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Transforming Sound into Knowledge

Sequence Note

Background Noise Simulation to ETSI ES 202 396-1 Standard

Introduction

This sequence calibrates a 4.1 speaker array in accordance to the ETSI ES 202 396-1 standard *"Loudspeaker Setup for Background Noise Simulation"*.

The standard is available for free download from the ETSI website here.

The sequence begins by measuring the front/rear balance of the left and right main speaker pairs. If they are within 2 dB of each other, the sequence will continue by measuring the combined sensitivity of each pair and, using pink noise, equalize the output of each pair. Once the left and right pairs are calibrated, the subwoofer level is manually adjusted to match the output level of the four main speakers.

Included with the sequence is a library of real world binaural recordings from the ETSI standard: cafeteria, pub, crossroad, vehicle, single voice distractor, and office noises. Custom or user-defined binaural recordings can also be used to create background noise tests directly applicable to your product. This sequence has many applications including evaluating ANC on headphones, noise suppression on communication devices, voice recognition testing of smart speakers / IoT, SNR optimization of microphones on telepresence devices and beamforming directionality studies of microphone arrays.

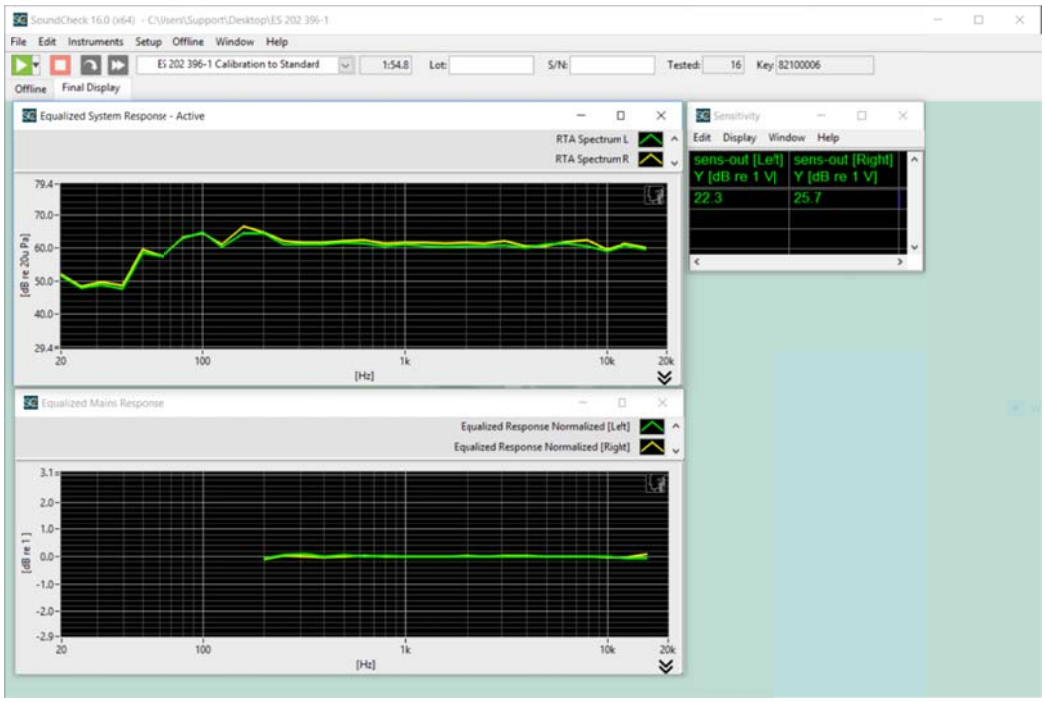


Figure 1: ES 202 396-1 Calibration to Standard – Final Display

Hardware Requirements

- Four (4) high quality monitor loudspeakers capable of flat response from 120 Hz to 20 kHz. The speakers may be powered or passive.
- Four channels of amplification (not needed if the main speakers are powered), e.g. Listen SCAmp or similar
- Powered subwoofer with a high frequency cutoff of 120 Hz and a line out to send the test signals on to the speaker array.
- Audio interface having at least 2 inputs and 2 outputs, e.g. Listen AudioConnect or similar
- Head and torso simulator (HATS) e.g. B&K Type 4128C or similar
- 2 channel microphone power supply, e.g. Listen SoundConnect 2 or similar
- 4 channel loudspeaker management system capable of creating precise delay values in the range of 0 to 30 ms.
- Splitter cables (Y adapters) to send the left and right output signals from the subwoofer line out to the two amplifier/powered speaker inputs. The termination configuration of these adapters will be determined by your specific subwoofer and amplifiers.

Software Requirements

SoundCheck Plus version 16 or higher including the following optional modules

- 2004 - Post processing
- 2005 - RTA
- 2013 - EQ a WAV file
- 2014 - Signal Generator
- 2015 – Multimeter
- 2023 – 4 channel acquisition (8 channel optional)

Hardware Setup & Calibration

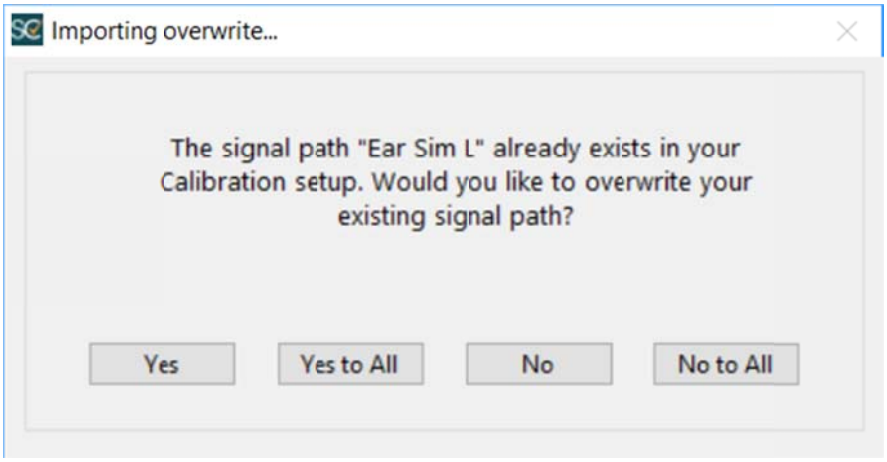
1. Observe the instructions in the standards document for recommended Test Room Requirements (section 6.1) and Loudspeaker Placement (section 6.2).
2. Connect the hardware as shown in the System Diagram below
3. Calibrate the HATS ears as described in the SoundCheck user manual

Software Setup & Calibration

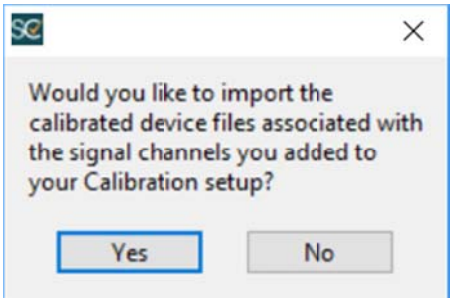
Copy the folder containing the sequences and documentation to your SoundCheck PC. The sequences uses signal paths and calibrated device files that are unique to this sequence and not likely to be present on your current SoundCheck installation. To populate these paths and files into your calibration, please do the following.

1. Launch SoundCheck and open the Calibration Editor (Setup > Calibration)

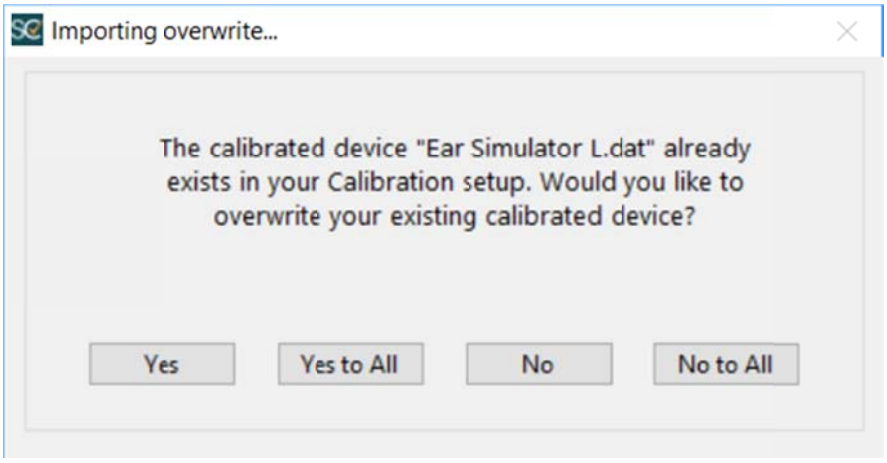
2. Click the Import button, browse to the Calibration folder in the ES 202 396-1 sequence folder, select the file named system.cal and click OK. You will then encounter several dialog messages which you should respond to as follows:



Respond with: **Yes to All**



Respond with: **Yes**



Respond with: **No to All**

At this point, your Calibration table will open automatically (open it manually if it does not) and you should assign Hardware Channels to the newly added Signal Paths.

Important: Note that the Calibrated Output device files referenced in the calibration sequence (Left and Right) are unique to this calibration sequence. The EQ, correction and sensitivity data created during the sequence run will only be written to the Left and Right Calibrated Output device files.

Also note that there are diffuse-field correction curves contained in the provided Ear Simulator calibrated device files. This correction is applied during analysis so it is critical that the default calibrated device files provided with this sequence package are used when running this calibration sequence.

System diagrams

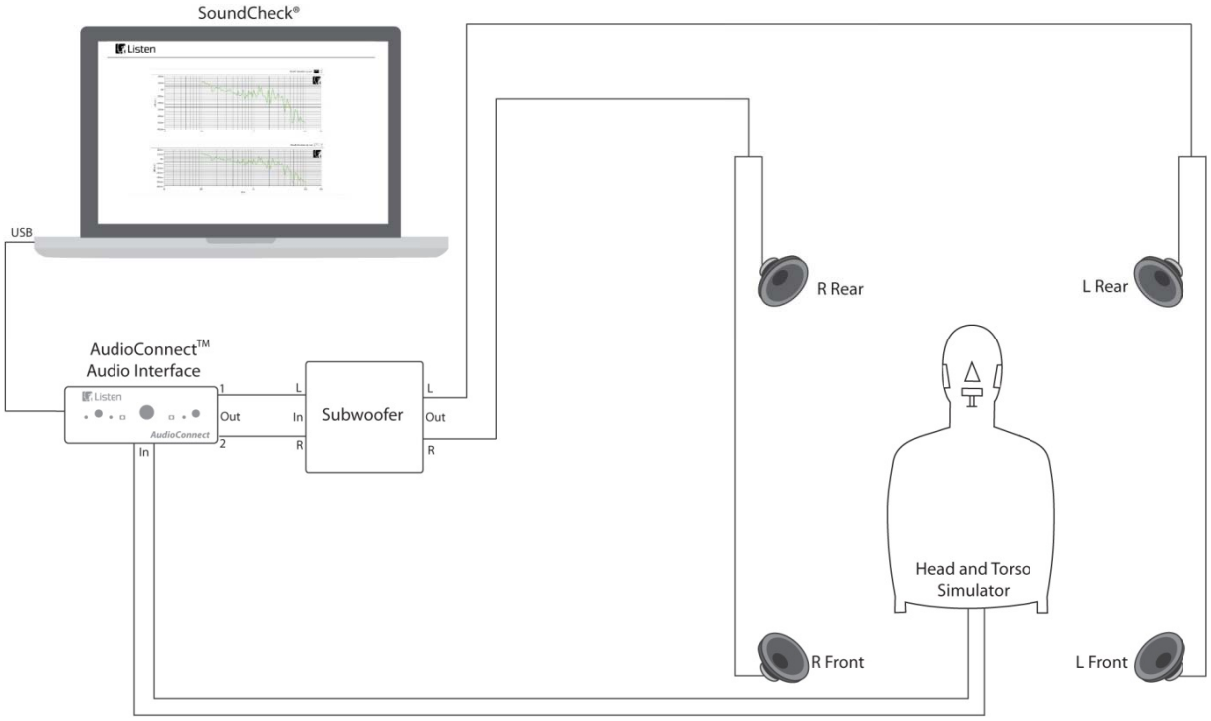


Figure 2 - Hardware Setup Using Powered Speakers

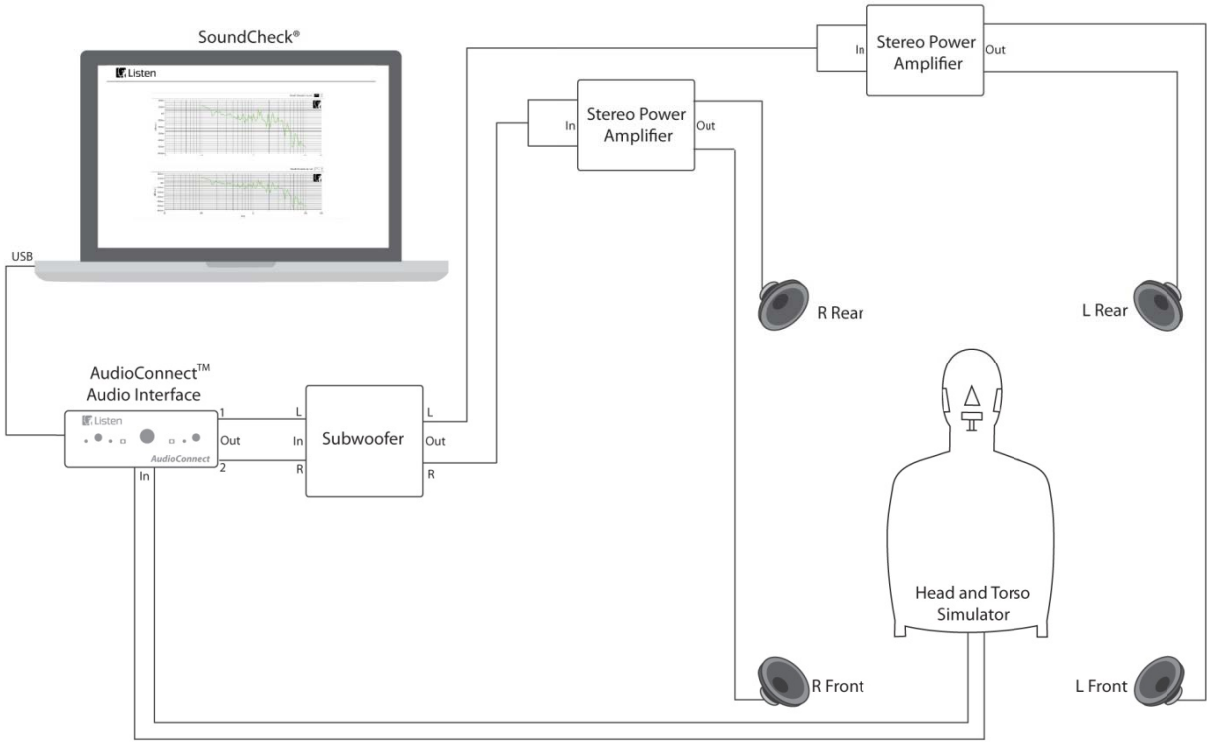


Figure 3- Hardware Setup Using Passive Speakers

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Sequence Logic – EQ and Sensitivity Calibration

Type	Step Name	#	Out	In	Comments
Mes	Test Level cal	1			// Hidden - Sets test level at 80 dBSPL
Pos	Initialize Cal Value	2			// Creates sens start value
Pos	Initialize Cal Data	3			// Creates sens out value
Pos	Initialize Cal Data	4			// Creates eq start curve
Pos	Initialize Cal Data	5			// Creates corr start curve
Pos	Reset Cal Data	6			// Reset EQ Curve
Pos	Reset Cal Data	7			// Reset Correction Curve
Sti	Cal - Sensitivity	8	Direct Out 1		// Pink noise for sensitivity calculation
Acq	Play & Record	9	Direct Out 1	Ear Sim L	
Ana	Anechoic Cal Stim	10			
Pos	Sensitivity cal	11			// Calculates 1 kHz sensitivity
Pos	Rename cal	12			// Creates sens-out
Lim	Sensitivity cal	13			// Sensitivity limits step
Mes	Sensitivity failed cal	14			
Sti	Cal - Output Source Equalization	15	Left		// Unequalized stimulus for first sweep
Acq	Play & Record cal (Read only)	16	Left	Ear Sim L	
Ana	Fundamental	17			
Pos	Curve Average	18			
Pos	Curve Subtraction dB	19			
Pos	Calculate EQ	20			// Creates eq-out curve
Pos	Rename cal curve	21			// Creates Left eq-out curve
Lim	Response margin cal	22			// Applies limits to normalized fundamental
Dis	Calibration 1	23			
Mes	Source response failed	24			
Mes	Calibration passed	25			
Sti	Cal - Output Source Equalization EQd	26	Left		// Equalized stimulus
Acq	Play & Record cal (Read only)	27	Left	Ear Sim L	
Ana	Anechoic Cal Stim	28			
Pos	Curve Average	29			
Pos	Curve Subtraction dB	30			// Offset Equalized response to 0 dB
Pos	Calculate Correction	31			// Creates corr-out curve
Pos	Rename cal curve	32			// Creates corr-out curve
Lim	Response margin cal2	33			// Applies limits to the normalized response curve
Dis	Equalized 1	34			
Mes	Operator Dialog	35			
Pos	Rename cal	36			// Re-sets eq-out curve to unity
Pos	EQ-out tweak	37			// Tweaks eq-out curve
Pos	Sens-out tweak	38			// Tweaks sens-out curve
Pos	Rename sens-out	39			
Pos	Rename Normalized Curve	40			
Dis	Final 1	41			//Final Display Step

Sequence Logic – Front Rear Balance

Type	Step Name	#	Out	In	Comments
Mes	Operator Message	1			
Mes	Operator Message	2			
Acq	Virtual Instruments	3	Direct Out 1	Ear Sim L	// Left Front Level Measurement
Mes	Operator Message	4			
Mes	Operator Message	5			
Acq	Virtual Instruments	6	Direct Out 1	Ear Sim L	// Left Rear Level Measurement
Pos	Curve Subtraction	7			// Calculates Front - Rear Difference
Dis	Left	8			
Lim	Single Value - Upper Only	9			
Lim	Single Value - Lower Only	10			
Mes	Operator Message	11			
Mes	Operator Message	12			
Mes	Operator Dialog	13			
Mes	Operator Message	14			
Mes	Operator Message	15			
Acq	Virtual Instruments	16	Direct Out 2	Ear Sim R	// Right Front Level Measurement
Mes	Operator Message	17			
Mes	Operator Message	18			
Acq	Virtual Instruments	19	Direct Out 2	Ear Sim R	// Right Rear Level Measurement
Pos	Curve Subtraction	20			// Calculates Front - Rear Difference
Dis	Right	21			
Lim	Single Value - Upper Only	22			
Lim	Single Value - Lower Only	23			
Mes	Operator Message	24			
Mes	Operator Message	25			
Mes	Operator Dialog	26			
Dis	Final	27			

Sequence Logic – Subwoofer Level Set

Type	Step Name	#	Out	In	
Mes	Operator Message	1			
Acq	Virtual Instruments	2	Left Right	Ear Sim L Ear Sim R	// Signal Generator and RTA for level adjustment
Dis	XY Graph - Standard	3			