

Loudspeaker Focus

Sanders Model 10e Hybrid Electrostatic Loudspeaker

A Different Approach to Speaker Design

Robert E. Greene

The Sanders Model 10e is the culmination of decades of work by designer Roger Sanders towards perfecting hybrid electrostatic design. And a culmination it is, indeed. This is one of the best speakers ever made. Forget that the price of it is modest by contemporary standards for speakers aspiring to be as good as possible. Within its design brief of producing a relatively narrow radiation pattern that emphasizes direct sound, the Sanders 10e's are as close to perfection as any speaker system I have ever encountered, outside of installations where room and speakers were purpose-built as a unit. For domestic purposes, you can spend a great deal more money, but I do not think that you can buy a better speaker if this type of radiation pattern is your sonic goal.

Let me be straightforward immediately: I like speakers that direct sound at the listener, and I always have. Way back in Issue 94, I wrote: "The first principle is this: Only the direct radiation from the speakers contributes to the completely honest stereo image. Sound reflected off walls, floor, and ceiling cannot and does not provide information about what the absolute sound at the recording session was nor even about what is recorded on the record (or CD). Indirect, reflected, or reverberant sound additions can only create a certain amount of stereo confusion." I might be slightly less uncompromising today, but essentially I still believe this is right. Various research efforts have shown ways in which sidewall reflections can affect spaciousness without changing timbre and so on. But when the chips are down, I like to hear the direct sound a lot.

This is not to say that if you love the sound of omni radiators, say, then I think you are mistaken. This is a matter of personal preference, of what you want out of your audio system. But I think there are really good reasons, which I shall go into later on, for listening to speakers which produce a high percentage of direct sound in their early arrivals and which have minimal sidewall early reflections. If you agree, then I think you will find the Sanders 10e's (hereafter just the Sanders) speakers to your liking to an extreme—and likely alone at the top.

The review that follows is going to be analytical. A speaker that sounds this wonderful tempts one to go all gushy with ad-



jectives—I shall do this a bit near the end. But mostly I am going to describe as well as I can how the Sanders speakers do what they do, my ideas of why they work so well, and what the results are literally. This is a serious speaker design, one of the most serious, and it deserves a serious description, not just some sort

of golly gee-whiz write-up or salesmanship package. But be assured that in my view the Sanders are a benchmark of speaker design, a design that is superb in all respects and in some respects raises speaker design to a level never reached before. As conventional drivers have improved, new possibilities of excellence have opened up for box speakers made with cones plus tweeters. Some of these are wonderful and are very satisfying musically, especially if one is willing to listen to them at close range to get rid of room effects. But the Sanders offers things that no speaker can really do unless it has a large enough radiating area to make it directional, as I shall explain. Please just take the “golly gee whiz” for granted, and let us get down to the serious business of what this speaker actually does.

The Physical Nature and Operating Principles of the Speaker

The Sanders consist in each channel of a flat electrostatic panel that is mounted above a box woofer which is transmission-line loaded. The speaker has to be bi-amped. The crossover is realized at line level (either analog line level input or digital input) with analog outputs to the amplifiers. The crossover is done via digital signal processing. Analog inputs are converted to digital for the crossover functions. (If you think this conversion to digital is inevitably a problem, then we have to agree to disagree. To my ears, in this case it is not a problem at all, and the result fully justifies the use of DSP here.)

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Specs & Pricing

Type: Hybrid electrostatic/box woofer with external (line level) DSP electronic crossover, intrinsically bi-amped

Driver complement (per channel): One 10-inch aluminum cone woofer in transmission-line loaded enclosure, one 13" by 40" electrostatic flat panel

Sensitivity: 90dB

Woofer impedance: 4 ohms

Electrostatic panel

impedance: 112 ohms at 500Hz falling to 1.2 ohms at 20kHz

Bass power handling: 250 watts continuous, 1000 watts momentary

ESL power handling: Not damaged by any practical input level

Inputs: Analog, PCM digital up to 96kHz/24-bit

Dimensions: 15.5" x 69" x 8"

Weight: 82 lbs. (per channel)

Price: \$17,000 (including speaker, electronic DSP crossover from dbx, and one Sanders Magtech amplifier)

SANDERS SOUND SYSTEMS

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The crossover module includes a bass level adjustment and a room correction system, and also allows user-programmable EQ functions. The crossover is very steep (48dB/octave), the crossover frequency being at 170Hz. (In principle, the crossover is user-adjustable, but I would not do that if I were you). The speaker comes in pieces but assembly is very easy and fool-proof. You do need an amplifier for the top that can handle the low impedance and capacitive loading of the electrostatic element. I would recommend the Sanders Magtech. One comes with—buy a second one and use one Magtech for bass, one for treble, is what I would suggest.

Electrostatics are flat in response by nature as frequency goes up, as opposed to cone drivers which have a rising response before their final roll-off. But as the frequency falls below a certain threshold depending on the dimensions of the speaker, there is an increasing dipole cancellation so that the *de facto* response falls as frequency goes down. In the Sanders, this effect is compensated by equalization so that the panel is flat to the crossover frequency. One might expect this to limit the dynamic capacity of the panel at the bottom of its operating range. But in actuality, Sanders has developed a panel with truly startling dynamic capability so that even with the EQ included, the speaker is unconstrained in dynamics. In a room of anything like rational size, one will never feel that the speaker is about to run out of steam.

It is also indestructible. Even extremely high input signals will not cause arcing. One of the major bugbears of electrostatics has been eliminated!

The steep slope DSP crossover makes things all the better—the panel is not asked to produce any bass at all, really. (If one runs the panel alone to the crossover box without the bass be-

ing connected, the output is gone by 100Hz—just out of there.)

The low crossover and the steep slopes also eliminate the possible effects of the switch from dipole for the panel to omni for the woofer. At such low frequencies, the ear really hears only the level, so if one matches the bass to panel level, coherence is complete.

And of course from the crossover point on up, there is only one driver in action. The panel operates as a pure dipole up to the point where the wavelength gets down to the minimum frontal dimension of the panel, which is 13 inches. This is the wavelength of 1kHz, and a little above that frequency the panel will become more directional in the horizontal plane with increasing frequency. (The panel is 40" high so directional behavior vertically happens much lower down. Floor and ceiling interaction is minimal above the bass.) The unity and coherence of using only one driver over the whole frequency range above the bass makes the idea of trying to build a soundfield by combining the output of lots of drivers crossed over in such a way that extremely precise time-alignment is needed to get them to work together seem more than a little misguided. There is a good reason that BBC speakers ran a single driver up to a high crossover point—but no crossover at all is even better.

This pattern has several effects. First of all, there is no "baffle step" in the midrange, no frequency where the pattern changes from omni to forward as there is in a box speaker. (Why, you may ask, is this subject almost never

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discussed in audio reviews? Good question!). The baffle step introduces a discontinuity in off-axis response, which for narrow-front speakers is right in the midrange, typically around 500–800Hz. The effect is a droop of about 3dB in this range in the response at 60 degrees off axis or so, which is typically what is bouncing off the wall to the listening position. Designers do their best to ameliorate the coloration effect of this. One approach is to use a wide baffle so that the baffle step is below the midrange (c.f., the JBL LSR6332 for example, off-axis responses shown here (jblpro.com/ProductAttachments/JBL.LSR6332.pdf)). But with narrow-front floorstanders, the almost ubiquitous type of speaker, this is very likely to be a problem to some extent.

With the Sanders, the midrange has no such step at all. This uniformity of pattern, changing only at frequencies above the mids or below them, together with the absence of resonant coloration gives the midrange of the Sanders a lack of coloration that is truly in the top echelon. This is one of the lowest coloration speakers there is.

And to repeat, since there is only one driver above 170Hz, the speaker is also completely coherent. There is no crossover like no crossover. And ultra-low in distort-

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tion, both literally and in listening terms. Just what were you looking for here that is missing? Nothing that I can think of!

How the Sanders Operates in the Room

There is of course the issue of the directional behavior. First of all, because the speaker is a dipole above bass frequencies, one can set it up so it is in effect sending no acoustic signal to the nearer sidewall's first reflection point. Nothing is bouncing off the sidewall to give an early reflection. (The first reflection off the far sidewall will be set to arrive behind the listener with natural positioning.) The effect of this is that it is a long time before any reflection at all arrives at the listening position. The fact that the panel becomes more directional in the higher frequencies makes this effect all the stronger. The Sanders gives the impression of an RFZ room (reflection-free zone) without the need for building one!

If you get the speakers far enough from the backwall, say five or six feet at least, the backwall reflection will arrive too late to blur the direct arrival, and in the high frequencies, with the speaker angled towards the listener, the backwall reflection will not arrive directly anyway. And of course one can damp the backwall, too, if desired. This will change the balance of the room sound—one can adjust to taste and to the overall “softness” or “hardness” of the room. To my mind, the best results are obtained by making the backwall a combination of absorbing and diffusing. (I would not recommend something like a glass wall without curtains behind.)

And as already noted briefly, the speaker does not bounce any energy to speak off the floor and ceiling in the mid and high frequencies. This has the positive effect of making the speaker sound very un-speaker-like, and also of preventing the speaker from sounding positioned front to back. (It is primarily the floor interaction that gives the ear/brain cues as to the front-to-back position of a speaker.)

In short, the sound from the panel interacts with the room about as little as possible. Of course, reflections off the backwall arrive eventually, but with proper placement, this is delayed long enough as to not disturb imaging nor color the sound. As Peter Walker once explained the idea of dipole electrostatics, there is time for the brain to “sort things out” before any reflections arrive. One can get something of the resulting effect of being immersed in the recorded soundfield from box speakers by sitting really close to them, supposing they remain coherent enough at close range. But here with the Sanders, the effect of immersion remains at normal listening distances. The “sound of real music in real space” depends on giving the ear/brain time, as Walker said, to “sort things out” before there are any secondary arrivals. And here you have the time, indeed.

All this applies only to mid and higher frequencies. Bass in a room of domestic size presents the bass as a unit, with no clear distinction even in principle between direct arrival and room sound. Moreover, bass always interacts with the room around. In the Sanders, a room-correction system is offered as a part of the crossover box. The crossover box is in fact a programmable unit from dbx. It has a lot of features, being a pro unit for general speaker design and control. But Sanders supplies



a clear, easily followed set of instructions for using the parts that are relevant to the speaker. One has no trouble getting the basic bass level adjustment done correctly, and the room-correction system is also clearly explained. (Sanders recommends using the room correction only in the lower frequencies.)

One can also use the dbx box to adjust the response to taste as it were and also to tweak away any residual room effects that strike you as colorations. These will be minimal, given how the speaker works, but still, you might want to do something. Control of your own life is good! There is a recommended target curve, which pulls the bass up a bit relative to nominally flat (steady-state RTA flat). I too would recommend this for reasons explained in part here (regonaudio.com/Records%20and%20Reality.html). Also if you want, you can lift the response slightly in the lower part of the midrange, just above the crossover, to give the effect that a box speaker would have of filling in that region a bit more in the room sound than a pure dipole does, thus mimicking the box

speaker room sound a little. Personally I was happy with the direct panel sound as such, with room-corrected lows following the “target curve.” But you have a lot of room for adjustment using the crossover box, which offers parametric EQ options.

Why This Electrostatic Hybrid and No Other

Electrostatic/box woofer hybrid speakers have become reasonably common. And quite a few of them have some sort of built-in bass-correction system. But the Sanders 10e's have an advantage over the other ones which have curved panels. I know it is unconventional in audio reviewing to have really definite opinions about general types of speakers. “Circumstances alter cases” could well be the motto of audio reviewing. But in this case, I need, like Marc Antony, to be “a plain, blunt man” and say what I have found to be true. In experience, curved panel speakers do not image correctly. My guess is that this is because curved panels generate a time smear which does not diminish with distance, whereas as listening distance increases, all points of a flat panel approach having the same distance to the listener.

This is basic geometry. If you are 100 inches from the center of a 12-inch-wide flat panel and straight out from the panel, the distance to the edge of the panel is the square root of $10,000 + 36 = 100.18$. So you are only 0.18 inches farther away from the edge than from the center. At 200 inches, the difference would be 0.09 inches. But if the panel itself curved so that the edge was say 0.5 inches back of the center,

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then even at large distances the 0.5 inch difference would persist. Curved panel means time smear that does not go away with distance, though the audible effect of such theoretical considerations is always debatable.

But whether this is the reason or not, to my ears curved panels do not generate precise images. One might interpret this lack of precision as “dimensionality,” but to my mind it is really smear. Stereo imaging is a real thing. It ought to be as precise as the material allows. The speakers ought not to smear it at all. But I admit that taste varies here. Some people really like recordings made with widely spaced microphones, which have blurred images by nature!

Psychologically, imaging precision leads to an enhanced sense of resolution. Listen to some choral material on the Sanders. Because individual voices are precisely located in space, the sense of hearing them separated from each other is more natural and precise and convincing than a speaker with blurry imaging would provide. Electrostatic panels have a lot of resolution in the sense of having a pure sound with little secondary noise added. But this effect too is more convincing with the flat panels, or so I have found.

Now one has to have a certain listening distance for all this to happen. Up really close, one hears to some extent the panels as distributed radiators rather than as point or line sources. But this effect goes away at normal listening distances and, since the speakers bounce so little sound off the sidewalls in early reflection, one does not need to sit really close, as one does need to do with box speakers of wide pattern—if one wants to get the sidewalls out of the sonic picture.

What It All Adds up to

As described, the Sanders offer what is very close to “facsimile reproduction,” a literal replication of the signals on the recordings.

So what is the effect of this in listening terms, one might ask. The most immediately striking aspects in musical terms are the purity and the neutrality of the sound. Female vocals are bewitching in their absence of distortion. The Sanders are right in there with the Carver ALSes and the Eminent Technology LFT-8bs for low perceived distortion, which is to say that they are at the top rank for this (cf. my ET 8b review on theabsolutesound.com). But the Sanders offer in addition to the low distortion a smoother frequency response than the ETs, which have a few quirks in that regard (though they have a much lower price, however). Purity and smoothness—the Sanders offer a really beautiful reproduction of the mid-to-upper frequencies. Sopranos individually or collectively in a chorus are gorgeous, as are violins. Violin recordings being as they are—no fault of the speakers—may tempt you to cut the top slightly. And you can easily do that with the crossover box. However much that some audiophiles eschew such things, pen-

alty-free correction of balance errors in recordings—many of which are too bright—is a very useful thing in musical terms.

The Sanders are also outstanding in unraveling complex musical textures. While many speakers have some transparency in the higher frequencies, as frequency goes down, the transparency tends to be obscured by a certain muddle; some sonic confusions arise. Much of this, indeed most of it in my opinion, arises from room interaction. (Gradient of Finland showed many years ago how transparent speakers tend to be if one hears only their anechoic output. It is the room around that is primarily responsible for the increasing confusion as frequency diminishes.) The Sanders with their strong differentiation against adverse room effects, arising from their dipole radiation pattern and their superbly precise (as well as room-corrected) bass maintain transparency and clarity from the top on down. Nothing turns to mush!

I wrote long ago of how the directionality of the Gradient 1.3s put them among the speakers that one might want to use if one needed to write down an orchestral score from listening (cf. regonaudio.com/Gradients.html). The same principles apply here: woofers correctly loaded by the floor, and floor bounce eliminated by the directional radiation from the crossover to the panels on up, as well as the elimination of sidewall reflections. If you listen to complex music, you will hear the difference from speakers with lots of floor and ceiling bounce in particular. Hear the difference—

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and like it, too. There is nothing quite like hearing what is actually on the recording.

There are lots of good stories about conductors hearing small things in the midst of full orchestral activity—Stokowski noticing the missing third trombone part in one of the most tumultuous parts of the *Rite of Spring* and stopping the rehearsal to find out what had happened (the third trombone had left his part at home and was doubling the second trombone). Live, this sort of thing is impressive all right but believable. But in most audio, it can seem like a remote dream. With the Sanders, these stories seem not only plausible but also reproducible. Listening to my various ensemble and orchestral test pieces—the Bach/Sitkovetsky *Goldberg Variations*, the Mata/Dallas Symphony *Rachmaninoff Symphonic Dances*, one hears everything there is to hear, but with no sense on the other hand of detail being shoved at you unnaturally. Inner parts are revealed exactly as they should be. This is genuine resolution in the real sense.

Playing recordings with real spatial information on the Sanders speakers gives a remarkable sense of immersion in the original venue’s acoustics. The *Water Lily Blumlein* recordings from Philadelphia and St Petersburg make one feel almost as if one were there in the respective concert halls. (Disclosure: I worked on these

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recordings.) So do the direct-to-disc Brahms recordings recently made by the Berlin Philharmonic (vinyl only), also done with Blumlein microphone technique.

It is worth remembering that when Harry Pearson, many years ago, was formulating his ideas about “soundstage,” he emphasized strongly that this had to be distinguished clearly from the generalized sense of space generated by reflections off the walls and that ideally only the direct sound would play any role. With the Sanders speakers, one hears this point acutely. (N.B., It is possible to use the sound of wide-dispersion speakers to reveal real spatial information if one does this correctly, but it won’t happen by accident. See my review of the Carver ALS speakers on theabsolutesound.com.)

The fact that the Sanders, because of the vertical size of the panel, presents a sonic image that is not fettered at a particular height while not theoretically predicated one way or the other (stereo does not have theoretical height impression) will add for some listeners an additional dimension of realism. Certainly those speakers that make one feel one is looking down at the music diminish the naturalness of the spatial impression. Point source speakers that present the height at ear level can be very natural, however. But there is a special impression generated by speakers that are enough like a line source to float the images vertically (so that the image moves up or down if the listen-

er does), which to me seems natural as well, in a different way.

Where the Sanders Stands in the World

In the late 1950s something along the lines of a new elegance in audio engineering, some analog of, say, the rise of the suspension bridge replacing the massive cantilever structures, almost happened in audio. Serious speakers only a little earlier and even at the time were sometimes as large as refrigerators. One thinks of the Electro-Voice Patrician, with its 30-inch woofer. Two things made fundamental changes, or at least potential changes. One was the development by Acoustic Research of the

acoustic suspension woofer, which showed how deep bass could be obtained from comparatively small drivers in boxes of moderate size. The second development that opened new prospects was the appearance of the original Quad ESL (and a few years later of the KLH Model 9).

The electrostatic speaker had been invented in the 1920s in principle, but the Quad and KLH were first practical realizations as commercial products. But the revolution they began was only partial because the Quad was limited in bass and dynamic capacity and so was the KLH, albeit less so. And these limitations dogged the electrostatic for a long time.

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The Quad made the refrigerator-sized speakers of the time seem oddly conceived. But it could not replace them for bass and dynamics, no matter how much better the Quad was in low distortion and low coloration.

But the Sanders 10e's belie these limitations traditional for electrostatics. Here are all the advantages of the dipole electrostatic—low distortion, low coloration, differentiation against the listening room—combined with bass extension, dynamic power, and indestructible operation. In anything like a domestic environment the 10e's have effectively unlimited dynamics and definitely adequate bass power and full extension. One can only wonder

about any further real need for speakers weighing hundreds of pounds and having multiple dynamic drivers (This does not refer to line arrays, which use many drivers in a different rationale.)

The Sanders 10e's, with their intrinsic sonic virtues and their built-in DSP processing (which is user-controllable and room-correcting), seem to me very much the way of the future for audio. Or at least what ought in my book to be the way of the future. In my view, user-controllable DSP adjustment, either built in or added on, is the way audio is going to go and ought to go. And a speaker will utilize it best if, like the Sanders, it is built with that in mind from the

beginning. It would not be fair to say that they are the only speaker designs that show how DSP and inventive sonic engineering can produce exceptional results at rational prices (I think for example of the Steinway Lyngdorf System S, though it lacks as much user control as I would like). But the Sanders reaches for, and to my mind, attains a sonic level in the highest echelon that, along with the possibility of user adjustment, makes most other speakers seem restricted and earth-bound.

In my view, no one speaker could be justly declared “the one and only world's best” because exactly what a speaker in a room is supposed to do is not something that is completely and scientifically agreed upon. There are, after all, people who will make a case for the intrinsic superiority of wide radiation pattern, though I am surely not among them.

But if you wanted to call the Sanders 10e the best speaker ever, you could definitely make a case. Within the category of speakers that emphasize facsimile reproduction of the direct arrival, the Sanders system can surely claim to be the equal of any and far superior to most. And when you consider that even if you buy two Sanders Magtech amplifiers—one comes along as part of the \$17,000 package—the total cost exclusive of source components is \$22,500, and that you can adjust the speaker to suit your room and your tastes, this system seems to me to be not only a wonder but also a bargain. **tas**