SoundCheck manual
3. Place the six microphones in the vehicle, adhering to the microphone array and positioning appendix section in the white paper.
4. All accessible audio system settings should be set to default or factory reset to neutral or flat. These settings should be documented.

You are ready to start the sequence.

System diagram



Further sequence development

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

- Sequences could be performed using open loop measurements by loading stimulus files onto a USB device, and manually playing them back through the infotainment system.
- Autosave steps can be added at the end of the master sequence, and/or after each subsequence measurement.
- Frequency response measurements can be performed at different levels to better characterize the infotainment system.