Listen

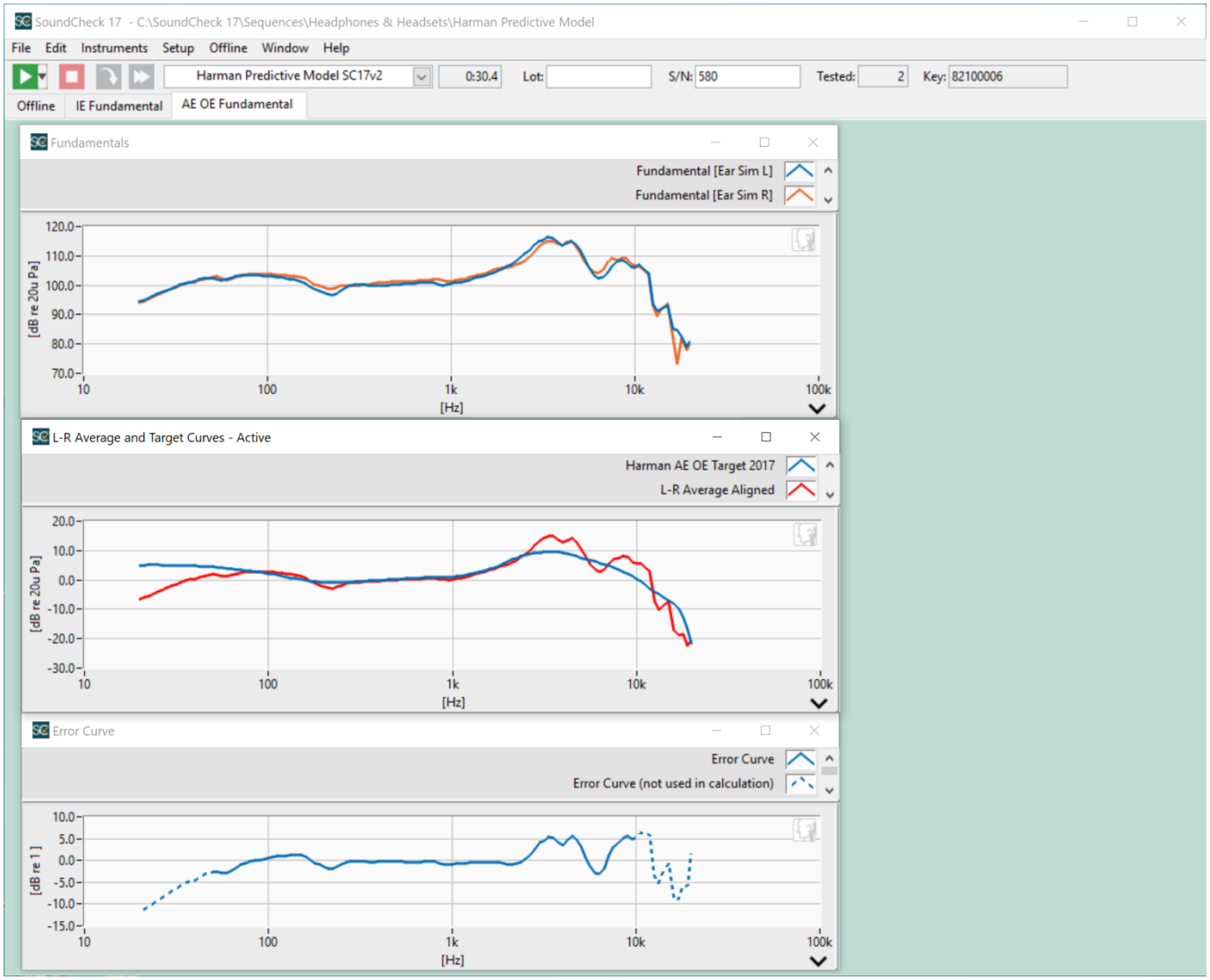
Transforming Sound into Knowledge

Sequence Note

Harman Predictive Model for Headphones v2

Introduction

The purpose of this sequence is to apply the appropriate Harman target curve for in ear or on ear/around ear headphones to a measurement made in SoundCheck or to a set of recalled curves in order to yield the predicted user preference for the headphone of interest. The sequence gives the user the option of making an actual measurement or recalling curves into SoundCheck. The curves are then opened in an Excel template using a Print To Excel step where the necessary calculations are performed to produce a Predicted Preference score using a scale of 0 to 100. The spreadsheet calculates an Error Curve which is derived from subtracting the target curve from an average of the headphone left/right response. The standard deviation, slope and average of the Error Curve are calculated and then used to calculate the predicted preference score.

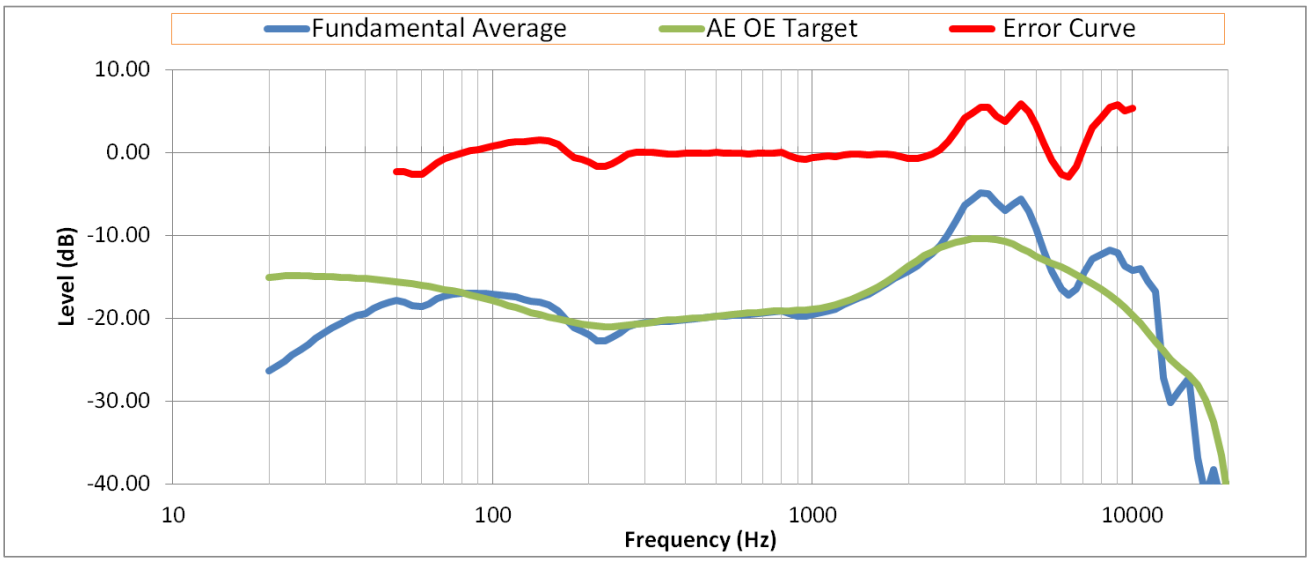


Final Display for *Harman Predictive Model for Headphones* v2 Sequence

Listen

Predicted Preference Report

STDEV OF ERROR	SLOPE OF ERROR	Predicted Preference
2.16	0.74	75.80



Final Excel Display for *Harman Predictive Model for Headphones v2* Sequence

Requirements

Software

SoundCheck Basic – version 17 or higher

Microsoft Excel – version 2010 or higher (Excel support available on Windows versions of SoundCheck only)

Hardware

No hardware required if recalling existing response curves. Otherwise, the following is recommended:

G.R.A.S. RA0045 coupler with GR0433 canal extender (for in ear measurements - see *Notes on Running the Sequence* below)

G.R.A.S. 45CA Headphone Test Fixture (for around ear/over ear measurements - see *Notes on Running the Sequence* below)

2 channel microphone power supply – Listen SoundConnect 2 or similar (Listen part # 4025/4026)

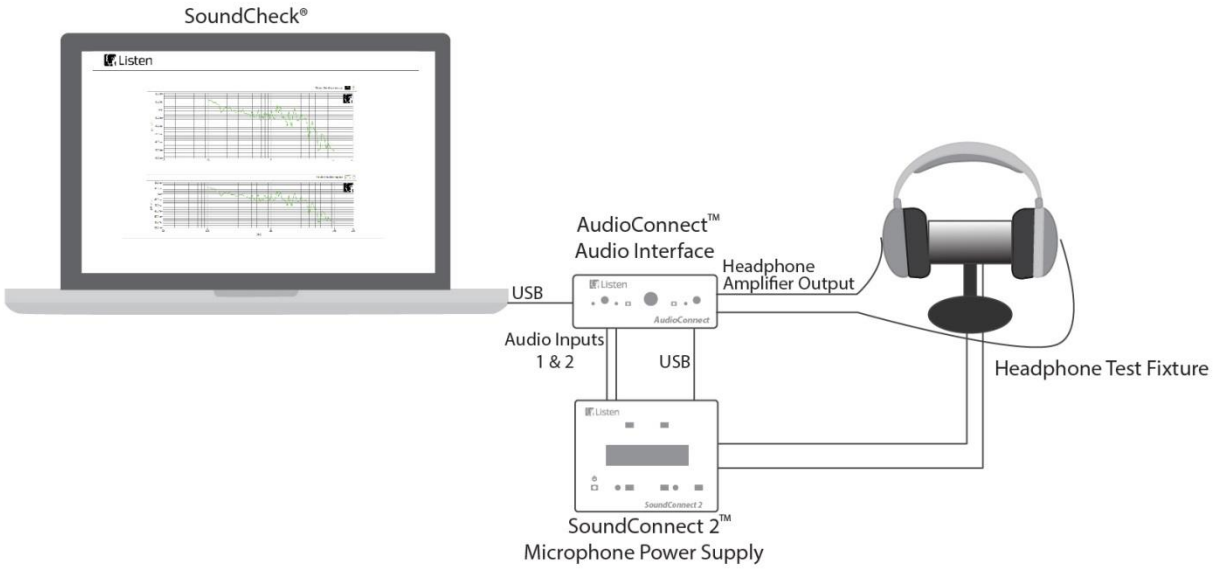
2 channel audio interface – Listen AudioConnect or similar (Listen part # 4050)

Headphone amplifier (optional if not using AudioConnect headphone out)

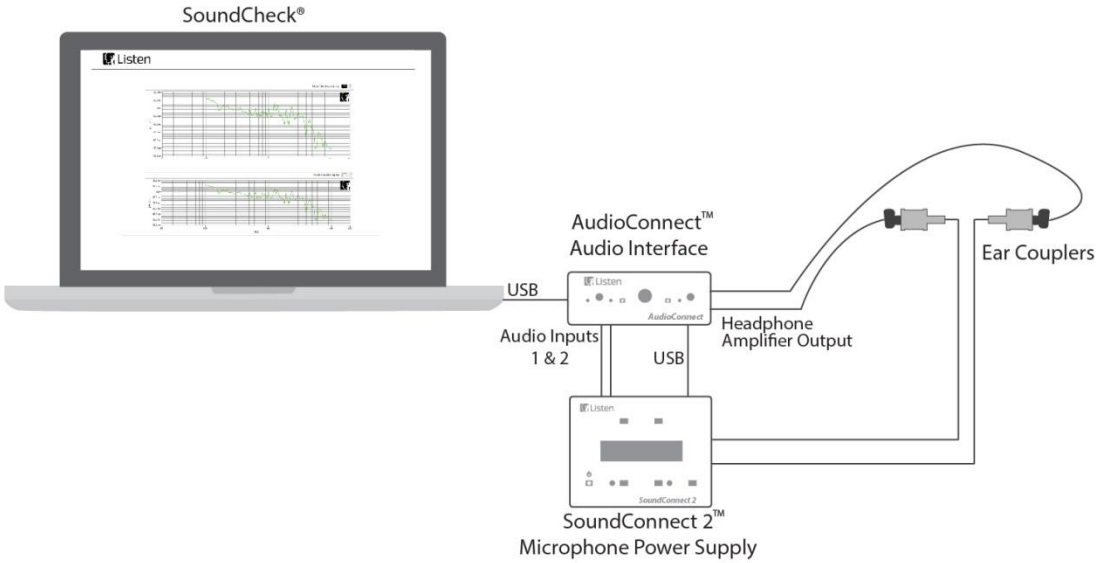
Hardware Setup & Calibration

1. Connect your audio interface outputs 1 and 2 to the input of your headphone amplifier
2. Connect the outputs of your microphone power supply to inputs 1 and 2 of your audio interface
3. Connect your ear simulators to the microphone power supply and apply the appropriate bias voltage
4. Calibrate your headphone amplifier and ear simulators per the instructions in the SoundCheck user manual
5. Connect your DUT to the output of the headphone amplifier

You are ready to start the sequence.



Hardware setup for around ear/over ear headphones



Hardware setup for in ear headphones

Notes on Running the Sequence

- The IE target curve was developed using a G.R.A.S. RA0045 IEC60318-4 compliant coupler. Other common fixtures for testing IE headphones such as B&K 4128, B&K 5218, G.R.A.S. KEMAR, etc. have not been validated against the target and may not produce results that correlate 100% to the predictive model.
- The AE/OE target curve was developed using a G.R.A.S. 45CA headphone test fixture with a custom pinna. Other common fixtures for testing AE/OE headphones such as B&K 4128, B&K 5218, G.R.A.S. KEMAR, etc. have not been validated against the target and may not produce results that correlate 100% to the predictive model.
- If you wish to save the Excel data, always use the "Save As" command. In other words**, don't save your data to the Template files** as this will render them useless.
- The default recall path for headphone L/R response curves is to the sub-folders containing example curves. You can modify the defaults to reflect where your actual headphone data is stored.
- Recall data must have R40 (1/12 octave) resolution that starts at 20kHz and ends at 20Hz (created from a sweep from high to low frequency). If your data has a different frequency resolution, a Resolution post processing step can be used to change it to the proper resolution.
- The Print to Excel steps use relative paths to their respective Excel Templates. If the sequence is moved to another location besides the original distribution folder, make sure that the Excel Template paths are re-set.

Further Sequence Development

This sequence has been designed for simplicity and has been written for a two-channel system, to be accessible to 100% of SoundCheck users. Ways in which you could modify or further develop the sequence include:

- Enable distortion metrics in the Analysis step
- Add autosave steps

Acknowledgements

Listen would like to acknowledge Sean E. Olive, Todd Welti, and Omid Khonsaripour of Harman International. This sequence is inspired by their Audio Engineering Society papers "A Statistical Model that Predicts Listeners' Preference Ratings of In Ear Headphones – Parts 1&2" presented at the AES 143rd in October of 2017 and "A Statistical Model that Predicts Listeners' Preference Ratings of Around-Ear and On-Ear Headphones" presented at the AES 144th in May of 2018. The authors also provided the spreadsheets which were used as the basis for the Excel templates in this sequence to perform the preference calculations.

References - Links to AES E-Library

A Statistical Model that Predicts Listeners' Preference Ratings of In-Ear Headphones: Part 1—Listening Test Results and Acoustic Measurements

A Statistical Model that Predicts Listeners' Preference Ratings of In-Ear Headphones: Part 2—Development and Validation of the Model

A Statistical Model that Predicts Listeners' Preference Ratings of Around-Ear and On-Ear Headphones

Listen

Sequence Logic

Type	Step Name	#	Out	In	
Rec	Recall Curves	1			// Recall target curves
Sti	Stweep - 20k-20Hz (R40)	2	Headphone Amp L		
Mes	Measure or Recall Data	3			
Mes	Measurement Type	4			
Lim	Single Value - Upper Only	5			// Logic for jumping to correct headphone acquisition step
Mes	Recall Type	6			// Prompts operator to enter headphone type
Lim	Single Value - Upper Only	7			// Logic for jumping to correct headphone recall step
Rec	Recall IE Example Curves	8			// Recall IE curves of interest
Acq	Play & Record	9	Headphone Amp L & R	Ear Sim L	// IE Acquisition
Ana	HarmonicTrak	10			// IE Analysis
Pos	Average Curve	11			// Average L & R headphone response curves
Lim	Curve - Aligned Data	12			// Normalize L & R average to 500 Hz
Pos	Curve Subtraction dB	13			// Calculate error (difference between target curve and L&R average)
Pos	Windowing	14			
Pos	Windowing	15			
Dis	IE Fundamental	16			// IE display
Pri	Print to Excel - IE	17			
Rec	Recall AE OE Example Curves	18			// Recall AE/OE curves of interest
Acq	Play & Record	19	Headphone Amp L & R	Ear Sim L	// AE/OE Acquisition
Ana	HarmonicTrak	20			// AE/OE Analysis
Pos	Average Curve	21			// Average L&R headphone response curves
Lim	Curve - Aligned Data	22			// Normalize L&R average to 500 Hz
Pos	Curve Subtraction dB	23			// Calculate error (difference between target curve and L&R average)
Pos	Windowing	24			
Pos	Windowing	25			
Pos	Windowing	26			
Dis	AE OE Fundamental	27			
Pri	Print to Excel - AE OE	28			