LISTEN INC

Transforming Sound into Knowledge

Sequence Note

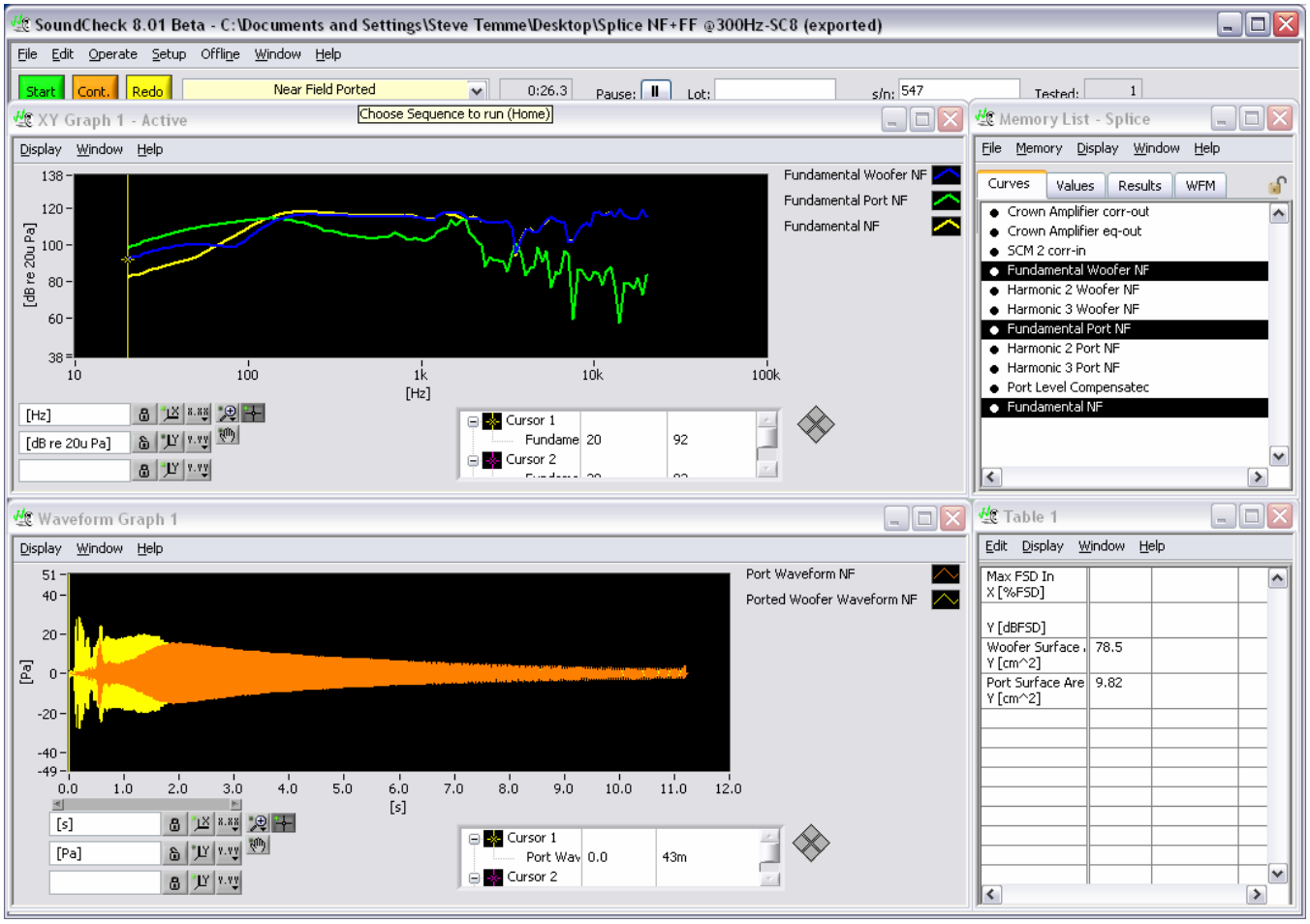
Splice Near and Far Field Sequence

(including Ported Loudspeakers)

Introduction

The purpose of this sequence is to measure the anechoic response of a loudspeaker in an ordinary room using both a near field and time-windowed, far field measurement "spliced" together to cover the full bandwidth of the loudspeaker's response from 20 to 40 kHz.

First, the near field frequency response is measured using a 1/12th octave stepped sine sweep by placing the microphone very close to the low frequency driver and the port(s) if any. Then the far field frequency response is measured using a continuous log sweep with the Time Selective Response analysis algorithm.



Top graph: Near Field Response of both Woofer and Port, Bottom graph: Recorded Time Waveforms of both Woofer and Port, Table: Calculated Woofer and Port(s) surface areas

The near field measurement is not affected by room reflections but at high frequencies, it does not represent the free field response. The far field, time-windowed measurement is not affected by room reflections but at low frequencies, it is affected by the room size which limits the width of the time window and corresponding frequency resolution. The goal is to find an overlap range of the two measurements where they are both valid and to choose a frequency at which to splice the two halves of the measurements together and obtain the full range free field response of the loudspeaker. This is done in several Post-processing steps including the inverse FFT of the final frequency response back to the time domain to calculate the impulse response.

There are two subsequences for both sealed and ported loudspeakers. The Near Field Ported loudspeaker sequence measures both the port and woofer. Then it asks for the surface area of both the woofer and port (or ports combined). It uses this information to scale the port level to the woofer level before complex summing their responses (see the references at the end of this application note for specifics).

The difference in level between the near and far field (both amplitude and phase) at the splice frequency is calculated and displayed in the table along with the phase correction and microphone distance from the loudspeaker.

The sequence can be run with stored data as well and experimentation with the time window can be performed without having to remeasure data. The curve data and time waveforms (e.g. impulse response) can be exported for further analysis in programs such as our SoundMap™ time-frequency analysis software.

Required Hardware

- SCM-2 calibrated measurement microphone PN 4004
- SoundConnect Microphone power supplies PN 4020
- Power amplifier (Crown D45 PN 5600)

Required Software

- SoundCheck 8.0 or later
- Stepped Sine PN 2018
- Time Selective Response PN 2006
- Post-Processing PN 2004

Optional Software Modules

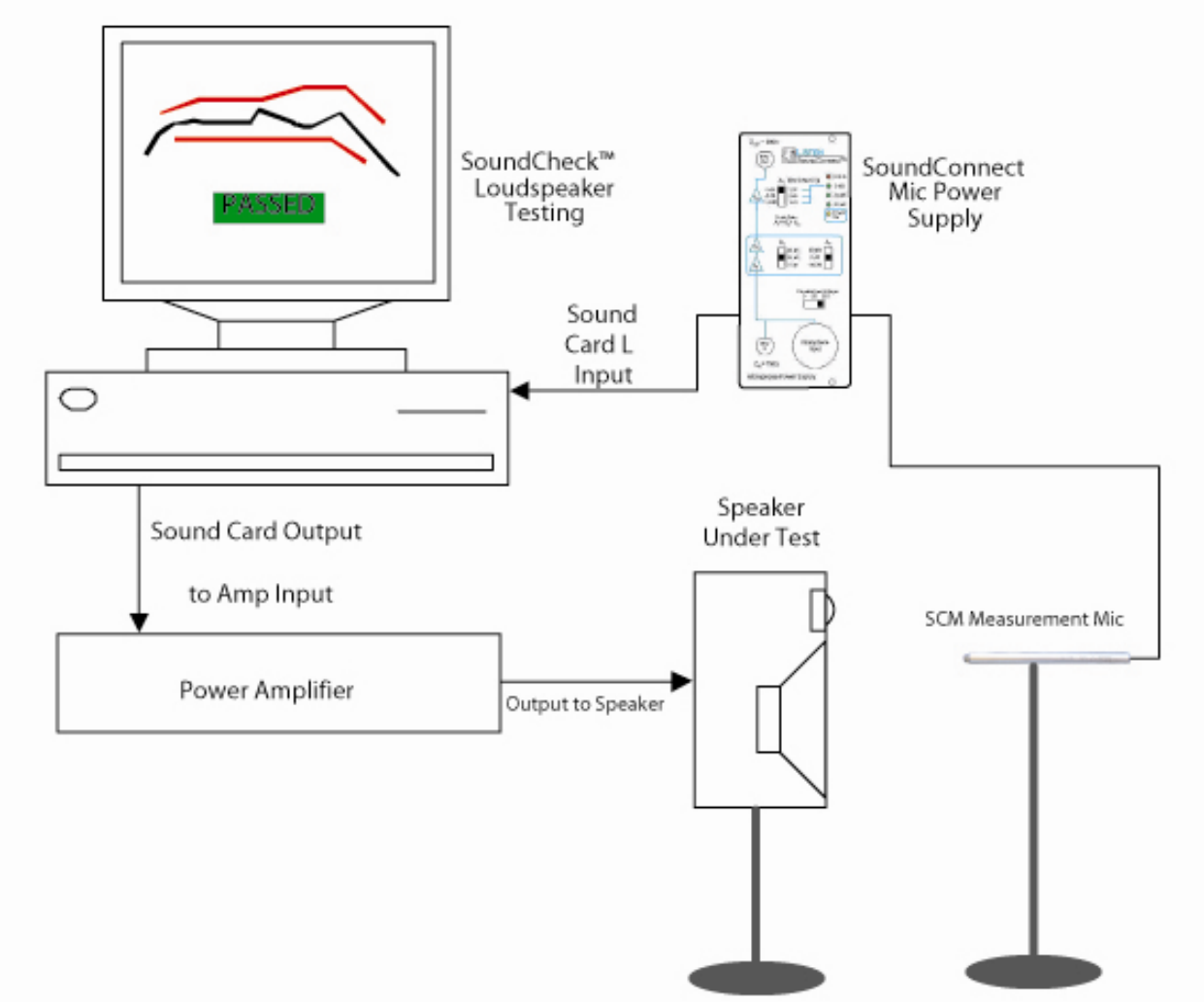
- Harmonic Distortion PN 2001

Setup & Calibration

1. Connect left output of the sound card to the left input of the amplifier. To calibrate the amplifier, follow directions in the SoundCheck manual for amplifier calibration.
2. Connect the left output of the amplifier into the loudspeaker under test.
3. Connect the SCM microphone into SoundConnect microphone power supply and the microphone power supply into the left input of the sound card. To calibrate the microphone, follow the directions in the SoundCheck manual for microphone calibration.
4. Place both the loudspeaker and microphone on stands so that they are roughly in the middle of the test room both horizontally and vertically. This will optimize the minimum permissible low frequency cut-off for time-windowed free field measurements.

You are ready to start the sequence. If you just want to look at stored measurement data, select Recall Data at the beginning of the sequence.

System diagram:



Sequence Logic

Type	Step Name	#	Comment:
Har	CardDeluxe 40kHz bandwidth		
Cal	Crown Amp & SCM 2 Mic		
// Near Field			
Mes	Ported Speaker	1	// Is the speaker ported?
Seq	Near Field Ported	2	// If ported, run the Near Field Ported sequence
Mes	dummy jump	3	
Seq	Near Field Woofer	4	// If sealed (not ported), run the Near Field Woofer seq
// Far Field			
Seq	Far Field	5	// Run Far Field sequence
Pos	Curve Subtraction	6	// Find difference in level between NF & FF
Pos	Curve Average	7	// Choose Splice Frequency (300Hz is default)
Pos	Phase correction	8	// Calculate delay between NF & FF
Pos	Phase correction FF	9	// Calculate phase correction@300Hz (t=angle/360° x f)
Ana	FF	10	// Correct for time delay between NF & FF
Pos	NF to FF level correction	11	// Correct for level difference between NF & FF
Pos	Frequency Window	12	// Near field from 20 - 300Hz
Pos	Frequency Window	13	// Far field from 301 - 40kHz
Pos	Splice NF+FF	14	// Add level and phase corrected NF to FF
Pos	Calculate Impulse Response	15	// Perform an inverse FFT
Pos	Convert to ISO R40	16	// Convert Response to Standard ISO 1/12 octave response
Dis	Splice	17	
Mes	Save data	18	
Aut	Save to Wfm	19	
Aut	Save to Dat	20	
Mes	End Seq	21	

Further sequence development

This sequence has been designed for testing a small bookshelf loudspeaker in a reasonably small room (e.g. 10' x 10' x 10'). Ways in which you could modify or further develop the sequence include:

- Change the Splice frequency for different loudspeakers and room sizes (e.g. lower the splice frequency for bigger loudspeakers in bigger test rooms)
- Splice the harmonic Near and Far field distortion curves together
- Measure impedance at the same time as the Near Field response using an impedance box on the right input channel.

References:

C. Struck and S. Temme, "Simulated Free Field Measurements", JAES, Vol. 42, No 6, 1994 June
www.listeninc.com/files/pdf/AESFreeField.pdf

D.B. Keele, "Low-Frequency Loudspeaker Assessment by Near-Field Sound Pressure Measurement", JAES, Vol. 22, No. 4 (1974 March).