LISTEN INC

Transforming Sound into Knowledge

Sequence Note

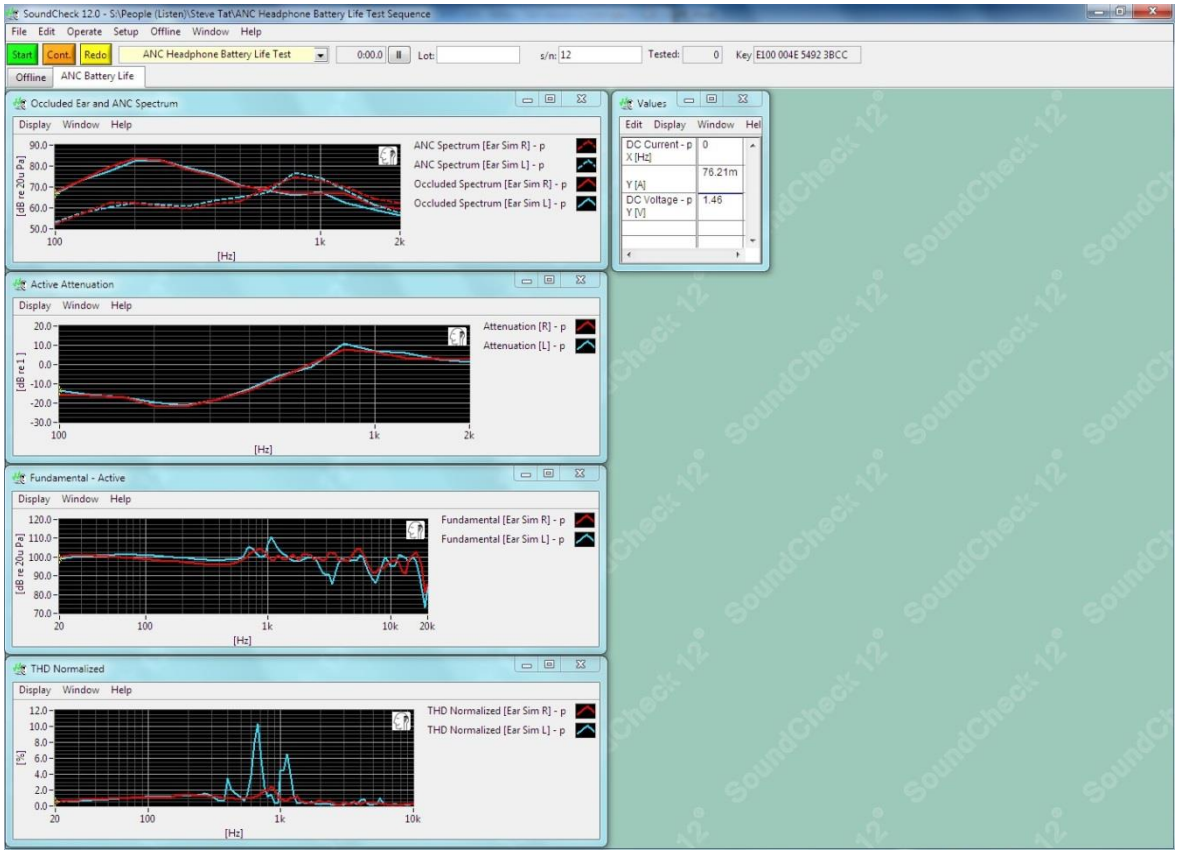
ANC Headphone Battery Life Test

Introduction

This sequence is designed to measure performance characteristics of Active Noise Cancelling (ANC) headphones while monitoring the DC voltage and current provided to the headphone by its batteries.

The sequence first measures the passive attenuation of the headphone before moving into a loop. The loop plays a 2 minute pink noise stimulus at high output level to accelerate battery drain. During this stimulus period, a current measurement is made by Listen's DC Connect. Immediately following the stimulus, battery voltage is measured followed by acquisition and analysis of audio parameters (response, THD and THD Normalized). The active attenuation of the headphone is then measured followed by a series of post processing and Autosave steps. The looping continues until no output is detected from the headphone, when the device shuts down due to insufficient battery capacity.

The sequence requires that the headphone's batteries be mounted externally and the series/parallel connections needed for current/voltage measurement and general operation of the headphone are automatically managed by digital I/O addressable relays controlled from SoundCheck.



Final Display for ANC Headset Battery Life sequence

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Requirements

Software:

SoundCheck 12.0

National Instruments NI-DAQmx

Hardware:

Head and torso simulator (B&K HATS or equivalent)

Listen SoundConnect 2, 2 channel microphone power supply (p/n 4024/4025) or equivalent

Listen DC Connect programmable DC power supply/DC current/voltage monitor (p/n 4030 or equivalent)

Listen AudioConnect 4x4, 4 channel audio interface (p/n 4051) or equivalent

2 channel audio power amplifier

2 channel headphone amplifier

2 loudspeakers

Digital I/O addressable SPDT relay box such as National Instruments ER-8/16 with PCI-6503

External battery holder such as Radio Shack 270-398 (2 x AAA)

Hardware Setup and Calibration

1. Calibrate the two amplifiers as instructed in the SoundCheck manual.
2. Calibrate the HATS ears as instructed in the SoundCheck manual.
3. Connect output 1 of your audio interface to the left input of the audio power amplifier
4. Connect output 2 of your audio interface to the right input of the audio power amplifier
5. Connect output 3 of your audio interface to the left input of the headphone amplifier
6. Connect output 4 of your audio interface to the right input of the headphone amplifier
7. Connect the HATS ear left/mic power supply output to input 1 of your audio interface
8. Connect the HATS ear right/mic power supply output to input 2 of your audio interface
9. Connect the DC Connect analog output to input 3 of your audio interface
10. Locate the two loudspeakers in close proximity to the HATS ears and connect them to the respective left and right outputs of the audio power amplifier.
11. Connect the DC Connect to your SoundCheck PC as instructed in the DC Connect manual
12. Mount the headphone on the HATS and connect it to the headphone amplifier
13. Connect the relays to the battery holder, headphone and DC Connect as detailed in Table 1

System Diagram

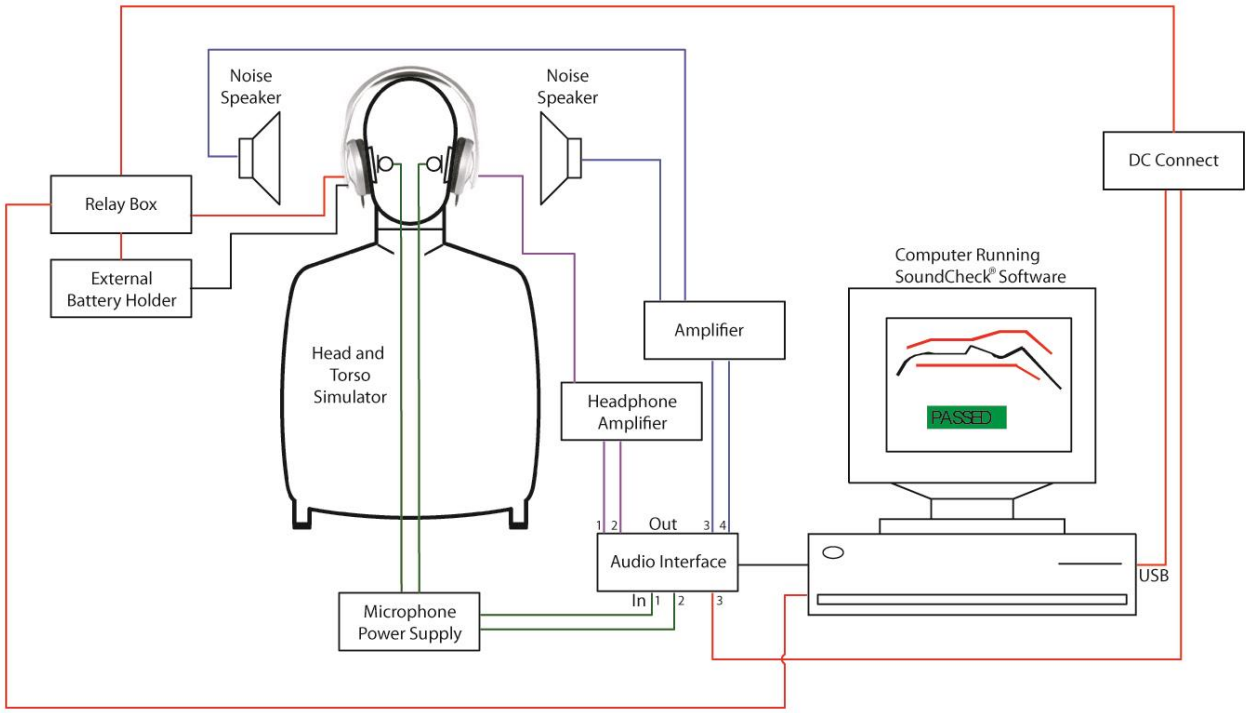

Figure 1 - Connection Diagram

Table 1 - Relay Connections

Relay 1	NO1	DC Connect + / Headphone + battery terminal
	COM 1	Battery +
	NC1	Not used
Relay 2	NO2	Battery +
	COM2	DC Connect –
	NC2	Not used
Relay 3	NO3	Battery –
	COM3	DC Connect –
	NC3	Not used

Note: DC Connect ground is floating (not connected)

Sequence Logic

Type	Step Name	#	
Mes	Turn off relays	1	// Sets all relays to OFF position
Mes	Headphone placement	2	// Prompts user for headphone placement on HATS
Sti	PinkNoise	3	// Pink noise stimulus for measuring attenuation
Acq	Play & Record	4	// Records response of occluded ear (ANC off)
Ana	Spectrum	5	// Spectrum analysis of pink noise @ occluded ear
Mes	ANC On	6	// Prompts user to turn the headphone ON
Sti	20-20k (R40)	7	
Mes	Turn off relays	8	// Sets all relays to OFF position
Mes	Wait	9	
Sti	DC Connect Analog v 30 mA	10	// DC Connect Analog Stimulus Step
Mes	Wait	11	
Mes	Current Measurement Mode	12	// Sets relays to current measurement mode
Mes	Wait	13	
Acq	Sig Gen x2 + Scope FFT	14	// Virtual Instrument acquisition step
Ana	DC Connect Analog	15	// Calculates DC current
Mes	Turn off relays	16	// Sets all relays to OFF position
Mes	Wait	17	
Sti	DC Connect	18	// DC Connect USB Stimulus Step (DC voltage measurement)
Mes	Voltage Measurement Mode	19	// Sets relays to voltage measurement mode
Mes	Wait	20	
Acq	DC Connect	21	// DC Connect acquisition step for DC voltage measurement
Acq	Play & Record	22	// Acquisition step for headphone audio test
Ana	THD	23	// Calculates L&R Fundamental, THD and THD Normalized
Acq	Play & Record	24	// Records response of occluded ear (ANC on) to pink noise
Ana	Spectrum	25	// Spectrum analysis of pink noise @ occluded ear ANC ON
Pos	Curve division	26	// Calculates active attenuation - Left channel
Pos	Curve division	27	// Calculates active attenuation - Right channel
Pos	Curve Average	28	// Calculates L&R average attenuation
Pos	Curve Average	29	// Calculates L&R average THD and THD Normalized
Pos	Curve Average	30	// Calculates L&R Fundamental average (SPL)
Lim	Test For Signal	31	// Applies lower limit to Average Fundamental value
Dis	ANC Battery Life	32	// Display step
Aut	Save Data to Excel - Append	33	// Autosave to Excel
Aut	Save curve	34	// Autosave to DAT
Mes	Turn off relays	35	// Sets all relays to OFF position
Mes	No Signal	36	// No signal detected - end of test message

Further Sequence Development

1. Input/output channel requirements could be reduced by only measuring a single headphone channel. This would allow for use of a 2 channel in/out audio interface.

2. Sequence loop length is primarily dictated by the length of Step #14 (sig gen x2 + scope FFT) which is set to 5 minutes by default. Considering that some headphones may take 60 hours (or more) to discharge their batteries, the default setting can result in 700+ sets of data being recorded/saved by SoundCheck. To change the default, open both signal generators in step #14 and change the number in the duration field to the desired stimulus length (seconds). If these values are changed, the record delay value in the step must also be changed. Recommended value is stimulus duration minus 10 seconds. Stimulus level may also be adjusted based upon the sensitivity of your DUT.

3. If the suggested National Instruments relay box and interface card are not available, alternate remote switching can be utilized, such as D I/O control via Listen AmpConnect. A schematic of the switch configuration is shown below:

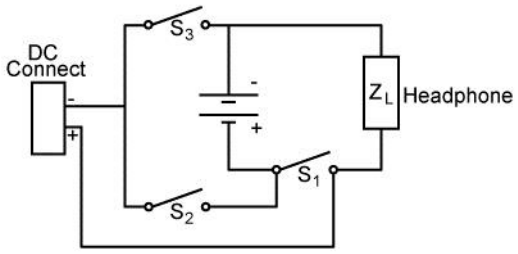

Figure 2 – Switch Configuration Schematic

4. Adjust the search range values in post processing steps 28-30 to better suit your device.

5. Create X-Y graphs from the data saved to Excel. An example is shown below.

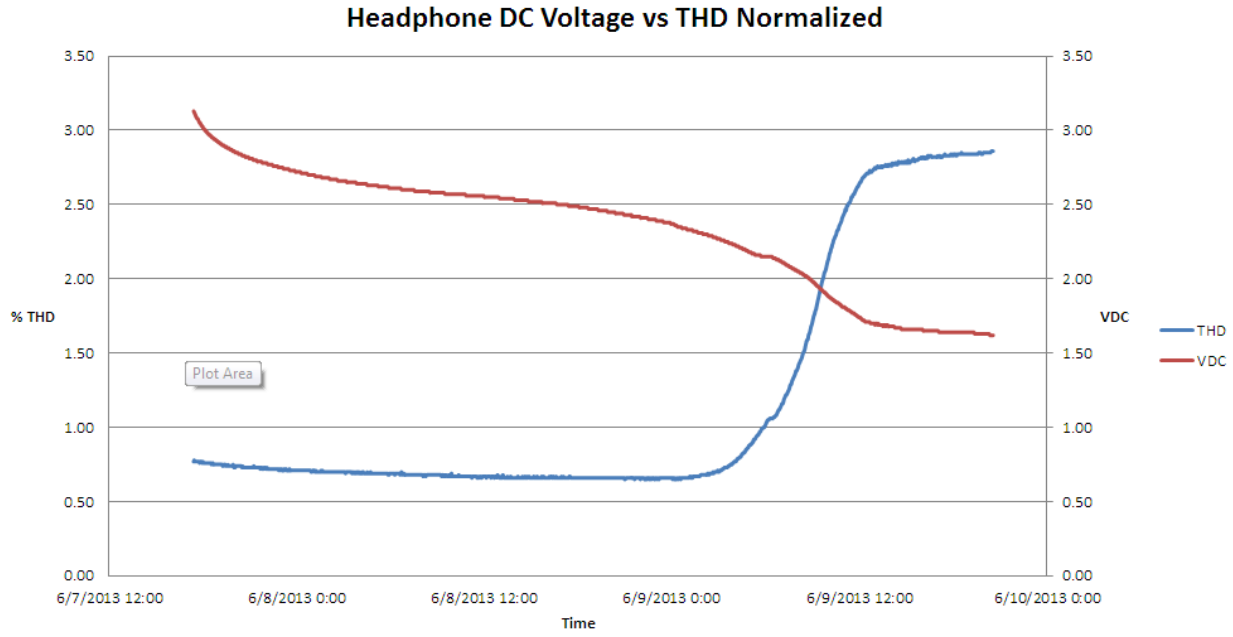

Figure 3 – Excel Chart Showing DC Voltage and THD Normalized vs. Time