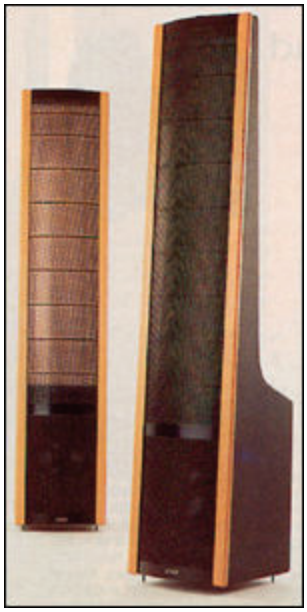
Floorstanding Loudspeakers

MartinLogan SL3 loudspeaker

By Wes Phillips • May, 1997

"Wow! What's that?" asked the pizza delivery boy, peering over my shoulder at the slender, 5'-tall Martin-Logan SL3 visible behind me.



"It's a new loudspeaker."

"No way! It's bee-*you*-tee-full."

I nodded, but this was old news. For weeks, everyone new to the household had been pointing out that these lean speakers, with their nearly transparent panels flanked by blond oak rails, were gorgeous, striking, sculptural, far and away too handsome to be practical...in short, nothing at all like any hi-fi gear they'd ever seen.

The SL3's smooth wood finish seems to invite caresses. Nearly everybody who walks by them pauses to stroke them sensuously—I have to admit, I'm getting jealous of all the frottage they've received. "Yeah, they're cute as kittens and smoother than *peau de soie*," I'm tempted to shout, "But what about *me*?"

Fortunately, I've learned not to ask such questions. Instead, I smile, cue up a CD, and start playing music through them. And always get the same response.

"I *knew* you were kidding about these being speakers. Where's the music *really* coming from?"

Sometimes you just can't win. Martin-Logan has produced a speaker that draws universal raves for its cosmetics and performs one of the best disappearing acts in audio, and the public refuses to believe their eyes and ears. So let me just say this once and get it over with: "Yes, they're speakers. They really *are* gorgeous. And yes, the music really *is* coming from them, hard as it is to believe. *Yes*, they really do sound as good as they look. Okay? *Okay?* OKAY?"

Excuse me. I don't know what came over me.

Hybrid vigor

The SL3 is the successor to Martin-Logan's Sequel, launched in 1987 (Lew Lipnick reviewed the original in Vol.11 No.12; JA weighed in on the Sequel II in Vol.12 No.8). I asked Martin-Logan's founder, Gayle Sanders, why the SL3 wasn't the Sequel III. He responded, "So many of its components have been upgraded or changed that we felt we should call it

something else—it's less a continuation than a departure." Based on the evidence of people's reactions at my house, not everyone is familiar with either of the original Sequels, so I'll describe the SL3 and highlight its departures from its predecessors.

The SL3 is 64" tall, but only 13" wide and 14" deep at the base. The 10" dynamic woofer is contained in a 20"-tall sealed-box enclosure that forms the base of the loudspeaker; the 48"-tall electrostatic element is mounted to its front, soaring above it. The perforated black stators and transparent electrostatic diaphragm are curved in a 30-degree arc that bulges gently in front of the thin wooden rails framing the loudspeaker's face (footnote 1). The result is one of the most elegantly stylish facades in audio—and, since you can see through the electrostatic driver, the effect approaches the ethereal.

Footnote 1: An electrostatic speaker contains three elements: the stators, the diaphragm, and the spacers that separate them. The diaphragm sits between the two stators; the spacers hold the stators away from the diaphragm, allowing it to move freely back and forth between them. The stators, which are essentially electrodes, are energized with high-voltage signals equal in strength but opposite in polarity. These charges attract and repel the resistively charged diaphragm according to the modulation of the musical signal.

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The electrostatic element is curved in order to minimize the treble lobing that plagues the horizontal dispersion of panel speakers, where the transducer is larger than the wavelength it is producing. This beaminess

created the notorious "one-person sweet spot" or "headphones effect" of older electrostatic designs. A large diaphragm projects a great deal of its HF energy at right angles to its surface; curving the surface in the horizontal dimension greatly facilitates treble dispersion—this was one of Martin-Logan's biggest innovations in electrostatic technology (see sidebar: "Controlling a Lightning Storm"). Tuning pads affixed to the diaphragm alter its resonant frequency, changing the single element into several smaller, better-controlled radiating areas. This prevents the diaphragm from having a single, lower (and therefore more musically intrusive) resonant signature.

Another way in which all Martin-Logans differ from earlier electrostatic designs is the way the transducer design has been pared down to the smallest possible number of component parts. The black metal screens that serve as the front and back speaker grilles are, in fact, the stators that drive the diaphragm. They are "conformally coated"; that is, insulated with a thick mask of specially formulated paint. Although they carry several kilovolts of potential, the paint is sufficient insulation to make them safe to touch—even at voltages far in excess to that any speaker will ever be subjected. Since this insulation covers all of the stators' surfaces, the diaphragm is protected from arcing when driven to high levels—unlike uninsulated electrostats such as my beloved Quad ESLs, which reacted disastrously one Thanksgiving to my wife's miscalculation of the peak volume of Vaughan Williams's *Fantasia on a Theme by Thomas Tallis*.

Like the Sequel, the SL3 uses a heavily damped 10" paper-cone drive-unit, this crossed over to the electrostatic element at 250Hz—but the SL3 uses a quasi-second-order 12dB/octave design. Sanders explains that eyebrow-lifting "quasi-": "We do some electrical lifting of the transducer because there's a natural acoustic rolloff below 500Hz with a dipolar source; we lift those frequencies slightly electronically to compensate. That means it doesn't have a pure 12dB/octave rolloff."

The bass bin's sidewalls extend to the top of the panel, tapering as they rise to focus the rearward wave of the electrostatic element—which also helps "lift" the bass response by preventing some small amount of dipolar bass cancellation. The result, Sanders claims, is a much smoother transition from the panel to the driver. "We were able to normalize the impedance of the speaker as a whole, which gives better low-level detail and superior blending of the 'stat and the woofer. The crossover design now optimizes the wave launch between the two elements."

The bass enclosure is another area where the SL3 departs from the Sequel. "We now have access to multi-axis CNC technology and special heat-set polymers that bind the cabinets absolutely rock-solid, making their resonant characteristics much more uniform," Sanders explained.

And despite the woofer cabinet's pebbly finish, Martin-Logan has abandoned Nextel finishes. "It's nasty stuff to work with—extremely toxic and very bad for the environment. We are now using a water-based coating that's easier to work with and far more benign."

The cabinet work is first-rate. The wooden rails flanking the speaker's face are coated with a clear lacquer whose lustrous finish is inviting to the touch, and the pebbled side and rear walls of the woofer enclosure have a high-quality if no-nonsense appearance. Component quality throughout the speaker is high—the transformers are custom-wound, and air-cored coils and polypropylene capacitors are employed.

The bi-wirable SL3 incorporates substantial metal binding posts of

Sanders's own design. "I wanted something more rugged than the typical five-way binding post. Until the new European connector regulations came along, the spade had become the de facto standard in the High End, so I wanted something you could really get a wrench on and cinch down. The posts also accommodate bananas, but unlike with five-ways, we haven't drilled out the center post, which weakens it. I didn't even want to accommodate bananas at all, but our dealers use them for the day-to-day setup and teardown of systems, so I grudgingly compromised." Sanders's posts *do* allow you to crank 'em down hard, and the two pairs of posts are—for once—far enough apart to accommodate the widest, thickest spades I have.

Don't hesitate—bi-wire the SL3, even if it means you must use less expensive speaker cables. I don't know whether or not the woofer's back EMF interferes with the "unusually revealing" electrostatic element, as Sanders claims. But I do know that the difference between running the SL3 with a single run and a double run of cable is not subtle. Bi-wiring results in *huge* gains in clarity, detail, and grace.

Next to the binding posts is a Bass Control Switch with two settings: "Flat" and "-3dB." If your room is small, or if you must operate the speakers close to the wall, the -3dB setting may help integrate the drive elements better. (I didn't need it in my room.)

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Since electrostatic drive elements must be energized, the rear panel also sports an IEC-type mains plug; this allows you to choose your preferred AC cord (the transformer is housed within the bass bin). I tried several different high-end power cords and didn't notice much, if any, difference, so I reckon you might as well use the ones that come with the speakers.

On the advice of Les Edelberg, however, I plugged the speakers into an API Power Wedge 112. *That* lowered the noise floor, further increasing low-level detail.

The SL3 comes with two sets of feet, one with metal "glider" pads. Use these while you establish the best position in the room for the speakers—a process that will take a longer time than for most speakers. Once you've chosen the permanent placement, use the set of spikes. This isn't optional—you *must* spike these speakers to a solid floor. The SL3 is capable of stunning clarity and transparency; when the speaker is not as stable as you can make it, you'll lose a substantial amount of both qualities. You paid for 'em and you deserve 'em; don't throw 'em away.

Location, location, location

Get the impression that this loudspeaker requires careful setup and component matching? Good—it surely does.

While the SL3 is revealing of every link in the chain before it, it is particularly demanding of power amplifiers. I started by connecting it to Conrad-Johnson's Premier Eleven A, which had proven an ideal mate to M-L's smaller Aerius. But the Eleven amp lacked the juice to drive my room, which has 14' ceilings; the speakers played, but sounded thin and bleached. Changing over to the Premier Twelve monoblocks—at twice the power—made a tremendous improvement. I wasn't playing the speakers any louder, but they began to energize the room. The sound became more detailed, truer to timbre, and much more revealing of the recorded acoustic.

I began to move the speakers about within the room, looking for the best compromise between bass response and detail. While one has to stalk that magic spot with all loudspeakers, the process is made harder with a dipolar radiator—the unimpeded rearward radiation can smear detail if you move the speaker too close to the rear wall. Generally, you want a dipole *way* out in the room. And that's where the SL3s ended up in my tall, fairly lively listening room.

By pulling them so far into my room, I sacrificed most of the rear wall's bass reinforcement. The balance between bass, midrange, and treble was reasonably uniform, but I was experiencing empha*sis* of tones that seemed out of sync with the musical signal. I still felt that the sound was, by and large, lacking in tonal contrast—my timbral box of Crayolas was missing all the primary colors; what was left were the pastels.

I was frustrated, but I reckoned a visit from Gayle Sanders might teach me a few new setup tricks. As luck would have it, he'd already scheduled an early winter visit to our home office. Then MIT's Bruce Brisson called. Earlier in the fall I'd spent a pleasant pair of days with Bruce, Joe Abrams, and Norm Varney, all of MIT, creating a veritable forest of ASC Tube Traps throughout my listening room while I was reviewing the Wilson WATT/Puppy 5.1 speaker system.

"How's the room sounding?" Bruce inquired. (Having done all that work, I guess he felt a vested interest in it.)

"I had to take out a lot of the Studio Traps we set up, since dipolars react with the room so differently. I can't see how to utilize them in this context—in fact, I don't think they'll even work with these speakers."

"I've done a lot of work with Martin-Logan speakers and Tube Traps, and I think I could show you a trick or two. Tell me when Gayle's coming in; I want him to hear this." (See sidebar: "California Brisson and the Soundroom of Doom.")

Truth goes, when she goes best, stark naked

Once Bruce Brisson and Joe Abrams had helped me tame the wild resonances in my room, I began to hear just how special the SL3 speaker system was. While I was tremendously impressed by the original Aerius, much of its strength derived from compromises made in its frequency response—it succeeded because it didn't try to woof too low. This was definitely not true of the SL3. It may have lacked ultimate bass extension, but it went plenty deep and had a buncha buncha heft and impact. And, just as Gayle had promised, the integration of dynamic woofer and electrostatic driver was seamless, despite the relatively high (according to conventional wisdom) crossover point.

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Bob Harley is fond of citing Frank Zappa's "The Ocean is the Ultimate Solution" (from *Sleep Dirt*, Rykodisc RCD 10527, CD) as an acid test of bass resolution, so I thought I'd give it a whirl. Bob's right. Not only does the sound of Patrick O'Hearn's acoustic bass require an uncolored transducer capable of deep, deep response, it also serves as the propulsive agent of the piece. If your system isn't capable of passing on to you a recording's pace and swing, then "The Ocean" just lies there. With the SL3, the bass was punchy, well-defined, and propulsive, while Zappa's guitar and Terry Bozzio's drum and cymbal work really benefited from the transient speed of the electrostatic drive element. Most of all, the three were working in unison—O'Hearn most emphatically did *not* lag behind the others. In fact, he was pushing them along; the song's momentum is all O'Hearn's, and that's the way the SL3 played it.

At WCES '97, Mesa Engineering's Srajan Ebaen sat me down and played *Suerte*, by Pedro Aledo and Abed Azrié (L'empriente digital ED 13029, distributed by Harmonia Mundi). I was entranced by this strange disc,

which celebrates the "surge of mystifying energy that traverses the body in the musical moment," as the liner note has it. Azrié sings in Arabic in a calm, deep baritone, while Aledo sings in Spanish in a high, penetrating tenor. The songs are poems from the 11th-century Arabian-Andalusian flowering of arts, and celebrate that unique culture's fascination with love and beauty—all set to sinuous, exotic, multirhythmic music that borrows from flamenco, European, and Middle Eastern traditions. The fluid rhythmic structure changes constantly, and the musicians are accompanied (and egged on) by a rich background of hand-claps, castanets, dancing feet (a *zapateado* is credited), and shouted "encouragements" (*tatyib*). Several days after I returned from Vegas, I discovered that Srajan had mailed me a copy of the disc, which I had already determined to search out (and which I strongly encourage *everyone* to do).

Coming home to the SL3 speaker system, I thought I'd play *Suerte* while cooking dinner. I kept getting pulled out of the kitchen by the sensation that there were people in my living room. Fair enough—I took the disc off and returned to it after dinner, when I was prepared to listen more attentively. But even with my attention fully engaged, I was stunned by how realistically the musicians were present in the room via the SL3s. When Carmen Alvarez began to dance, I immediately knew not only that it was a woman dancing (!), but also everything about the size of the room she was in, the placement of the musicians and the other *palmistas* (clappers), and the weaving of Azrié as he sang. I know that all of that is extra-musical, but I cared about it because of the intensely musical presentation of the song itself, much of which seemed to result from the incredible accretion of detail. Spatially, tonally, rhythmically—I had no complaints whatsoever.

Many electrostatic speakers can handle small ensembles, works of constrained dynamic range, or the presentation of the leading edges of transients—that's what they're good at, after all. So I played Mahler's First in the wonderful Peter McGrath recording featuring James Judd and the Florida Philharmonic (Harmonia Mundi HMU 907118, CD). I had to turn the sound up quite a bit to energize the room realistically, but that didn't faze the SL3 a bit. The stormy cymbal crash that introduces *Stürmisch bewegt* (the final movement) rang forth decisively, full of brassy color and HF clang. When the brass and woodwind choirs took up the movement's theme, the hall was filled with a gloriously burnished sound that contrasted superbly with the hushed strings' reiteration of "Frère Jacques" and the first movement's central theme. And at the finale, the timpani, tam-tams, and bass drum just thundered—I could hear the soundwave crash against the walls of the hall—while the brass, winds, and strings built to a heroic D-major crescendo again and again. Could the SL3 handle big orchestral works? Oh *man*, I'd say so.

The best is the enemy of the good

As enthusiastic as I am about the Martin-Logan SL3, I urge potential buyers to consider a few warnings. First, since they radiate unimpeded acoustic energy to both front and rear, they will interact with your room far more than more conventional designs. If your room lacks uniform frequency dispersion, as mine did, you either need to fix it or look elsewhere.

Second, I would pay a lot of attention to room size in matching these speakers to an appropriate amplifier. My room's extremely high ceilings required that I drive the speakers hard to achieve realistic levels for full-scale orchestral works. This meant that high-powered or high-current amplifiers—such as the Plinius SA-100, or the Krell KAS or Full Power

Balanced 600—were required to control the speakers and energize the room. In a smaller listening room, such as my erstwhile Brooklyn apartment, I'm convinced that smaller amps like the C-J Premier Eleven would have worked just fine.

Actually, you need to be extremely careful in matching the SL3 to a system, period. While not inexpensive, the SL3 is one hell of a lot of speaker for $3500, and it will tell tales on any upstream component that's not doing its job. At the very least, mate it to a superior front-end.

But fed a first-rate signal, the Martin-Logan SL3 should deliver a first-rate response. It is transparent (sonically and, to a great extent, visually) and detailed, but capable of spectacular tonal color and impact. I never tired of playing music through these reliable performers, and *that* state of affairs is rarer than you'd think. And, while they required effort in placement and component matching, they repaid my efforts by mirroring every improvement I made in the system or the room. While some people may prefer a speaker that demands less from them, these speakers are designed for those who demand nothing less than the best from their speakers.

Article Continues:Specifications »

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MartinLogan SL3 loudspeaker:
Specifications

Sidebar 1: Specifications

Description: Hybrid electrostatic/moving-coil loudspeaker system. Drive-units: 48" curvilinear electrostatic midrange/HF transducer; long-excursion, sealed-box, 10", damped-paper-cone woofer. Crossover frequency: 250Hz. Crossover type: quasi-second-order, 12dB/octave. Frequency response: 30Hz-22kHz, ±3dB. Dispersion: horizontal, 30 degrees; vertical, 4' line source. Sensitivity: 89dB/2.83V/m. Nominal

impedance: 8 ohms. Minimum impedance: 1.5 ohms at 20kHz. Recommended amplifier power: 80-200W. Finishes: light or black oak, standard; dark oak, walnut, custom finishes available at additional charge.
Dimensions: 64" H by 13" W by 14" D. Weight: 65 lbs each.
Serial numbers of units reviewed: SEHE068/069.
Price: $3195/pair; (dark oak or walnut add $300). Approximate number of dealers: 86.
Manufacturer: Martin-Logan Ltd., P.O. Box 707, Lawrence, KS 66044. Tel: (913) 749-0133. Fax: (913) 749-5320. Website: www.martinlogan.com

Article Continues:Associated Equipment »

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Associated Equipment

Sidebar 2: Associated Equipment

Digital Front-End: Krell KPS-20i/l, Naim CD3 CD players.
Analog Front-End: Linn Sondek LP12 turntable with Naim Armageddon power supply, Naim ARO tonearm, Transfiguration Temper cartridge; or VPI TNT Mk.III turntable with JMW Memorial tonearm, van den Hul Frog cartridge.
Phono Section: Naim Prefix/HiCap, Ayre phono module, or Krell KPE Reference.
Preamplifiers: Ayre K1, Conrad-Johnson Premier Fourteen, Krell KRC-HR.
Power Amplifiers: Conrad-Johnson Premiers Eleven and Twelve, Krell KAS and FPB-600, Plinius SA-100.
Interconnects: MIT balanced 350, Cardas balanced phono, Monster M-1000i, Straight Wire Crescendo.
Loudspeaker Cables: Monster M2.2S, MIT 850, AudioQuest Crystal/Argent bi-wire, Straight Wire Black Silc bi-wire.

Accessories: API Power Wedge 112 (two: one each for electronics and loudspeakers), Magro 24 Component Stand, Bright Star Audio Ultimate TNT Isolation System, The Shelf by Black Diamond Racing, Mark 3 (equipment) and Mark 4 (speakers) Cones from Black Diamond Racing.
Room Treatment: RPG Abffusors; ASC Tube Traps, Bass Traps, Studio Traps, and Slim Traps; Urbicolous lapcat.—**Wes Phillips**

Article Continues:California Brisson and the Soundroom of Doom »

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MartinLogan SL3 loudspeaker:
California Brisson and the Soundroom of Doom

Sidebar 3: California Brisson and the Soundroom of Doom

MIT's Bruce Brisson and Joe Abrams flew to Santa Fe the day before Martin-Logan's Gayle Sanders, thinking that Gayle would prefer to hear the completely treated system upon arrival.

At 16' wide by 17' long by 14' high, my living/listening room is awfully close to a cube; still, the dining alcove behind my listening position gives me another space 8' wide by 12' deep by 8' tall, and this cuts down early rear-wall reflections. Exposed 2" by 14" beams support the ceiling, and the floors are large ceramic tiles set over a poured concrete slab. Although the walls are covered with shelves of books and records, the room is by nature quite bright and acoustically reflective. The tendency of the upper walls (above 8') to develop flutter echo has been partially controlled by the placement of four RPG Abffusors 10' above the floor on opposing walls, although I still need to work in this area.

Brisson's Prime Directive: Prevent nonlinearities caused by bass lobing. Toward this end, we placed a large Bass Trap in each corner of the room with its absorptive side facing the room. (The cylindrical Tube Traps have a reflective coating over 180 degrees of their surface; the other 180 degrees, lacking it, are absorptive.) We then listened to my system and

discovered that many of the frequency anomalies—specifically, the unpredictable emphasis of some tones over others—had disappeared. Homing in on the kiva-style fireplace in one corner behind the speakers, Bruce flanked it with Bass Traps. Oddly, the result was to more firmly center the sound between the speakers.

Using a mirror, we calculated the first reflection points on the sidewalls and placed Studio Traps—reflective side out—at those points. (To calculate first-arrival reflection points, sit in your listening position and have a friend slowly walk the length of the sidewall, holding a mirror reflective-side out against the wall and sliding it along as he or she walks. When you see the speaker in the mirror, you have found the first-arrival reflection point.) This broadened the soundstage dramatically. We then placed a 10"-diameter Tube Trap, absorptive side out, against the wall behind the speakers and precisely between them. This deepened the soundstage, seeming to throw it beyond the wall itself.

Had I been on my own, I would have stopped then. But Bruce was on a roll. To my amazement, he put a 10" Trap directly behind each speaker to absorb the backwave. Details previously lost in the ambient murk leapt out vividly. Then he flanked the speakers with Studio Traps, reflective side facing the listening position, which fleshed out the tonal balance with an almost bodily presence. Studio Traps have height-adjustable stands; by raising the Traps above the floor, Bruce threw the soundstage up so that it presented an illusion of height that greatly facilitated the presentation of sonic holography. Bruce then added another pair of Studio Traps on the outside edges of the speakers, rotating them as though focusing their projection, and I'll be damned if that didn't alter—and improve—the amount of precise detail discernible at my listening position. By day's end we had placed a total of 16 Tube Traps around the room, and the difference between the sound of the system that evening and when we had started was (*ahem*) day and night.

When Gayle walked in the next morning and saw the grove of Traps surrounding his speakers, he took a long, slow saunter around them, examining the setup with a sardonic smile. He shot a challenging look at Bruce and sat down in the sweet spot. Seconds after the music began to play, he leapt up and checked each Trap's placement *very carefully.* Then he demanded, "Take 'em all out and show me what you did!" So we started all over.

Did the experience make a believer out of Gayle? Yesterday, he told me that it had. "What the Tube Traps bring to an absolute reference system are bass control and dispersion control. As a result of the work we did in your room, I have changed my beliefs concerning dispersion.

"In order to have a product that images well," he continued, "you need to damp the nearfield reflections. The late-arrival energy needs to be randomized throughout the room—you need to even it out. That way, you obtain very keen imaging within a big ambience envelope. But even late-arrival energy can confuse resolution and ambience, so our recent research is showing us that we need to bring up reflections in the 10-20 millisecond window—which triggers your perception of ambience—and then damp it out.

"In your room, we tried something startling for a dipolar design—we damped most of the backwave. Then we opened up the dispersion a bit by putting the reflective side of the Studio Traps near either side of the SL3s. We emphasized that energy, but we had enough absorptive material in the room so that the energy died rapidly and was quite evenly distributed. That gave us better imaging, better focus, and a better sense

of space.

"That whole experience has altered the way I think. I used to depend upon the backwave, but absorbing it showed me that we can free ourselves from it. We can start to work closer to that back wall as long as we can emphasize that midfield energy."

Could we have gotten similar results using something other than the Tube Traps? Perhaps, but as Bruce Brisson pointed out to me, we got extremely linear results using them—and that was by design, not accident. If you have rugs, wall hangings, pillows, futons, by all means use them—in fact, I know that a thicker, bigger rug would improve still further the sound I'm getting right now. But I'm convinced that ASC Tube Traps, Bass Traps, and Studio Traps are powerful tools that will free a speaker from fighting the room, and I intend to make them a permanent part of my reference system.—**Wes Phillips**

Article Continues:Trying to Control a Lightning Storm »

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MartinLogan SL3 loudspeaker:
Trying to Control a Lightning Storm

Sidebar 4: Trying to Control a Lightning Storm

Talking to Gayle Sanders is always a treat; he's enthusiastic and gestures effusively, staying in constant motion until something totally engages his attention. Then, it's as though you can see the intellect click on: His eyes narrow, and he seems to quiver as he brings his full attention to bear. This can cause conversations to move in an odd rhythm, but one adjusts. I recently realized that I had never heard the saga of Martin-Logan's early days. I asked Gayle to tell me how he'd gotten into hi-fi, and why he'd

been driven to build electrostatic loudspeakers.

Gayle Sanders: I grew up in a musical family. As a kid, I built my own guitar. I read a bunch of articles, sourced my magnets, built a body, hand-wound my own pickups, cut the neck out of rosewood, fretted it myself—and I had my very own instrument. Not that I posed a big threat to Fender.

I went into architecture because I loved to design, but there was much too much rote work and not enough design. Looking around for something to do, I began working at an audio store as a salesman, and fell in love with the audio industry—it was the perfect place for the musician/technologist. And I was absolutely enchanted by electrostatic technology from the very first time I experienced it.

The Quad ESL gave me a hint of what I was looking for, but I'd have to say that hearing Arnie Nudell's Infinity Servostatics really was a defining moment. I owned a pair, so I also became very familiar with the rather considerable problems confronting electrostats—which is, I'm sure, why Arnie has moved on to other technologies.

Wes Phillips: What were those problems?

Sanders: While the Servostat showed that inefficiency and dynamic-range limitations could be transcended, the mechanics were still hard to resolve: keeping the diaphragm correctly tensioned, keeping the conductive coatings bonded to the diaphragm, preventing the diaphragm from arcing under dynamic excursions—these were all extremely problematic.

At about that time I suffered audio burnout and left the industry. I moved to Lawrence, Kansas, where I ended up working for Rueuter Organ Company—a firm that builds tracker organs from the ground up. I would take the ranks of pipes and the wind-chests and the consoles, and I would engineer the organ into a specific room. I just *loved* it—it was a thrilling experience every time out. But I like building things, so the whole time I worked for Rueuter, I was moonlighting—assembling systems for friends and for discos, constructing record racks, and stuff like that.

I met John Kiefer, a local record mogul, and we started a hi-fi shop. We were immediately successful, but I discovered that retail wasn't my thing. By 1978 I realized that I wanted to *build* stuff. Kansas University had a great engineering library, so I spent a year and a half in the stacks investigating everything ever written on the subject of electrostatic speakers.

Phillips: Some of that information must have gone practically back to Edison.

Sanders: Absolutely! Kellog and Rice did their work in the '20s, which was the great flowering of speaker design—electrostats, ribbons, and moving-coil speakers all come out of that era. Kellog and Rice lacked really good insulation technology—and, my God! their diaphragm material was a pig's intestine burnished with gold leaf! Even so, the difference in clarity and response was immediately apparent. It was a delightfully accurate and enchanting technology—theoretically, you could design a low-mass, extremely linear, crossoverless diaphragm that was capable of handling up to nine octaves of information—but it had huge drawbacks in implementation. The materials were not available, and the technology didn't really mature because of all the focus that had been placed on dynamic speaker design.

When you design an electrostat, you're trying to control a lightning storm. Electrostats didn't get loud, they blew up amplifiers, they blew up themselves—but these were not immutable issues, these were *physical* issues. I never felt that the *concept* was flawed. I pursued electrostatic technology believing that finding the right materials would solve the "insurmountable" problems that had plagued it.

Peter Walker, Jim Strickland, Arnie Nudell, and Arthur Janszen had all done significant work, but I still felt the transducer element could be taken much further. I took to calling high-technology firms and asking questions and, surprisingly, I found a lot of engineers who got excited by my project and contributed information that led to several of Martin-Logan's breakthroughs, including vapor-deposited coating of the diaphragm and conformal coating of the stator material. That's also how we got the highly insulated spars we use as spacing elements on our transducer.

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Floorstanding Loudspeakers

MartinLogan SL3 loudspeaker:
Trying to Control a Lightning Storm part 2

Phillips: I suspect we're getting ahead of ourselves.

Sanders: True, our first transducer had none of those elements. I built that first speaker right out of a hardware shop: perforated aluminum for the stators, Plexiglas for the spacing elements, epoxy glue to hold everything together. I found some half-mil polyester film somewhere and sprayed insulation onto the stator. To get a conductive coating onto a diaphragm, I burnished graphite onto the film.

Phillips: You just rubbed it into the polyester?

Sanders: That's right. It gives a nice semiconductive surface—you don't want a totally conductive surface on the diaphragm because all you want

to do is establish a bias charge, so the more resistive the surface is, the better off you are. That keeps the charge from migrating.

I had the basic elements together, but my strengths were in physics and mechanical design—I was not really a sophisticated electrical engineer. I met Ron Sutherland by chance and mentioned that I was designing this speaker, and that I needed someone to design the power supply. He said, "Oh, I'll do that." That was the beginning of Martin-Logan. The name comes from our middle names.

We finally completed the speaker and hooked it up to a little Hafler power amp. It worked! It looked like something right out of a barn—it was 2' by 3', with bare metal stators and wires hanging off it—but it worked right out of the chute. We'd chosen the right power supply, the right spacing element, and the right transformer. There wasn't much bottom end due to dipolar rolloff, but the midrange and the top end were transparent, immediate, and open. It was glorious. Tears were running down Ron's cheeks. We'd been working on this for a year and a half, and it had paid off.

Flushed with success, I uttered those famous words: "Let's turn it up!" A lightning bolt shot across the panel with a loud *crack*, followed by absolute silence and a curl of smoke rising from the stator. We had just experienced the power of an electrostatic loudspeaker—about 5000 volts had ripped a huge hole in the diaphragm, burnt away the insulation, and blown up the amplifier.

That's when the *real* research started. We went back to the drawing board and tried to figure out why it had happened, and how to prevent it in the future.

Phillips: Wouldn't a sane man have said, "Oh, this is why nobody is doing this," and walked away?

Sanders: Exactly. Anybody else would have said, "This is why we need dynamic speakers." What did I say? "I'm going to start a company to make more electrostatic speakers."

Phillips: Really? At the point of failure, you decided to make it your business?

Sanders: No, not really. But neither were we deterred. We knew that the only way to make a successful product was to address reliability, longevity, dynamic range, and full-bandwidth response. So we knew, even before we had a successful electrostatic transducer, that we would have to design a speaker that coupled a dynamic woofer with a workable electrostatic driver.

What had given hybrids a bad name up to that point was that they were designed by specialists in planar speakers—the dynamic driver was practically an afterthought. We knew, long before we had the planar element designed, that we would have to do a better job with the woofer than anyone else had, or we wouldn't have a product that people would want.

From the get-go, our first product *had* to be the Monolith. I knew the panel had to be 48" tall, so that you had even frequency response whether you were standing or sitting; and I knew, since it was a curvilinear line source . . .

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Trying to Control a Lightning Storm part 3

Phillips: We were just talking about your prototype, which used flat panels. How did you determine that you needed curved panels?

Sanders: That's the classic drawing-on-a-napkin-in-a-Chinese-restaurant design story. Ron and I were eating dinner, chit-chatting about speaker design. As we talked, I sketched a waveform moving away from a point-source. It became clear to both of us that the information on-axis was farther away in time than the information coming from the sides—I drew these little points and we literally connected the dots. I looked at the napkin and said, "Ron, could it really be this simple? Could we just curve the diaphragm?"

I couldn't sleep that night, so I got up and tried to build a curved panel, with no success. I couldn't stretch the polyester in two dimensions and get it to curve. I finally found a way to curve the diaphragm in free air, and then use curved back and front stators to control it.

Phillips: How do you do that?

Sanders: We don't really discuss that. Just say that, under tension, the panel is rigid enough to maintain the curved shape, despite the fact that the material resembles Saran Wrap in its free form. Any competent engineer could devise a system of controlling the material enough to keep it from caving in to the rear stator, but the challenge is to do it repeatedly and predictably. Forming the panel into an arc allows us to control the way its acoustic energy interacts with a room.

Phillips: So that's the major breakthrough?

Sanders: One of them. We also developed a new insulating technique for the stators, and utilized the vapor-deposit method of making the panels conductive. Vapor deposition actually shoots the copper oxide and palladium into the diaphragm material. These were the major factors that

made our speakers reliable and long-lived. We actually made—and sold—speakers before settling on the vapor-deposition process, and it cost us a lot of money in our first few years, replacing all the diaphragms we'd already sold with better ones. But it was worth it—I don't think Martin-Logan would be in business today if we hadn't stood behind our products from the very beginning.

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MartinLogan SL3 loudspeaker:
Measurements

Sidebar 5: Measurements

I hate measuring panel speakers. Why? Because the usual assumptions you make when you measure a loudspeaker—that the microphone distance is large compared with the physical size of the speaker and that the mike is therefore in the speaker's farfield—are no longer true. As a result, the interaction between the microphone and the speaker is much more complex than is normally the case. In addition, the measured performance of panel speakers is enigmatic. Compared with a typical moving-coil speaker, the measurements can look worse—yet listeners like the sound more. So why measure? Because I believe even a small bit of knowledge is better than a large amount of ignorance.

Having got that off my chest, how did the SL3 look in the test lab?

The Martin-Logan's B-weighted sensitivity weighed in at an estimated 85dB/2.83V/m. This is somewhat lower than the specification, but in a room the line-source behavior of the panel will mean that the SL3 will sound louder than a similarly specified point-source speaker. Its impedance (fig.1), taken with the woofer switch set to "Flat," reveals it to be a hard load for the partnering amplifier, which might partially explain why WP found it very revealing of amplifier quality. Though the impedance drops to 1.5 ohms at 20kHz, there isn't much musical energy

present up there, meaning that the amplifier will not be taxed too much. In addition, as is typical, the lowest impedance magnitude coincides with a phase angle of 0 degrees.

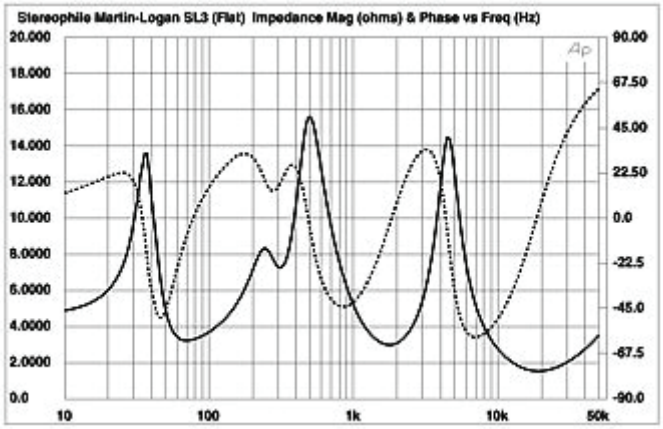

Fig.1 Martin-Logan SL3, electrical impedance (solid) and phase (dashed) with woofer switch in "Flat" position (2 ohms/vertical div.).

However, there are three problem areas at lower frequencies, both where the music has a lot of energy and where the SL3 features a combination of low impedance and high phase angle, something that asks a lot of an amplifier. At 50Hz, 4.5 ohms impedance is coupled with a capacitive phase angle of -47 degrees; at 1kHz, a magnitude of 5 ohms coincides with a phase angle of -42 degrees; while at 8.2kHz, a magnitude of 3.8 ohms combines with a phase angle of -57 degrees. In each case, the amplifier's output stage will be maximally stressed.

Switching in the 3dB woofer control usefully increases the impedance in the bass, and reduces the woofer output by between 3dB and 4dB, depending on frequency. The tuning of the moving-coil woofer is revealed by the peak in fig.1 at 36Hz. The impedance plot was free from resonance-induced wrinkles—I found the enclosure to be acoustically dead.

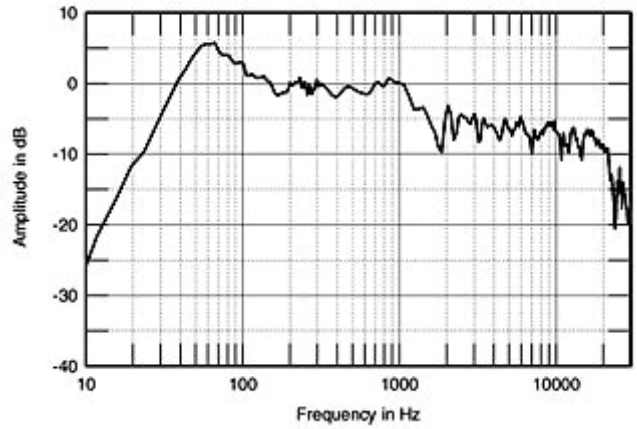

Fig.2 Martin-Logan SL3, anechoic response on mid-panel axis at 50", averaged across 30-degree horizontal window and corrected for microphone response, with complex sum of nearfield woofer and panel responses plotted below 350Hz.

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Measurements part 2

Moving on to the measured frequency response, this was taken on an axis level with the midpoint of the electrostatic panel, 42" from the floor. Visually smoothing out all the little ripples, the SL3's response appears to shelve down above 1kHz. Remember, however, that there will be an interaction between the speaker and the measured response due to the relatively close microphone distance. There will be a "proximity effect" that raises the speaker's apparent midrange output the closer the microphone is to the speaker.

This is graphically shown in fig.3, which shows the on-axis response measured at my usual 50" mike distance (bottom trace) and at 108" (top), the farthest away I could place the microphone in the *Stereophile* listening room where I perform my speaker measurements. You can see that not only does the midrange dramatically shelve up at the closer mike position, but that the speaker acquires more presence-region energy at the farther position. What is true for the microphone will also be true for the listener. In small rooms, the balance of the SL3 will depend very much on how far away the listener sits.

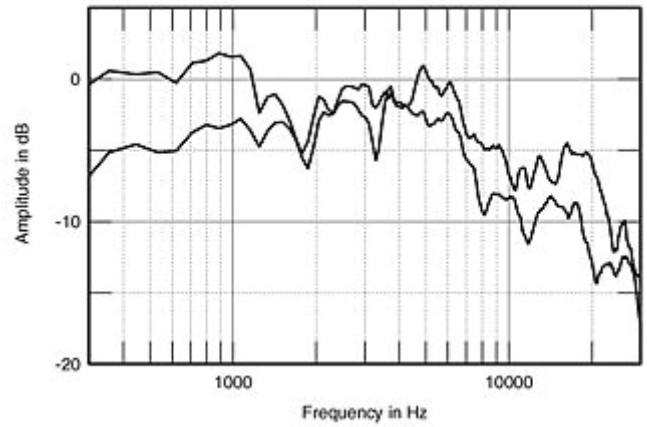

Fig.3 Martin-Logan SL3, anechoic response on mid-panel axis at 50" (top) and at 108" (bottom) (5dB/vertical div.)

Vertically, the Martin-Logan seemed quite uncritical of exact listening height. Sitting with your ears anywhere between 32" and 48" from the floor will give similar balances. Laterally, however, fig.4 shows that while the curvature of the panel gives reasonably good dispersion below 1kHz, the speaker is still very beamy in the treble (other than in the 10kHz region, where the speaker actually puts out slightly more energy off-axis). As a result, the Martin-Logan's balance might sound rather uninvolving in rooms that are heavily furnished. Dispersive room surfaces will be better than absorptive. Much of the ragged-looking behavior at extreme off-axis angles is due to the presence of reflections of the panel's output from the tapered "wings." This should be subjectively inconsequential, however.

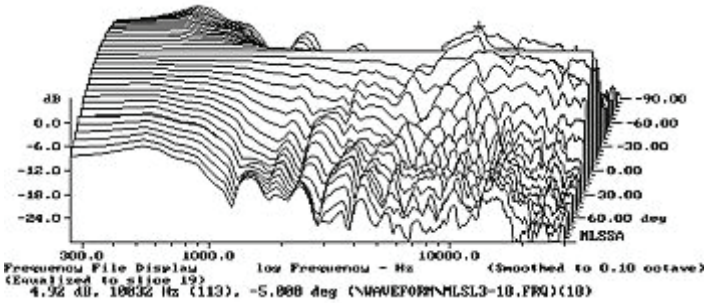

Fig.4 Martin-Logan SL3, horizontal response family at 50", normalized to response on mid-panel axis, from back to front: differences in response 90 degrees-5 degrees off-axis; reference response; differences in response 5 degrees-90 degrees off-axis.

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In the time domain, the SL3's step response (fig.5) is beautifully coherent, the rise away from the time axis being almost vertical. Further analysis is difficult, so I have also shown the individual step responses of the panel and woofer (fig.6), plotted to a slightly different scale. The panel can be seen to overshoot the time axis on the return of its step to zero, with its second positive-going move overlaid with the slow rise of the woofer output. There will be some cancellation between the two drivers, meaning that the SL3 owner should experiment with the room placement to get the optimal blend between the two drivers in the lower midrange. I do note that WP was not bothered by any integration problems in his room.

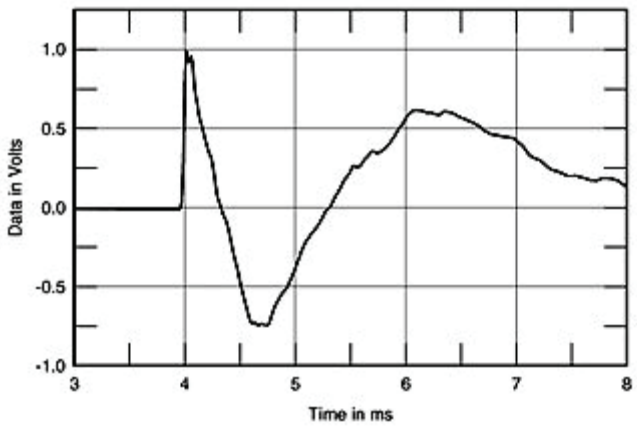

Fig.5 Martin-Logan SL3, step response on mid-panel axis at 50" (5ms time window, 30kHz bandwidth).

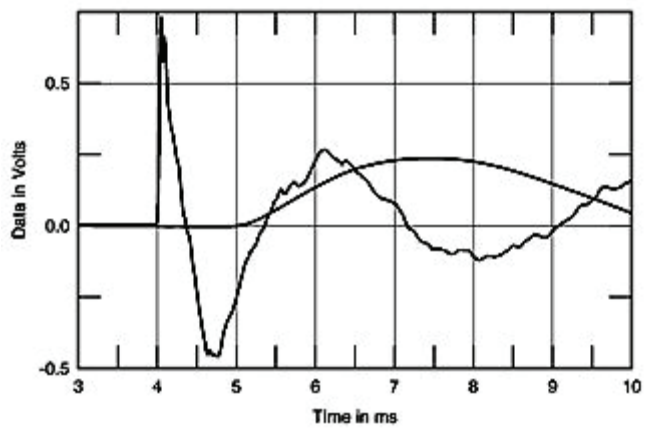

Fig.6 Martin-Logan SL3, individual step responses of panel and woofer on mid-panel axis at 50" (7ms time window, 30kHz bandwidth).

Finally, the SL3's cumulative spectral-decay or waterfall plot (fig.7) doesn't look very good, there being ridges of delayed energy apparent in the low treble and a good deal of hashy behavior in the high treble. However, as WP found the speaker to sound clean and transparent, I must assume this graph looks worse than it is. However, I believe all panel speakers, to a greater or lesser degree, exhibit chaotic behavior (in the mathematical sense): Although the drive signal is uniform across the panel area, the panel itself "shimmers" or "wobbles" as it moves in response to that signal. In effect, some areas of the diaphragm move a little more than they should, others a little less, the result being the hashy-looking plot of fig.7. However, as long as the speaker designer knows what he is doing with regards to the physical aspects of the panel design, this will be to a large extent a random process. The ups and downs will therefore tend to cancel, leaving a subjectively clean reproduction of the input signal.—**John Atkinson**

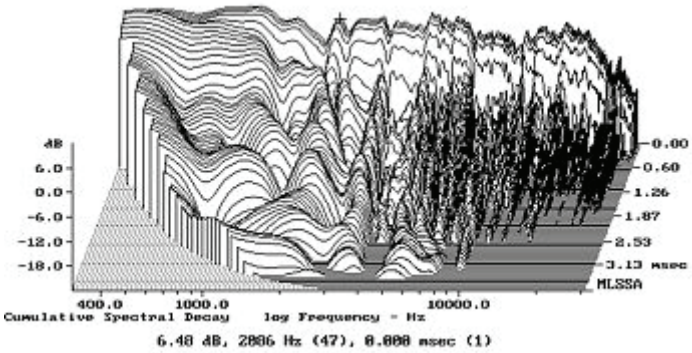

Fig.7 Martin-Logan SL3, cumulative spectral-decay plot at 50" (0.15ms risetime).

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Sidebar 6: Manufacturer's Comment

Editor: I know when the team of Wes Phillips and John Atkinson get hold of a speaker the manufacturer is going to learn even more about his product than he knew before the process began. We are Martin-Logan feel that the SL3 represents new levels of audio performance and it feels good "back here in the Midwest, that your observations are close to ours."

A few issues regarding the testing procedures. Yes, our products are different from point source products in the way that they launch information and, as a result, our testing procedures differ from the norm. I have taken the liberty to enclose a small explanation as to how we arrive at our testing measurements, and you can see that basically we move our testing position to the listener position, which we assume is about 3.2 meters from the speaker. As you can see, the frequency response evens out and the sensitivity scales much close to 90dB at that position.

With a point source it is easier to test at 1m, then certain things will occur at the listening position. With our product, we feel it important to test at, or close to, the listening position.

Also the waterfall can look slightly hashy as a result of a large line source launching information into the room as opposed to a point source. Information is arriving from the entirety of the panel to a single point on the microphone which is a partial contributor to a less-than-clean look. However, John is correct in his discussion as to how the ear handles this information making it less relevant than the test would imply.

And yes, Martin-Logan speaker products do benefit from better amplifiers. And yes, we are not the easiest load to but by far not the most difficult load to drive. As a result of that revealing nature, our electrostats most certainly benefit from better front ends and amplification.

Sometimes Martin-Logan products are easier to place in the room than point source products and, sometimes vice-versa depending on the

nature of that room. The controlled frontal dispersion actually makes it easier to place a Martin-Logan in a long or narrow room, and therefore a better image and focus can immediately be achieved versus a wide dispersing product.

Again, thank you for your revealing work. We look forward to being sliced, diced, and dissected by *Stereophile* again in the future.

Martin-Logan on measuring panel speakers: Measuring panel speakers can be a challenge. Since we are no longer dealing with a point source, some care must be taken in making measurements. This always brings up the issue of near field and far field. The question is "are we taking measurements in the near field or the far field." An equation that gives the approximate distance of the transition point is:

transition_point = D-squared/lambda

Where D is the largest dimension of the transducer and lambda is the wavelength of the sound being produced. (This is just a rule of thumb equation, not an absolute mathematical definition.)

When we look at an electrostatic element with a D of 48", the transition point is shown in fig.1. At 10kHz, the transition point between near and far field is over 100' from the speaker! However, at 200Hz, the distance is only 3'. So some of our measurements are going to be in the near field. (By the way, for a conventional tweeter, the transition at 10kHz is 3/4".)

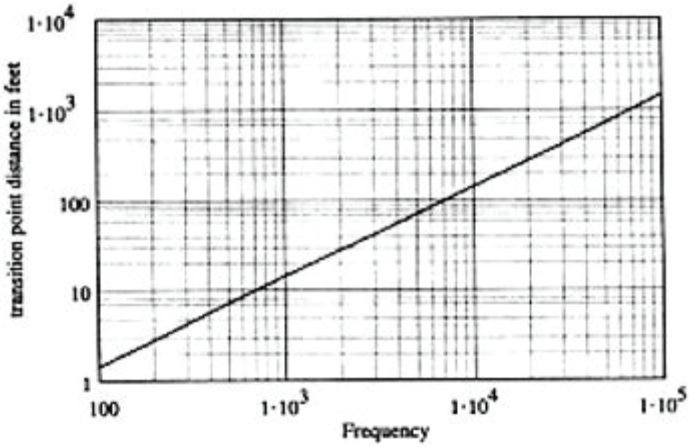

Fig.1 Transition point in feet plotted against frequency for a 48" diaphragm (note logarithmic vertical scale).

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What is the difference between the near field and the far field?

In the far field the dispersion pattern can be described in terms of angles and a constant (1/R) term. Meaning the radiation pattern is independent of the distance. In the near field, this is not the case. The radiation pattern *is* dependent on the distance.

What the hell does all this mean to us?

What it means is that a person sitting 3' away from the speaker will hear something different than a person sitting 10' away, even if they are at the same angle to the speaker. How then do we get a fair measurement of the speaker's frequency response? The way it is done at ML is to set the speaker up according to the owner's manual and measure the response. This is usually done at a distance to the speaker of 9-12'. The SL3's response curve at 10' is shown in fig.2. (Note: 8.9V at 3.2m is scaled such that a 90dB/2.8V/m point-source speaker would read 90dB on this graph.)

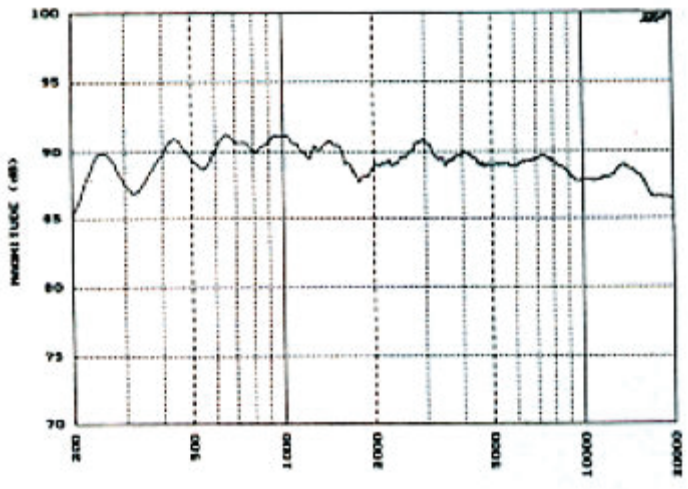

Fig.2 Martin-Logan SL3, response on-axis at 3.2m, 8.9V input level (5dB/vertical div.).

The speaker has been designed so that a person who takes these speakers home, reads through the owner's manual, and sets them up accordingly will achieve a response similar to the one shown above. The most critical part of the set-up is to get the speaker positioned so that when the listener looks at the curve of the ESL element they see the inside third of the panel.—**Gayle M. Sanders, Martin-Logan Ltd.**

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