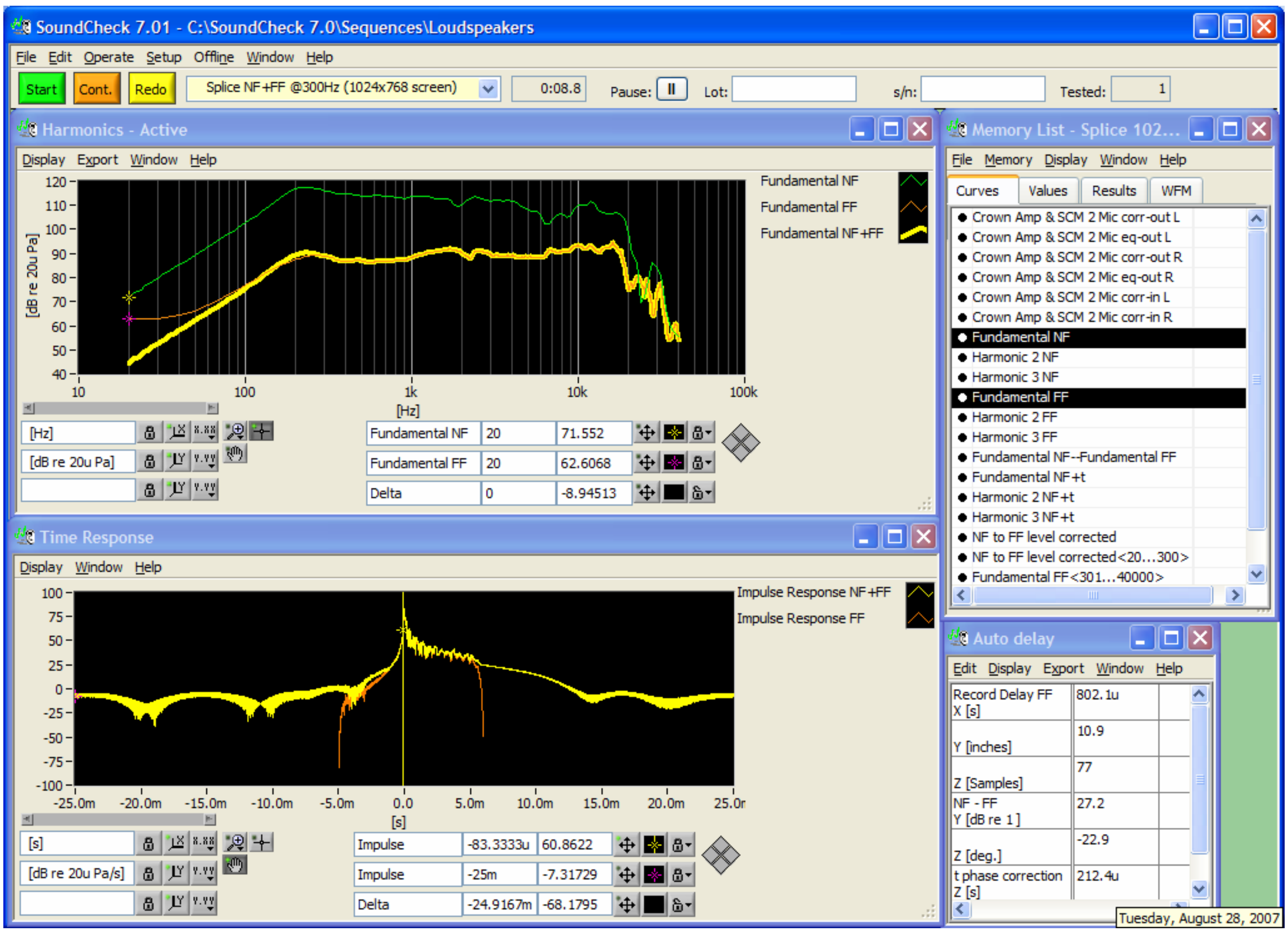
Splice Near and Far Field Sequence

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 (less than an inch from the woofer). Then the far field frequency response is measured using a continuous log sweep with the Time Selective Response analysis algorithm.



Top graph: Near Field, Far Field, and Spliced Frequency Responses, Bottom graph: Time-windowed Far Field and Spliced Impulse Responses Table: Mic distance, NF and FF level and phase difference

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.

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

Optional Software Modules

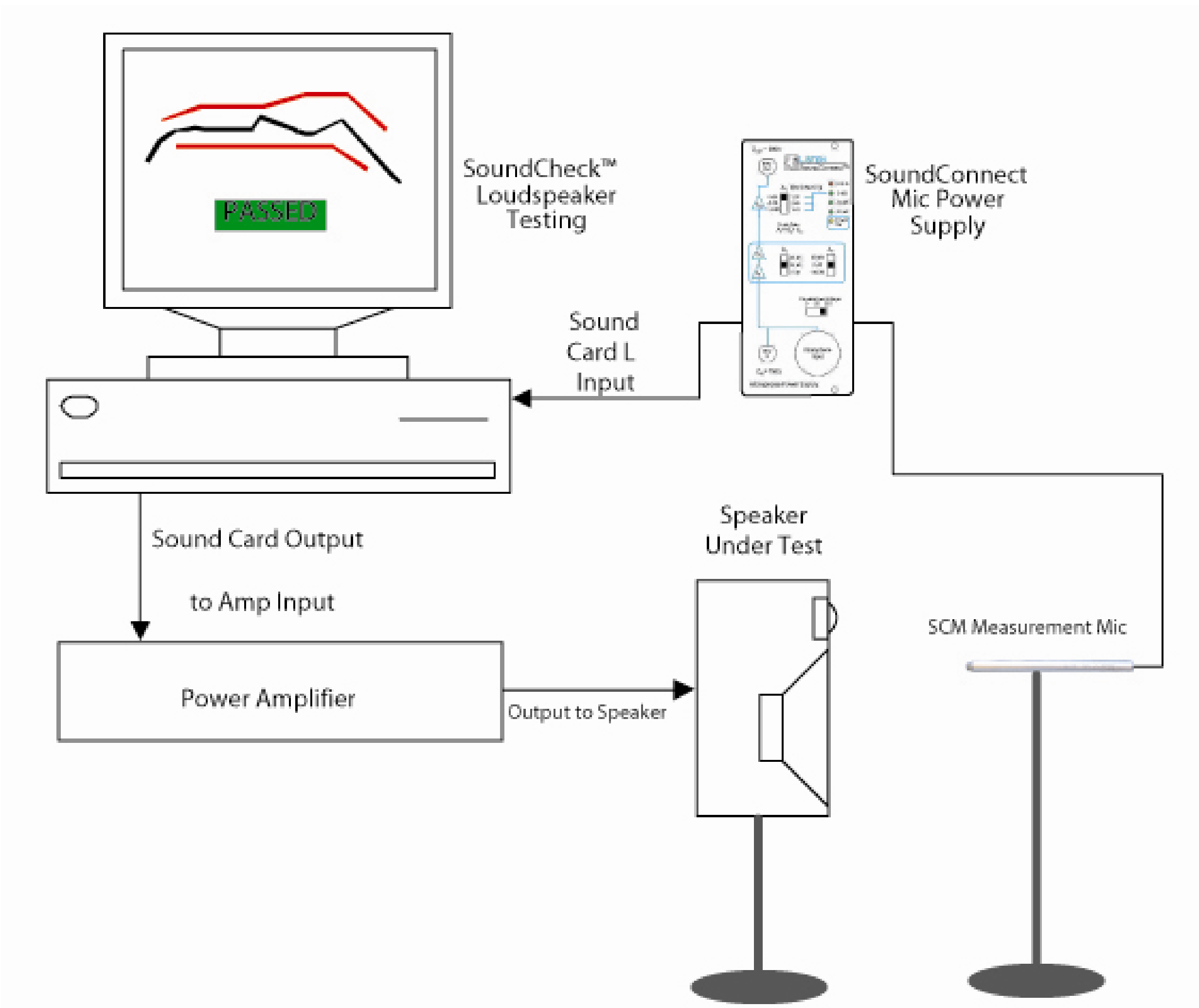
- Harmonic Distortion PN 2001

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	#	Out	In	Comment:
Har	CardDeluxe 40kHz bandwidth				*1 channel in/out at 96 kHz sampling rate*
Cal	Crown Amp & SCM 2 Mic				*standard amp & microphone*
Mes	Recall data	1			*Recall data or measure?*
Rec	Recall waveforms	2			*Recall saved waveforms*
Rec	Recall curves jump on pass to # 12: FF	3			
Mes	Near or Far Field display step jump on fail to # 12: FF overwrite curves	4			*Measure the Near field or analyze the Far field?*
Mes	Near Field	5			
Sti	NF Stweep	6	L		
Acq	Play & Record	7	L	L	
Ana	NF	8			
Mes	Far Field	9			
Sti	FF TSR	10	L		
Acq	Play & Record	11	L	L	
Ana	FF	12			*Adjust time window to remove reflections*
Pos	Curve Subtraction	13			*Subtract Far from Near field curves*
Pos	Curve Average	14			*Find difference at 300Hz*
Pos	Phase correction	15			*Calculate phase correction@300Hz ($t=\Phi/360^\circ f$)*
Ana	NF	16			
Pos	NF to FF level correction	17			
Pos	Frequency Window	18			*Near field from 20 – 300Hz*
Pos	Frequency Window	19			*Far field from 301 – 40kHz*
Pos	Splice NF+FF	20			*Combine the two curves*
Pos	Calculate Impulse Response	21			*Perform an inverse FFT*
Mes	Save data display step jump on fail to # 25: Splice 1024x768 overwrite curves	22			*Save data and waveforms to disk?*
Aut	Save to Wfm	23			*Save time waveforms to disk*
Aut	Save to Dat	24			
Dis	Splice	25			

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.
- Measure a ported loudspeaker using multiple Near field measurements of port(s) and woofer(s) and sum them together before splicing with the Far field measurement

References:

C. Struck and S. Temme, "Simulated Free Field Measurements", JAES, Vol. 42, No 6, 1994 June