Moran in the Market - Deep-Bass Trolling by David Moran

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Separately and together, the three or so octaves we call bass—from somewhere below 20Hz up to, say, 150Hz—are often misidentified or mischaracterized.

The upper part of this range, if boosted, can thicken male voice and all other sounds that are "thickenable." Rock bass (except for kick drum at approximately 45Hz) lies lower, in the 80–110Hz range, and can sound inexplicably deep, especially over a car-stereo system. Aggregate rock bass reaching its loudest levels below 80–90Hz is not common, however.

The octave below that point, down to 40Hz, is what should be identified simply as bass. Indeed, after he listened to the subwoofered Snells and then looked at a measurement of their response (see discussion and top graph of *Fig. 1, SB* 2/92, p. 79), showing a room-related valley between 30 and 125Hz which includes dips at 50 and 100Hz, speaker researcher Floyd Toole observed, "Hmm, I *thought* they lacked bass." (No, I am not going to drop his name every column, I promise.) When I countered with "But they have tons of it," he returned, "Low bass, yes, but I didn't hear much bass."

The soul-shaking crack of a bass drum, as in a large orchestral work or a holiday parade, which up close can sound like the end of time, has its fundamental somewhere around or just below 40Hz. (You'd swear it was DC, though, or at least 5–15Hz.) Note furthermore that the scary and thrilling part of this concussion—its crackly leading edge—lies well into the treble. Most of the time, then, you must have good tweeters to have superb bass sonics. Such a loudspeaker system, if it can also deliver 35–40Hz clean and loud, is going to sound as if it has a superlative—and very low—low end.

The majority of pipe organs (including monstrously sized ones) do not have truly low bass, i.e., below 35Hz, even when they sound thunderous and growly and have huge, towering pipes. Many produce little loud output below 50Hz. And in the rare instruments that do play the really shuddery stuff, it's sometimes produced by a woofer playing tones, not a pipe! Different centuries, different motors.

The octave below 35–40Hz is simply of another character. It sounds shuddery sometimes, more often just like thuds and thumps. Footfalls, heavy damped stage doors closing, steps and stomps, slowly beating helicopter blades: all such information lies in the realm of ±20Hz. If you want to hear it right now, stamp your foot on a wooden floor, or kick a couch, desk, table, or similar large heavy object with your shod heel. Such sounds, when continuous and loud enough and rolling through a cavernous cathedral, are indeed impressive: chest- and gut-shuddering.

Low Concoctions

From the very presence of bass overtones or harmonics, the human ear sometimes is able to make up the missing fundamental, so when listening to 4″ or 5″ "woofers" or 6″ modular "subwoofers" we can concoct lower bass. When actually there, on the other hand, bass levels have to be healthy, owing to the ear's progressive insensitivity. We are quite deaf to quiet low bass and especially to quiet very low bass; for instance, we don't hear weather fronts. But also note that once thresholds are reached, a little change, a very few dB, may go a long way as far as the ear is concerned, and may have surprising impact and consequences.

The cleaner and clearer the fundamentals—the lower the distortion, in other words—the more bass we sense and hear, as the true pitch comes through. So now let's turn to subwoofers, whose job this is. By the term subwoofer I refer to real ones, not the boxes that come with three-piece systems. I mean ones that, playing the right CDs and broadcasts, provide "startlement," which may take the form of head-turning (as you try to figure out if that unlocalizable thump was the dog turning on his side, your child falling out of bed, or something in the basement), or jaw-dropping, or head-shaking. These are subwoofer experiences that make a difference you subsequently don't want to go without.

Low Reproductions

In the latter 1970s I learned first-hand what proper equalization with infrasonic filtering (not, please, "subsonic") does for bass playback. The Allison Electronic Subwoofer (ESW), designed by then-freelance engineer Mark Davis to make various Allison loudspeakers flat to 20Hz, with steep skirts below that point and above 20kHz, worked superbly with any robust acoustic-suspension design. Still does, in fact. It was an absurdly precise, hard-to-demonstrate, and somewhat expensive piece of gear, but it showed what happened and could happen below 40–50Hz—given the rumbly sources of the time. (As regular readers might suppose, I believe any phase distortions due to infrasonic filtering are audibly unimportant to the ear.)

Ten years after the ESW, in the later 80s, I got to hear and review my first Velodyne subwoofer, a powered, distortion-canceling, equalized design (their 12-incher in this case). What a powerful treat that was. It performed just as claimed, and is an admirable achievement of clever engineering. When it played back some quiet 19Hz organ pedal, I remember that my dog, Woofer, was certain there was something hovering overhead outside the house.

Like many audiophiles for the last couple of years I've also been awaiting the advent of the Allison SW20, with twin 10″ woofers, inversely mounted to achieve the hard-to-surpass low-distortion low-frequency performance of the company's IC20 loudspeaker.

Although larger and more expensive subwoofer designs abound in the marketplace, I habitually focus my interest on such as these, which are both affordable and of a size which a listening room and a non-audiophile spouse can accommodate with the least upset.

Cylindrical Sounds

Into this educational journey through the realm of very low bass comes now the Definitive Research SW10 (20013 Rainbow Way, Cerritos, CA 90701, (800) 554-0150). How very nice that this new product, based entirely on simple, straightforward science, humbly conceived, designed, executed, and fairly priced, does what it claims: delivers clean low bass at high levels. The DR SW10 comprises two separate units in the form of rigid, vented cylinders, made of recycled-paper laminate with MDF end pieces, each cylinder containing one ultra-long-throw (±10mm, or more than ¾″) 10″ woofer. Cabinet diameter is 14.5″ and height is 27″, with four thin 2.5-inch bolts to screw into the base and create each cylinder's stand. Plain-looking, the tube is covered in black knit cloth, and the standard cabinet top is matte black with walnut trim, although various dressier wood-veneer tops are available at extra cost.

The DR SW10 pair includes a required stereo (two-channel) passive speaker-to-line-level equalizer module, which you drive in parallel from your current speakers' amp and then feed the output to a separate 40–300W/channel, 50kΩ input-impedance, dedicated power amp (preferably with gain controls) for driving the SW10s. Obviously in this kind of design it is essential to observe ground hygiene. The EQ box has a benign input impedance of 400Ω. Note there is no highpassing crossover anywhere in the system to relieve bass strain on your main speakers; this is an augmentative subwoofer system only.

Price for the DR SW10 pair in standard finish is $480 (Eastern US) or $500 (Western). Quite the bargain, I would judge, for something that so entirely fulfills its promise. A bass-potent CD and a thorough instruction manual are included. The product is sold factory-direct, with a 30-day money-back guarantee and a five-year manufacturing-defect warranty. Other models from Definitive Research include the SW12, a slightly thinner, vented 7′ cylinder with a 12″ subwoofer, and the frightening-sounding InfraBass Reference.

The SW10 2π frequency response is said to be 20–40Hz ±1dB when used with an amp of the suggested input impedance (see measurements). Other bandwidth, crossover, and EQ configurations are available, most at additional cost. Minimum loudspeaker system impedance is specified as 7Ω.

Listening Session

There is not much to report, really. The DR SW10s worked just splendidly, ably producing clean, loud rumbly tones when such was the input, without requiring a humongous amp. Good show, I wrote in my notes. Get out your "Rite of Spring." The subwoofers were able to take plenty of power, too. I sited them both in and out of corners, with the expected differences of room gain (loudness level). I was very pleased to learn they can also be

used on their side—don't stick the woofer end right into a corner, naturally—which means greater versatility for less-obtrusive placement behind or beneath furnishings. After the audition I was eager to get to measurements. (Shouldn't I be sprinkling this paragraph with amusing sonic descriptions involving "transient speed," "neutrality," "fast response," "uncolored blending," and so on?)

Frequency Response

Figure 1 shows the gratifyingly flat ⅓-octave frequency response of a single SW10 system outdoors, taken at two different angles (vent side and nonvent side, there being no axis to speak of). It meets spec, to put it mildly, and the result speaks for itself: ±1dB or so from 20–40Hz, and extending with the nonrecommended amp I used (see below) flat to 90Hz. The usual test protocols were observed: precision flat pink noise, continuous spatial averaging with the AKG microphone 7–9′ away, 32–42″ high (seated ear height), and ±10–15° horizontally.

It is not easy to measure reliably outdoors under 80Hz even in a large quiet field: it's hard to hear what's going on and hard to get signal 10dB above the noise without overdriving. I managed, though. Note the graph in *Fig. 1* necessarily ends at 5kHz. Also note that the dbx RTA-1 real-time analyzer/PC does not measure much below 20Hz, so I cannot comment about the SW10's likely good performance for the last few infra-audio hertz, the range where the vent's own slug of air is what's hitting (vibrating) the air and producing the response. The manufacturer's specified −3dB point lies below 20Hz. At the other end, with the amps I was using, which have input impedances in the 20kΩ range, the response extends an octave or so higher than the specified 40Hz. This is how I would want to order the system anyway (why chop off so much of the woofer's output?). If you would be concerned about this extended out-of-spec behavior, and, for example, already have enough 60–100Hz from your main speakers, the input impedance of the amp for the DR SW10s is something to pay attention to.

Figure 2 (top) shows the raw or unequalized response of the SW10, and below it is the derived response curve of the little equalization box, which uses a simple RC network to knock down the natural 60–70Hz resonance. The lack of an inductor anywhere in the system must help contribute to the low distortion of the sound.

TABLE 1 50Hz TONE

Four 10″ woofers with inductor:	
Loud level (0dB)	3% 2nd and 3rd HD
Louder level (+8dB)	9% 3rd HD, 2nd harmonic much lower
Loudest level (+9dB)	10% 3rd, 2nd harmonic much lower
Single DR SW10 subwoofer:	
Loud level (0dB)	2% 2nd and 3rd HD
Loudest level (+9dB)	6% 3rd, 2nd harmonic lower

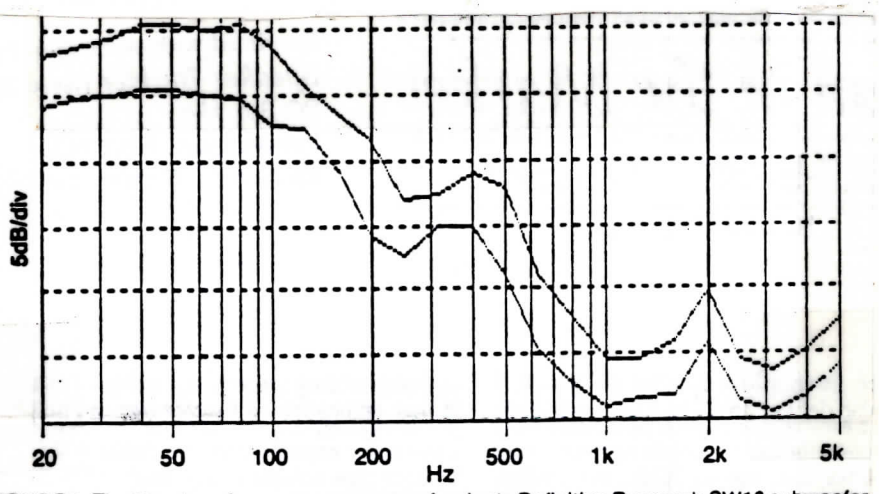

FIGURE 1: The ⅓-octave frequency response of a single Definitive Research SW10 subwoofer system measured outdoors, taken at two different angles. Response above 40Hz is affected by the 20kΩ input impedance of the amplifier used (DR recommends 50kΩ; see text). Plotted from 20Hz–5kHz at 5dB/division.

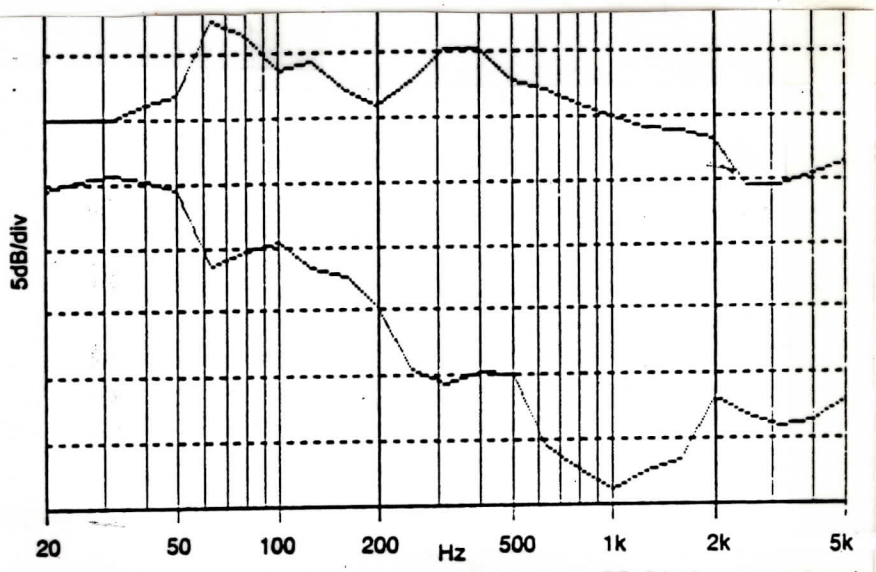

FIGURE 2: The top is the unequalized response of a single DR SW10, measured as in *Fig. 1*; below, is the derived response curve of the equalization module.

Harmonic Distortion

Harmonic distortion was measured playing tones in a listening room, with no EQ module in line. The power amp stayed well below clipping even at the highest input levels, but the room sure buzzed. Again the extraordinary results spoke for themselves, although I did feel making a comparison was important. So a single DR SW10 subwoofer in its cabinet was measured against a single loudspeaker system cabinet containing four beefy, entirely respectable 10″ Culver Tonegen woofers fed by a phased-array (non-paralleling) crossover with inductors.

For each system the front- and side-wall augmentation was identical. Distance to the floor was 4″ for the DR SW10 and approximately 10″ for the Culver Tonegen system, so boosting of the bass levels at these wavelengths by the floor was slightly different. Mike position was identical in each situation. All figures are rounded off. For this setup, the 0dB listed happened to equal 87dB SPL, but that's a meaningless figure, i.e., nothing can be extrapolated or inferred from it. (For these frequencies, a pair of speakers is going to give 4–6dB more output in most rooms with most stereo spacings, anyway.)

Even if one gives these data the most charitable interpretation, for example taking into account the conventional woofers' poor saturating inductors and the slight extra gain from the floor augmentation for the vented, cylindrically cabineted subwoofer, it seems clear that one DR SW10 subwoofer is *at least* twice as "good" as a conventional woofer.

Nice job, Definitive Research, nice subwoofer. When I have more means, I'm probably gonna get me some.

TABLE 2 24Hz TONE

Four 10″ woofers with inductor:	
Loud level (−3dB)	5% 3rd HD, 2nd harmonic lower
Louder level (−2dB)	10% 3rd HD, 2nd harmonic much lower
Loudest level (0dB)	30% 3rd, 2nd harmonic much lower
Single DR SW10 subwoofer:	
Louder level (+2dB)	3% 2nd and 3rd HD
Loudest level (+3dB)	4% 3rd, 2nd harmonic lower
Max level (+4dB)	7% 2nd and 3rd HD