Listen

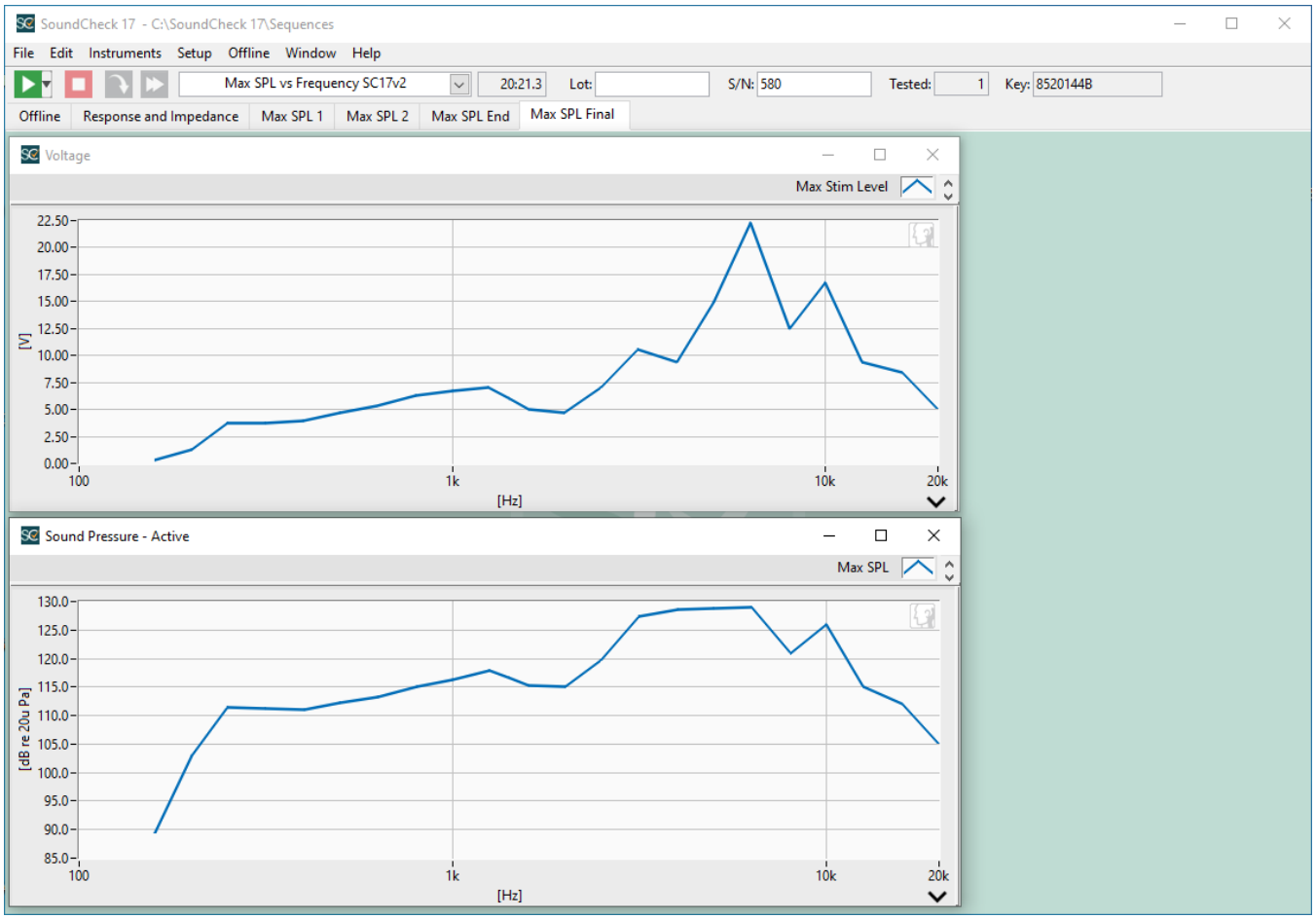
Transforming Sound into Knowledge

Sequence Note

Max SPL vs Frequency (v2)

Introduction

The purpose of this sequence is to characterize the Max SPL of a transducer by setting limits on specific metrics (THD, Rub & Buzz, Perceptual Rub & Buzz, Input Voltage and Compression) and then driving the transducer at a series of standard ISO frequencies, increasing the stimulus level until the one of the limits is surpassed. The sequence begins by measuring the frequency response and impedance of the DUT. The user is asked if they wish to use the -3dB from resonance frequency as the test Start Frequency or manually enter another value. The user is then prompted to enter a Stop Frequency, initial test level and limit values for the metrics of interest. The sequence then plays the stimulus Start Frequency in a loop, increasing the level +3dB with each loop iteration until one of the limits is exceeded. The stimulus level is then adjusted -3dB and the sequence continues to a second loop which increases the stimulus level +0.5 dB with each loop iteration until the limit is exceeded. At this point, the limit results are saved to an Excel file, the stimulus frequency is incremented by a constant multiplication step and the process is repeated until the Stop Frequency is achieved. Every time the main loop is completed, the individual SPL and Stimulus Level x-y pairs are concatenated to master curves. At the end of the sequence, the Max SPL and Stimulus Level curves are autosaved in .dat format.



Final display for *Max SPL vs Frequency* sequence

Requirements

Software:

- SoundCheck Basic – Version 17 or higher

Hardware:

- p/n 4002 – Listen SCM 3 reference microphone or equivalent
- p/n 4050 – Listen Audio Connect audio interface/microphone power supply or equivalent
- p/n 4060 – Listen SCAmp audio test amplifier or equivalent
- p/n 4009 – Listen Impedance Box (if not using Listen hardware containing internal impedance reference)

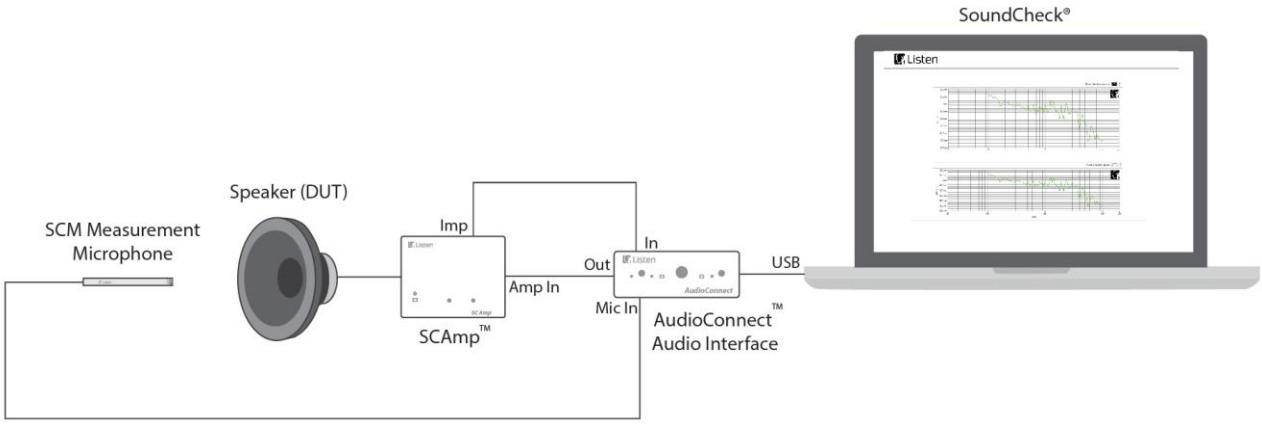
Hardware Setup & Calibration

Caution: Take care when setting the limits for the various metrics. You may damage your DUT if the limits are set too high. It is good practice to set a practical Vmax value that will guarantee that the thermal or mechanical limits of the DUT won't be exceeded.

1. Calibrate your amplifier and reference microphone per the instructions in the SoundCheck user manual
2. Connect your audio interface output 1 to the input of your amplifier
3. Connect the output of your reference microphone's power supply to input 1 of your audio interface
4. Connect your DUT to the output of the amplifier

You are ready to start the sequence.

System Diagram



Additional Sequence Notes

- The sequence default settings will measure the DUT using standard ISO 1/3 octave frequency resolution.
- Stimulus resolution is controlled by Step 25 **Stimulus Resolution Multiplier.** You can use different constant values in this step to produce different stimulus resolutions:

Stimulus Resolution	Constant value
1/3 octave (default)	1.259
1/6 octave	1.222
1/12 octave	1.059
1/24 octave	1.029

- If the stimulus resolution is changed, Step 32 **Resolution** must also be modified to reflect the stimulus resolution. The purpose of this step is to coerce the stimulus frequency to standard ISO values as the resolution multiplier sometimes produces non-ISO frequency values.
- If you are using Listen Hardware that supports Input Auto Range/Auto Gain (e.g. AmpConnect, AudioConnect or SoundConnect 2) we recommend that you enable these features to ensure that you achieve good Max FSD values in Acquisition. Since the sequence may present the DUT with a broad range of test levels, Auto Ranging will prevent input clipping during Acquisition by automatically adjusting the input signal path gain while optimizing Max FSD.

Further Sequence Development

This sequence has been designed to be accessible to 100% of SoundCheck customers. Ways in which you could modify or further develop the sequence include:

- Headphone/earphone testing
- Modify the sequence to use a higher resolution stimulus (Steps 25 and 32 as noted above) and save it as a new sequence

Changes from Max SPL vs. Frequency (v1)

1. Added initial response and impedance measurement
2. Added option to use f_0 -3dB as Start Frequency
3. User defined test level (that actually works)
4. User defined Stop Frequency – previous version relied on loop index logic to halt the sequence which varied depending on stimulus frequency range and resolution
5. User defined Vmax
6. Stimulus frequency is now coerced to standard ISO frequency points (in the past there was the potential for +/- 20 Hz error)
7. Stimulus type changed from Amplitude Sweep to Stweep
8. Incrementing Stimulus Level is no longer achieved by multiplying the stimulus waveform by a constant

Listen

Sequence Logic

Type	Step Name	#	Out	In
	(Overall sequence)			
Ser	Prompt for SN	1		
Mes	Operator Message	2		
Sti	Stweep - 20k-20Hz (R40)	3	Amp ch 1	
Acq	Play & Record	4	Amp ch 1	Reference Mic Impedance Box
Ana	Fundamental	5		
Ana	Impedance	6		
Pos	Est. Resonance	7		// Estimate resonance of impedance curve. Default search range=30-500 Hz
Dis	Response and Impedance	8		
Mes	Operator Dialog	9		
Pos	Curve Average	10		// Calculates sensitivity at resonance frequency
Pos	Curve minus constant	11		// Calculates -3dB point from resonance
Pos	Intersection	12		// Finds -3dB point and names it Start Frequency
Mes	Enter Start Frequency	13		// User prompt for start frequency
Mes	Enter Stop Frequency	14		// User prompt for stop frequency
Mes	Enter Compression Limit	15		
Mes	Enter THD Limit	16		
Mes	Enter Rub & Buzz Limit	17		
Mes	Enter Perceptual Rub & Buzz Limit	18		
Mes	Enter Vmax	19		// User prompt for max rms stimulus voltage
Mes	Logic Variable 1	20		// Creates Logic Variable 1 (y=1)
Mes	Enter Test Level	21		// User prompt for initial test level
Pos	Curve Subtraction Lin	22		// Create Dummy variable with x & y coodinates
Pos	Change Start Freq Variable	23		// Gives Stim Frequency a dummy y axis for later
Pos	Curve division	24		// Strips the units from Stimulus Frequency's y axis
Pos	Stimulus Resolution Multiplier	25		// Increments the stimulus frequency. Use 1.259 for (1/3 octave). Use 1.122 for 1/6 octave, 1.059 for 1/12 octave, or 1.029 for 1/24 octave
Pos	Initialize Stim Level dB	26		
Pos	Curve plus constant	27		// Initializes the Stim Level dB variable.
Com	comment	28		// Begin the measurement loop
Sti	Baseline Sweep	29	Amp ch 1	
Acq	Play & Record	30	Amp ch 1	Reference Mic
Ana	Fundamental	31		// Measure the baseline level
Pos	Resolution	32		// Takes baseline fundamental x value and coerces it to standard ISO frequency point
Pos	Maximum	33		// Converts x-y pair from previous step from curve to value
Pos	Curve minus constant dB	34		// Coerce y value from previous step to zero. Update Stimulus Frequency variable.
Lim	Stimulus-Upper Frequency	35		// Ends sequence when Stop Frequency value is exceeded
Pos	Curve Average	36		
Sti	Loop Sweep	37	Amp ch 1	

Acq	Play & Record	38	Amp ch 1	Reference Mic	
Ana	Max SPL Distortion	39			
Lim	FSD Limit	40			// Checks for sound card clipping
Mes	Clipping Sound Card	41			
Pos	Curve Average	42			
Pos	Curve Subtraction dB	43			// Compares current level to baseline
Pos	Curve minus constant dB	44			// Subtracts initial stimulus level from current
Pos	Curve Subtraction dB	45			// Compares the level and stimulus deltas
Lim	Compression	46			
Pos	Curve Average	47			
Pos	Curve Average	48			
Pos	Curve Average	49			
Lim	R&B	50			
Lim	THD	51			
Lim	Perceptual R&B	52			
Lim	Vmax1	53			
Dis	Max SPL 1	54			// Exits the loop when one of the measurement limits fails
Pos	Curve plus constant dB	55			// Increments the stimulus level
Pos	Curve plus constant dB	56			// Increments the stimulus tracker in dB
Mes	Loop Step	57			
Pos	Curve minus constant dB	58			// Decreases the stimulus level by 3 dB
Pos	Curve minus constant dB	59			
Com	comment	60			// Begin finer resolution Loop
Sti	Loop Sweep	61	Amp ch 1		
Acq	Play & Record	62	Amp ch 1	Reference Mic	
Ana	Max SPL Distortion	63			
Lim	FSD Limit	64			// Checks for sound card clipping
Mes	Clipping Sound Card	65			
Pos	Curve Average	66			
Pos	Curve Subtraction dB	67			// Compares current level to baseline
Pos	Curve minus constant dB	68			// Subtracts initial stimulus level from current
Pos	Curve Subtraction dB	69			// Compares the level and stimulus deltas
Lim	Compression	70			
Pos	Curve Average	71			
Pos	Curve Average	72			
Pos	Curve Average	73			
Lim	THD	74			
Lim	R&B	75			
Lim	Perceptual R&B	76			
Lim	Vmax	77			
Dis	Max SPL 2	78			// Exits the loop when one of the measurements fails
Pos	Curve plus constant dB	79			// Increments the stimulus level in 0.5 dB steps
Pos	Curve plus constant dB	80			// Increments the stimulus level tracker in dB

Mes	Loop Step	81	
Mes	Loop Step	82	
Pos	Curve multiplied by constant	83	// Convert stimulus level to linear
Lim	Stimulus Frequency	84	// Configures Stim frequency for auto-saving. Changes data type 'Value' to 'Result'.
Aut	Save Results to Excel	85	
Pos	Curve Multiplication	86	// Combines frequency and stimulus level
Pos	Curve Multiplication	87	// Combines frequency and SPL level
Lim	Logic Variable	88	
Pos	Curve multiplied by constant	89	// Records the first data point for Max stim level
Pos	Curve multiplied by constant	90	// Records the first data point for Max SPL
Pos	Curve plus constant	91	
Pos	Set Variable to 0	92	// Ensures the previous two steps will only be run once
Mes	Loop Step	93	
Lim	Logic Variable	94	
Pos	Point Splicing	95	// Combines the first and second points for Max stim level
Pos	Point Splicing	96	// Combines the first and second points for Max SPL
Pos	Curve plus constant	97	
Pos	Set Variable to -1	98	// Ensures the previous two steps will only be run once
Pos	Point Splicing	99	// Iteratively builds the Max stim level curve
Pos	Point Splicing	100	// Iteratively builds the Max SPL curve
Pos	Curve plus constant	101	
Dis	Max SPL End	102	
Aut	Save to DAT	103	
Dis	Max SPL Final	104	