SUBWOOFER SYSTEMS STANDING WAVE CANCELLATION (SWC)

Marshall Choong Audio

Audiophiles are well aware that the sound field produced in a small or medium sized room is highly irregular especially in the bass region from 20 - 100 Hz. The sound level distribution depends on the position of the listener and loudspeakers. This occurs due to the multiple reflections from room boundaries that have little or no absorption of sound energy in the bass region. The presence of strong complex standing waves in the room, is inevitable.

Fig 1. shows a slow bass sweep in a typical room. The large peak at 55 Hz is a fundamental resonance caused by an overlap of room modes in this frequency range.

If an attempt is made to install a full range system in a typical room, the final outcome for the listener is muddled, irregular and unnatural sounding bass.

For a high quality system, the large peaks and troughs that occur are greater than the ear can tolerate and the strongly resonant nature of the peaks gives rise to a seldom discussed problem, the bass dynamics.

A strong resonance i.e. the standing wave, will absorb sound energy from the source and manifest itself as large audible peaks in various areas of the room and deep troughs in other areas. The rise time of a bass transient feeding a standing wave, and music is composed mainly of transients, may be typically 0.5 to 1 second long. The energy absorbed by the resonance will take a similar time to dissipate. This represents a gross distortion of a real bass transient.

To deal with this problem, several approaches have been tried in recent decades some appearing as commercial products.

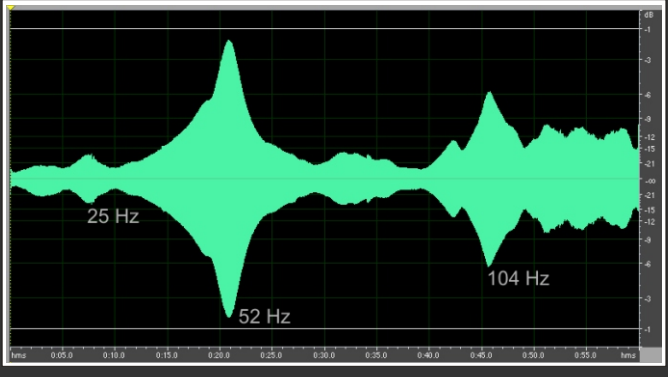

Fig. 1. Bass sweep in the test listening room, 20 - 160 Hz, normal speaker placement, no subwoofers

Speakers with Limited Bass Response

Audiophiles may consider this to be the optimum solution and explains the popularity of small high quality stand mount speakers. Bass extension below 80 Hz will often lead to severe irregularities as major room modes and room gain is encountered.

Optimum Speaker Placement

This is, at best, only partially successful, does not improve the bass dynamics, and is valid only in a small hot spot listening area.

Physical Room Treatment

The use of bass traps and wide range bass absorbers is an effective approach were it not for their excessive size and cost. To implement properly it would require a completely dedicated room.

Use of Simple Equalisers

High Q filters are necessary to reduce peaks but because of excessive power requirements, troughs cannot, in practice, be improved. High Q filters produce audible side effects, there is a small hot spot and other areas of the room are made worse. On balance, no improvement.

Digital Room Correction

Although far more sophisticated than simple equalisation, it is still unable to cope with the essential problems and has the same difficulties. Cost and complexity in this group of solutions is high.

Use of Multiple Sub Woofers

This is an alternative approach that is simple, relatively low cost and can have some success.

Slow bass sweeps are more revealing of room effects than , for example, pink noise sources.

The transient nature of bass frequencies in pink noise is often unable to fully excite room modes giving a different, smoother, response. This is a reasonable compromise for test purposes, representing most music. However, sustained bass notes are not represented by pink noise sources.

It is a good low cost alternative to full cancellation methods despite the effect on room dynamics being less predictable.

Standing Wave Cancellation Methods *

This is the system suggested by Marshall Choong as the most consistent and cost effective approach to the problem.

4 identical sub woofers are placed in the room as shown in Fig 2. The rear pair are fed with a delayed version of the signal to the front pair, with slight attenuation and reversed phase.

The particular placement of the front speakers is designed to set up an accurate representation of a plane wave front travelling down the room. As this reaches the rear speakers, the delayed signal from the rear cancels the reflection from the rear wall. With no reflection, all standing waves have a much diminished level and a listener in the centre area of the room will only experience the direct radiation from the front speakers.

Furthermore, the cancellation effect is effective over about a third of the room floor area, around the centre, and away from the near field of the sub woofers.

Fig 3. shows a tone burst sweep from 20 to 100 Hz in 1/6 octave steps. Each tone burst is 2 seconds long. Note the excellent rise and fall times and the overall response is about + / - 2.5 dB. (See the website for more details).

* CELESTINOS AND NIELSON J. Audio Eng Soc., Vol. 56, No. 11, 2008 November

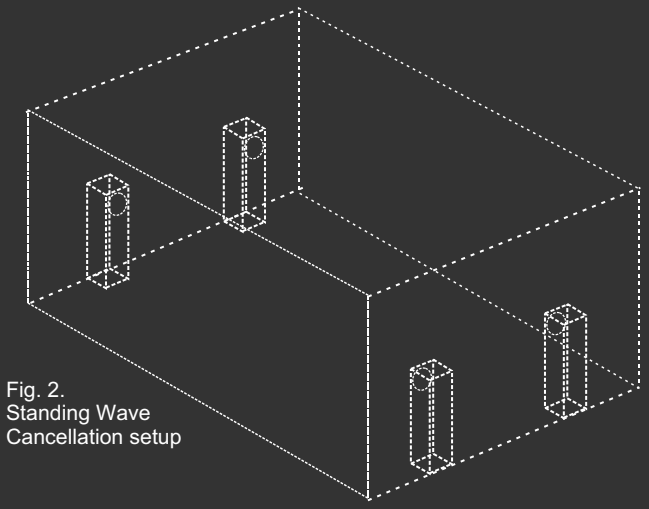

Fig. 2.
Standing Wave
Cancellation setup

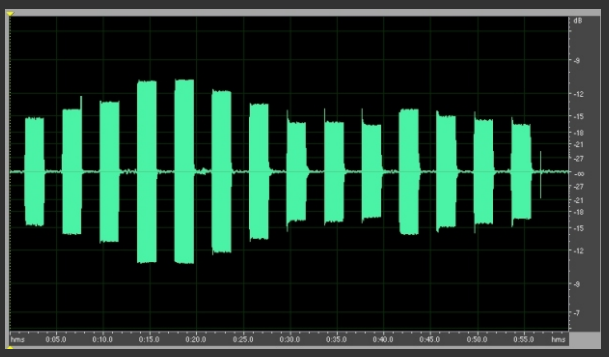

Fig. 3. Standing Wave Cancellation tone burst tests, 1/6th octave 20 - 100 Hz

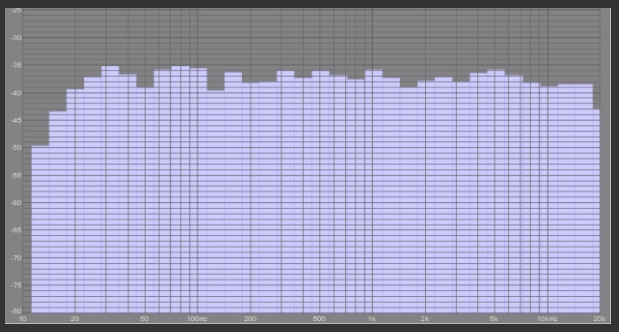

Fig. 4. 1/3 octave full range in-room response with Marshall Choong TA-4 speaker, all channels driven. 10 Hz - 20 kHz

Marshall Choong has a range of sub woofers designed for SWC applications either domestic or professional use. They are all full range closed box designs finished in real cherry veneer.

<u>Type SW1</u>
10 " driver, floor standing 70 litre cabinet
MC Intermodulation Distortion Test: -45dB, (0.55%), 90dBA 1m
Dimensions 300 x 300 x 1200 mm, weight 31 kg

<u>Type SW2</u>
8 " driver, wall mount 20 litre cabinet
Dimensions 300 x 200 x 400 mm

<u>Type SW3</u>
12" driver, floor standing, 90 litre cabinet
Dimensions 350 x 350 x 1200 mm

All systems come complete with a digital delay and sub woofer crossover.

Model SW-1