



Performance Media Industries, Ltd.

The Bass-ics
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Other than sticking it in your ear, what can you do with a sound level meter?! You can use it to tune the level of a subwoofer, but proceed carefully!

Subwoofers are a very misunderstood breed of product. Let me tell you what I think they should be all about:

A subwoofer should act just like an extra “way” in a two, three, or four-way speaker system. The extra “way” is an additional transducer system that handles the frequencies below those that your main speakers can comfortably or reliably produce. So if you have a “full range” speaker that claims to play down to 40 Hz, you can extend its response to 20 Hz by cutting off signals below 40 Hz and feeding them to a subwoofer that only plays 40 Hz and below. (Don’t use the subwoofer to play 100 Hz and below with this 40 Hz speaker, because the overlap from 100 Hz to 40 Hz will give you an uneven and bloated sound.) Things can get a bit more complicated, though. Your speaker might really only be comfortable playing 40 Hz frequencies at moderate levels, so loud bass sounds in movies, organ music, or that rap your kids won’t stop playing might overload the woofers. You may then want to do a hand-off from the speaker to a subwoofer at 60 Hz or 80 Hz. No problemo, you can set the filtering circuits of the subwoofer crossover at the right point to prevent sound effects that might remind you of the campfire scene in *Blazing Saddles* from leaking out of the subwoofer. How do you figure out the limit points? That’s again a little more complicated. Tomlinson Holman of THX fame produced a series of test CDs called the Hollywood Edge, which include a group of headroom test pulses. Play the test signal at 40 Hz, and listen to how well your speakers handle it at moderate, then high levels. Use Disc 1, Tracks 23 through 33 for a rapid check of headroom, or Disc 4, Tracks 14 through 47 for a more precise set of tones in 1/3rd octave bands.

If you don’t hear a clean pulse, move the subwoofer crossover frequency to a higher point. Note that the crossover has to affect both the speaker and subwoofer signals. The speakers need to have a *high-pass* (in other words a low-cut) filter applied to the signals

feeding them, and the subwoofer needs a *low-pass* filter. The Bass Management circuits in any recent A/V controller will incorporate these filters, and if they are adjustable, you are in luck for the test. If they are fixed frequency, they are usually set somewhere between 80 and 100 Hz. Note that many subwoofers also include low-pass filters, but may not have adequate complimentary high-pass circuits for the speakers.

How high can you go with the subwoofer crossover? Usually 80 Hz is a safe bet. In a series of tests conducted by a research team in Europe, it was found that most humans don't hear the location displacement of a subwoofer for frequencies of 80 Hz and below. In some cases you can cheat up to 120 Hz, but then you need to ensure that the subwoofer stays up front in the room to avoid localizing it.

And things can get even more complicated yet. Say that your listening room has nasty room resonances known as standing waves or room modes. These resonances make the bass sound all mushy and one-notey. Say that the problems are right at 60 Hz. You can often move the speakers around until their interface with the room resonance is reduced, and the 60 Hz errors become less audible. So now where are the speakers? Somewhere not at all related to the video display, right? Well, that's not going to work, is it?! Here comes a cool solution. Set the crossover to 80 Hz, put the speakers back by the screen, and locate the subwoofer where it produces the smoothest bass in the room. As long as you keep the crossover frequency below 80 Hz, and as long as the low-pass filter you are using is steep enough (at least 24dB per octave), you shouldn't be able to locate the bass sounds playing out of the subwoofer!

Now, you have selected the crossover frequency based on your speaker's bass extension, bass headroom, and the room's standing waves. It's time to set the level of the subwoofer relative to the speakers. Ideally, you will do this by using a sophisticated piece of test equipment called a spectrum analyzer. You will play pink noise out to the whole speaker system through the crossover in the A/V controller or elsewhere in the chain, and you will measure the overall frequency balance of the system. Then you can adjust the subwoofer gain until the levels above and below the crossover frequency match up for a smooth transition. If you are in any way serious about your work, you will have bought one of these analyzers from Sencore, Gold Line, or Audio Control to name but a few. Once you set the subwoofer gain, you may be surprised that the bass is finally clean, and presents none of the lack of integration, fatness, or other criticisms that people often associate with subwoofers. It may also take time for you to realize that the bass is, in fact, set just right, and you shouldn't turn up the subwoofer because that would blow the performance of your fine system.

If you haven't yet sprung for one of these analyzers, you can get pretty close to the same results with that ubiquitous analog Realistic sound level meter from Radio Shack. (*Don't*

use the digital one.) The trick is to play the right test signals through the subwoofer, and correctly measure the level coming from it. The right test signals are those that produce an equal average voltage out to both the speakers *and* the subwoofer so all you have to do is match up their acoustic levels. This test signal set is typically pink noise band-limited from 500 Hz to 2 kHz for the speakers and from 40 Hz to 80 Hz for the subwoofer. Using a slow integrating voltmeter, the levels of the two signals are made electrically equal, and they should therefore play back at equal sound levels. This all sounds pretty darn complicated until you realize that those test signal sets are exactly like the ones in decent A/V controllers today, particularly those that have gone through THX certification. Alternatively, a few test DVDs include these test signals if you want to double-check your work. Look at the *Avia* disc by Ovation Software and the *5.1 Audio Toolkit* by PMI/Gold Line. (Yeah, so I produced the latter; you can't blame me for liking it!)

The little Realistic sound level meter is reliable down to 40 Hz, so you will be just fine if the subwoofer test signal is limited to the range of frequencies above that (which it should be). Use C-weighting and the Slow mode, and hold the meter at seated ear height. I do recommend moving the meter around the listening area, because you might find some variations from seat to seat, and you might want to take an average through the area. All you have to do now is adjust the level of your subwoofer so that it yields the same measured value as your main speakers. You can set the gain right on the subwoofer, or better yet use the level control inside the A/V controller. The resulting sound character should be smooth and balanced, which you can verify by listening to program material.

A final word: don't just plug pink noise directly into your subwoofer, then directly to your speakers to match them up. That just doesn't work because the differences in reproduction bandwidth between the speaker and subwoofer will result in completely erroneous measurements. You'll be fishing for bass in the wrong spot...

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