

Originally
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Widescreen
REVIEW & Custom Home
Theatre Design

Bass Management

PART 1

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Widescreen Review Bass Management **PART 1**

Bass is good!
Good bass is even better!!
Really good bass is hard to get!!!

What more can I say?
Well, about 5000 words, I can say.
Why can I say that? Because I have spent about 40 years working in and around bass quality in listening rooms and home cinemas, and I think I may just be starting to get it. Maybe...

Bass Matters. Why does bass matter so much? Research in the field of psycho-acoustics shows that about 40% of a sound system's performance grade comes from the quality of the reproduction from 20Hz to 80Hz. In other words, 2 octaves, out of the 10 we can hear, contribute to about half of how we perceive the system. There is great return on investment in the process of improving bass quality!

The cool thing about good bass is that pretty much anyone can hear it. It's tactile, emotional, rhythmic, rich, full, real, and it's also really hard to get right. You have to manage it.



Why is it so hard? Because it's not just about getting bigger subwoofers. A lot of other items factor into the process. Here's a short list:

- **Room dimensions**
- **Rattles**
- **Bass Damping**
- **Seating locations**
- **Subwoofer and speaker selection**
- **Subwoofer and speaker locations**
- **Crossover Settings**
- **Tuning (Time Optimization, EQ, Levels)**

You can see that Bass Management is in fact a lot more than setting a Subwoofer Crossover. When I coined the term, back in the mid-1990s, it was meant to cover much of these issues. The meaning got diluted over time, but the problems haven't gone away! My intention is to discuss all of the above in a multi-part article series. I occasionally lecture on this, and the advanced course I teach at CEDIA Expo and ISE takes a good 4 hours. It's a head-spinner! It will take just about that reading time to get through the deep dive, so get ready for some good bassoholic fun.

Let's start off with a bunch of introductory work in this first part. Then we'll peel away all the pieces so as to get clean and powerful control of those pesky low frequencies.

You will see that I love making lists. It helps me keep track of the information progress, and also helps with clarity. Here is the second list (first one was above):

What do we care about in Bass Matters?

- **Bass sound pressure capability.** First off, you have to make sure that the bass sound pressure capability of your system is a match to your specified needs. What I mean by this convoluted notice is that it all kinda depends on what you are listening to. Since most of us in this audience are interested in movies, the number is simple. Film performance standards require 115dB of peak

Sound Pressure Level in the 20 to 100Hz region. It's all pretty straight and mathematical. The reference level of subwoofers in film post-production studios is set at 95dB SPL for -20dBFS signals (20dB below maximum Full-Scale modulation of the digital track). At max signal modulation of 0dBFS, the sound pressure will be at 115dB, simply $85+20$. I am simplifying a bit because there are considerations of long versus short signal modulation, but close enough for this discussion. At 115dB SPL, the room really rocks. That sea creature foot stomp in Pacific Rim will make you feel the pressure from your head down through your body. Scary and cool!

- **Bass extension.** How low does the system go, but not just at moderate sound levels. How low does it go when playing back at 110dB and more? Ideally you can make it all the way down to 20Hz, or even 16Hz for better systems. In reality, down to 30Hz will make most people very happy.
- **Bass frequency response.** Do all the notes from 20Hz to 100Hz play back in the room with equal level, without peaks or dips? A frequency response measurement, averaged over a relevant section of the listening area, should yield a smooth set of values, within a 3dB window. You can usually go up to a 5dB window without noticing too much error, but beyond that, you no longer are in the obsessiveness window of this

publication's readership!

- **Bass temporal response.** Do all the bass notes play with equal rise and decay? You need it in order to get to that mythical “punchy” bass, but it gets to be really hard when the room has potential standing wave resonances at 60Hz, right down the middle of bass energy of film action scenes, and most modern music. The resonances can hold some bass notes in the room for over a second in some worst-case scenarios. That's just not right!
- **Bass balance.** In addition to the bass region being smooth and punchy, its level also needs to balance well against the mid and high frequencies in the sound system and room. Something this simple, that just seems as basic as setting the level of the subwoofer, can be a matter of lots of trial and error until it all sounds just right.
- **Localization.** Low bass is clearly not directional to human beings due to the very long wavelengths; orders of magnitude longer than the spacing between our ears. However, many of the percussive bass effects in movies are meant to come from a direction associated with the action on or off the screen. The directionality is in fact caused by the higher frequency content of the thumping sounds, but can be messed up by standing waves and sound reflections in the room, as well temporal misalignment of the speakers and subwoofers.

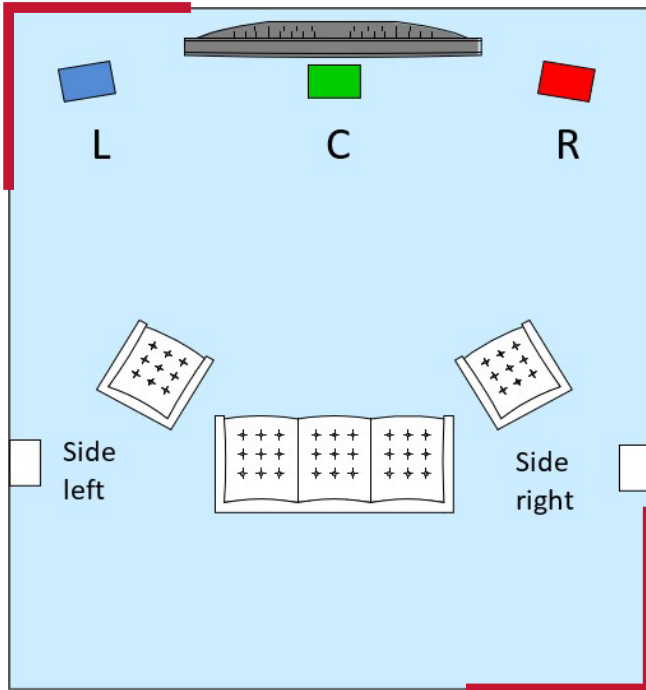
- **Consistency throughout the room.** No, it's not enough to get good bass at one sweet spot. You need it over the entire seating area of your home cinema or listening room. How else are you going to impress your friends? They all need to know how bad-ass and magnanimous you are. If you aren't careful, one of your friends could be hearing 30dB less bass than another, and there again, that's not right! You think I'm exaggerating? I have data from many of the over 1,000 rooms I worked on that shows this lousy condition. And by Murphy's first law of acoustics, it's often at the main seat, the “captain's seat”, that there is a hole in the bass region. That's even worse!

Legends

There are many, many legends in the field of acoustics and speakers.

One of them is that since low bass is in fact non-directional to the human listening system, you can put a subwoofer anywhere you want in the room. Is this true or false?

Let's run a few experiments in a basic listening room and check it out. We will place a really good subwoofer in five locations of a 16x13x9' (5x4x2.75m) room, that correspond to the locations of L, C, R, Side-left, and Side-right speakers. We will measure the frequency response from 20Hz to 200Hz at the main listening position, and see if there are any differences.



The subwoofer is first measured outdoors in the nearfield, with the test microphone right up against the cone, using a high-resolution impulse response scheme (Room EQ Wizard)

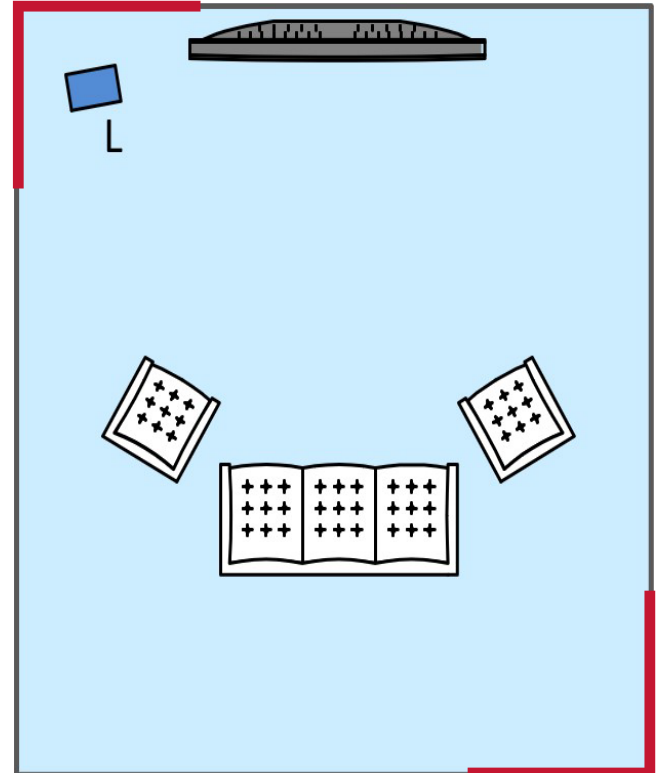


Here's the nearfield anechoic response of the subwoofer:

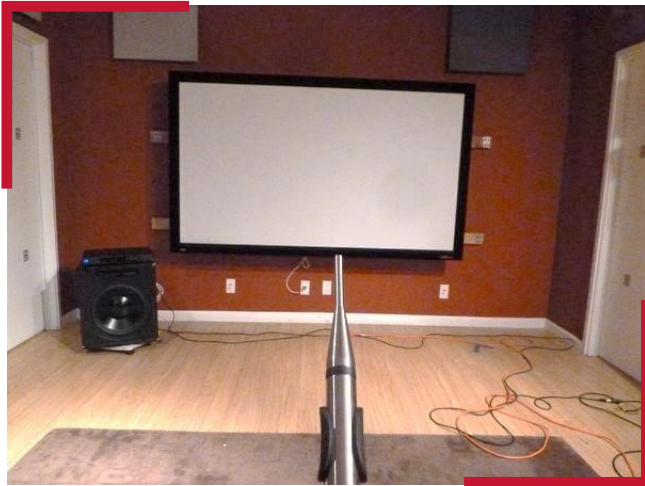
Really good and smooth from 20Hz to 200Hz, with no more than a 2dB maximum deviation window.



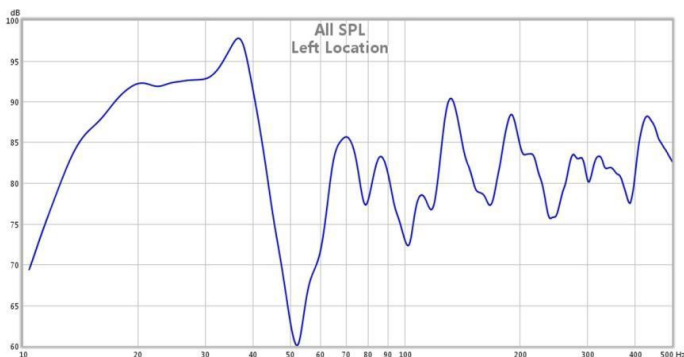
Up next, let's put this subwoofer in the Left speaker location, to see how it behaves there, or even what the bass response of a "full range" speaker would be from this location.



Here's a picture of the subwoofer in our test room. The measurement microphone is located right at the main listening position.

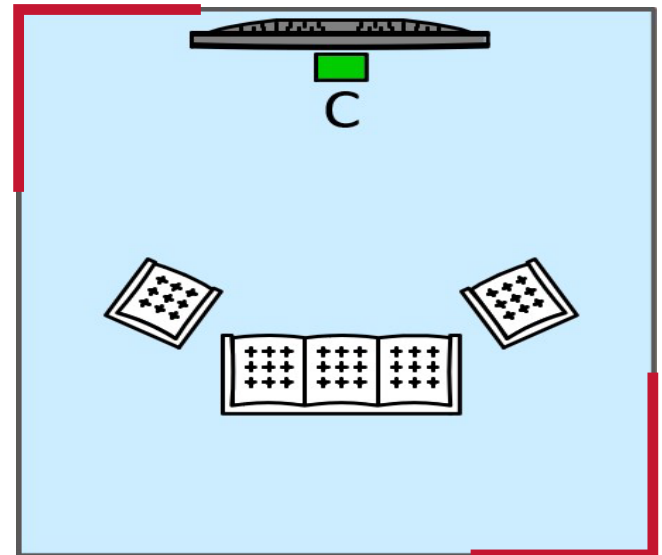


And here is a measurement at the listening position of the same subwoofer in the left speaker location in the room:

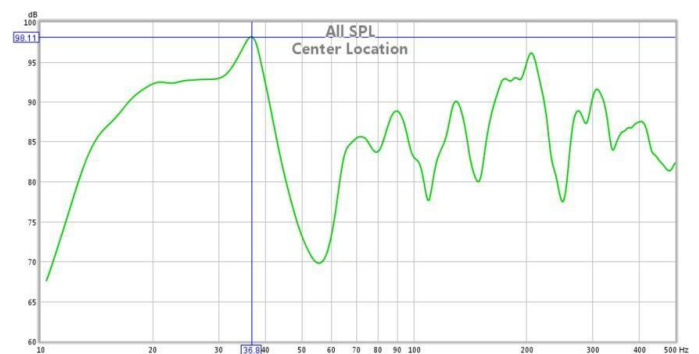


Ouch, that is hard to believe! Below 30Hz, it's pretty much like the nearfield, but then there is a 38dB range from the peak at 37Hz to the dip at 52Hz. That's bad!!

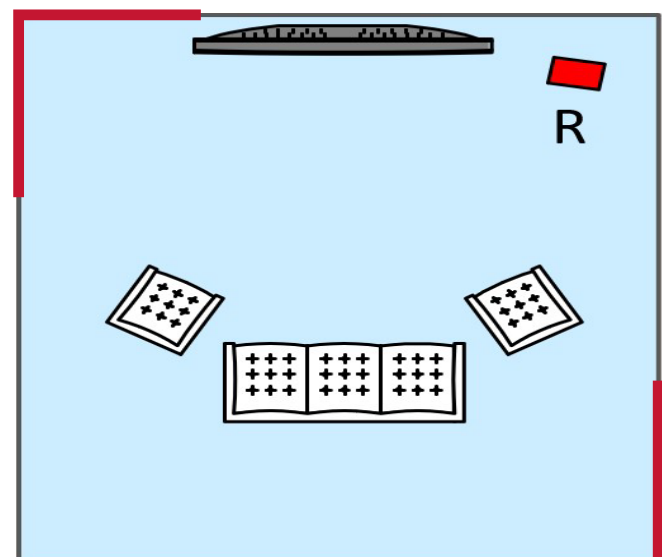
Next up, let's put the subwoofer in the Center speaker location of the room, and measure again at the main seating position.

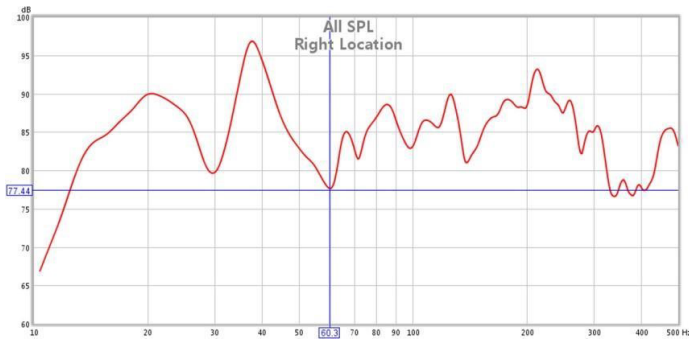


The error range is now 28dB from the peak at 37Hz to the dip at 55Hz. Different than the Left position, and still bad!

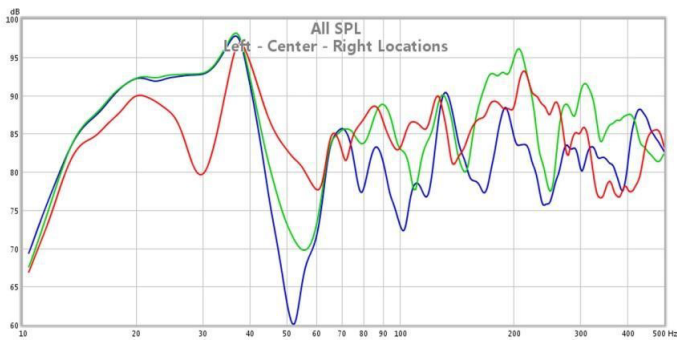


Next up, let's move the subwoofer to the Right speaker location and re-measure



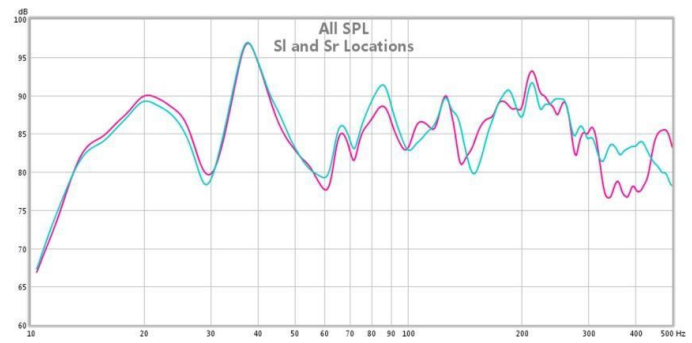


The error range is now merely 20dB from the peak at 38Hz to the dip at 60Hz. Different than the Left and Center positions, and still bad!



For review of the issues, here are the three measurement curves superimposed. Same subwoofer, same room, same mic location at the listener point, different subwoofer placements. Clearly different!

Also, interesting to note how differently the Left and Right subwoofer locations behave in the rectangular and apparently symmetrical room. Well, it isn't acoustically symmetrical at low frequencies; the framing and sheetrock is different enough, the door locations different enough, the large window at the back of the room isn't on the centerline, and then there are some other mechanical differences.



And just to finish up, here are the subwoofer responses when placed at the Side-left and the Side-right locations. Still bad at 20dB error window.

Like they said on the MythBusters show, Myth busted*.

***Footnote:** Grant Imahara, the “geeky” scientist on the show was my first engineer in the early days at HomeTHX. He then went off to live his lifelong dream of working in robotics at ILM, before joining his ex-ILM pose at MythBusters. He passed away suddenly a few years back. I hope he is having fun running remote controls of a larger-than-life R2D2 or an Energizer bunny somewhere up in the clouds!

So now, do we agree that there are in fact some problems in the proper reproduction of the bass in listening rooms and home cinemas? The errors can be as large at 30dB or more, and they depend on driver location, listening position, wall construction, and more.


The next parts of this article series will start to delve into the room-related issues of standing wave resonances, boundary conditions, and bass absorption.

Until then, enjoy the ride!



When you like Bass so much that you tattoo a Bass Clef on your arm!

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A dimly lit room, likely a home theater or recording studio, featuring a large window with acoustic panels and a tall rack of electronic equipment.

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