



LEGEND ACOUSTICS

SMALL RED ISOBARIC LOUDSPEAKERS

Kangaroos in Australia can get big. Bloody big. And while little joeys—and wallabies—can be cute—the Big Red kangaroo is a monster roughie that can easily kill a man if cornered and threatened. Strangely enough, although kangaroos can be found throughout Australia from desert to mountain to beach, you mostly have to travel well outside the major cities to come across one in the wild—at least with the exception of the national capital city, Canberra, which has hundreds roaming some suburbs.

But whether we Aussies like it or not, there is no denying that the kangaroo has become an icon that represents the freedom, expanse and cultural richness and diversity of the land Down Under. Perhaps for this very reason, Legend Acoustics has

chosen to name many of its speaker creations with various Aboriginal names for the numerous kangaroo varieties.

Regular readers may recall that I reviewed the excellent Legend Acoustics 'Big Red' (also known as the 'Kumbar Wirri') speakers back in the July/August 2007 issue. That fully loaded DEQX'd twin enclosure speaker with active bass—now, incidentally, available in updated form—was an advanced and highly-sophisticated design that required nothing more than a source and some connecting cables to be up-and-running. I had the pleasure of being one of the very first to review an early version of this extremely capable and somewhat underrated wonder of a component. In the Big Red the DEQX formed the very heart of the speaker by performing all manner of

duties from driver correction to active crossover, preamplifier, amplifier for mid and tweeter... and even room correction. A true 'jack-of-all-trades', it was an Aussie army knife. At the time, the Big Red had been the flagship in Legend's loudspeaker catalogue: That title now belongs to the new Tikandi, the top-of-the-line version which uses the latest iteration of DEQX. The Big Red was a superb performer that could compete in far loftier price ranges on dynamic range, bass power and depth and overall accuracy.

Now Dr Rod Crawford, Legend Acoustics' chief designer and principal, is offering the Small Red—yes, a name that is simple and logical—which aims at offering much of the considerable sonic qualities of the Big Red *sans* DEQX in a smaller passive single-box stand-mount package. What a challenge! How do you even approach the remarkably big sound—especially in the bass—of which the Big Red is capable, in such reduced physical form? If anyone can, it would be Crawford, who has extensive experience designing small speakers with big performance. (And the many years he spent designing loudspeakers in the UK for Scottish firm Linn Products would certainly not have gone astray!)

THE EQUIPMENT

Crawford's first trick was in the design of the rather deceptive enclosure. By keeping the front of the cabinet narrow and making it pyramidal (this in itself has sound diffraction and dispersion benefits), Crawford was able to stretch the enclosure in height and depth. This cabinet geometry maximises internal enclosure volume while maintaining an illusion of an overall smallish enclosure. But what the extra depth really allows for is the *coup de grâce* in the Small Red's execution. Crawford uses the highly-regarded 8545 Scanspeak 177mm driver in its more suited role of a woofer (unlike many high-end designs—most notably Wilson Audio—which use this driver in dual mid-range/bass applications), but he then places a *second* bass driver inside the cabinet, directly behind the visible one.

This transforms the Small Red into an isobaric design, the acoustic result of which is that the two woofers work in unison to deliver far deeper and stronger bass than the size of the enclosure would suggest. (Come to think of it, a kangaroo also hides another one of itself inside its pouch.)

The other drivers selected also show the mark of a clever designer. Crawford has chosen high-quality ingredients which, although not particularly exotic, represent real-world value and, when used wisely, have the potential to deliver outstanding performance. For example, the tweeter is the excellent Visaton KE25SC—as used on the Big Red—which sits within a shallow horn flare. New to the Small Red is the superb SEAS Nextel 130mm driver, which performs exclusively midrange duties. It was because of the unusual nature of the design that I decided to ask Crawford for some insights into his thinking when he was designing the Small Red and thought I'd start with the reasons for the tweeter's horn flare: 'The horn adds about 2dB of efficiency but was not done for that reason as the tweeter was already more efficient than the midrange. It was done mainly to control the directivity of its output in the lower treble so that there is not such a large change in dispersion when crossing over [from the midrange to the tweeter]. Floyd Toole's work suggests that sudden changes in directivity/dispersion into the room (and thus the room response and indirect sound

arriving at the listener) are important as well as the direct sound. The Revel Ultima loudspeakers (designed when Toole was head of technology at Harman) do something similar.'

I then asked him what—apart from what was already known as a result of designing the Big Red—important design decisions he had to make when designing the Small Red. His answer? 'Not a whole lot. The Small Red is mainly an attempt to bring as much technology as possible from the new flagship Tikandi and the Kubar Wirri to a more affordable sector of the market in the hopes of commercial success. In general we tried to minimise distortion by choosing the best, lowest distortion drivers we could reasonably find. We put these in a cabinet that minimises distortions from internal standing waves, external diffraction and cabinet resonances. I then designed the crossovers—with again the best, lowest-distortion components we could afford—to minimise driver distortion through the usual iterative cycles of measurements and extended listening. We used recent hi-res recordings of live music to avoid a distorted view... especially of the treble. Of course the bass alignment had to be different from the Tikandi and Big Red. I certainly did use my experience at Linn with the so-called isobaric bass loading, especially that of the Sara where they put it inside a stand-mount with a two-way driver configuration. This led to great bass but an awful midrange. The two mid/bass drivers started to decouple when the sound's wavelength became comparable to the distance between the drivers.'

'How did you avoid this problem now?' I asked. 'This was actually avoided in Linn's Isobarik DMS already. That was a three-way system with the isobaric woofers being rolled off before they could decouple. Of course Legend's isobaric Small Reds are also three-way. Perhaps you could say that the isobaric Small Red is a stand-mount speaker like the Linn Sara but one that was properly designed! I believe that designing a loudspeaker is not magic. It is mainly about hav-

LEGEND ACOUSTICS SMALL RED

Isobaric Loudspeakers

Brand: Legend Acoustics

Model: Small Red

Category: Bookshelf Loudspeakers

RRP: \$6,450

Warranty: Seven Years

Distributor: Legend Acoustics

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- Powerful bass for the size
- High quality drivers



- Requires powerful high-current amp
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ing a good understanding of the physics, engineering, materials and psychoacoustics involved, then implementing it as best one can... including the inevitable compromises. That does involve intuition and experience. For example, because of the different wavelengths involved, the ear evolved for survival over the millennia using different strategies for directional discrimination at different frequencies. So I try to use lower-order crossovers at low frequencies where time/phase effects are more important. If necessary, I use higher-order filters at higher frequencies where amplitude effects are more important (and where cone break-up with its amplitude distortion is usually paramount). At low frequencies, the longer overlap of driver frequency due to shallower slopes is also less important because beaming/lobing is not a problem when distances between drivers are much shorter than the wavelengths [Crawford has written a 'White Paper' on this subject, which is available on his website, linked to a review of his Legend Kantu]. I have tried to use most of this knowledge with not just the Small Reds but all the speakers I have ever designed.'

The Small Red needs a short—but high-quality—stand in order to deliver its full bass potential. A stand about 46–51cm high will do the job perfectly. The speaker is quite nicely finished (my review sample came in a natural Jarrah veneer, but other finishes are available) and though not extravagant,



it's the solidity of the cabinet which really impresses. The old knuckle rap 'rewards' with a dull thud and mild bruising to said knuckles! There's some serious bracing inside—no doubt partly due to the internal support system required for the second, hidden, woofer. Size is a manageable 500mm high with a 230x350mm footprint at the base. Each speaker weighs 17kg. As mentioned, the Small Red is a three-way isobaric design. The nominal crossover points are at 220Hz and 2.5kHz. The frequency response is quoted on Legend's website as 40Hz to 25kHz (no tolerances provided) and efficiency as 86dB SPL at one metre for a 1-watt input. Legend Acoustics suggests using an amplifier with a power output of around 100–300 watts that is capable of providing ample current. I should note that Legend also provides a generous seven year warranty on its speakers—two years longer than the industry norm.

TIE ME KANGAROO DOWN, SPORT!

I sat the Small Reds on solid MDF 460mm spiked stands and although the speakers had been run-in at the factory, I gave them another 10 or so hours before starting the review, just to be on safe side. With the whole idea of an isobaric speaker making big bass from a small enclosure, that was the quality I first attempted to evaluate. In my opinion, the design mandate has been very successfully met. The Small Reds possess an ample bass register that easily equals that of small to medium-sized floor-standing loudspeakers.

However, this conclusion needs qualification. I initially tried the Small Reds with a high quality 50-watt amplifier. The sound was generally good and the bass potent, but I thought the midrange lacked vividness and life and that the lower registers needed firmer control. The speakers sounded somewhat restricted, overly bloomy and... well... *almost* boring. Changing to a more

powerful amplifier completely exorcised this lack of snap and life—as did connecting several other powerful amplifiers (I trialled the additional amplifiers just to be on the safe side, to ensure I wasn't reaching an erroneous conclusion!) The moral here is that the Small Reds need a substantial amplifier that is capable of providing generous levels of current to exercise firm driver control: I'd be thinking along the lines of 150-watts per channel minimum—be it solid state or push-pull valve.

At the tail end of a NuForce Reference 9SE V3, Ray Brown's acoustic bass genius in *The Real Blues* was reproduced with thunderous power and very good clarity. By clarity I mean not just detail and resolution but also a phenomenal level of harmonic and timbral accuracy that mimics the real instrument. What's more—and this is somewhat paradoxical—certain notes had a jump factor and dynamic snap that was almost startling, the paradox being that the speaker's overall presentation was entirely and expertly balanced. Those surprising skip-beat notes were actually on the recording and the Small Reds were simply able to convey this without compression.

My favourite big bass 'killer' track at the moment is Mino Cinelu's *Oncoming Horizons* from his self-titled CD. This track starts with an immense bass drum thwack that would scare the bejeezus out of many a respectable woofer. The Small Reds didn't quite cruise through this torturous test—there was some just-perceptible distortion at the lowest end of the note—but they still managed to dish out a realistic whack that rattled nearby windows. This was superb performance from a speaker this size. Give the Small Reds complex rhythms and they will comply by revealing a very good level of resolution and separation. The German tweeter shows its mettle and all manner of cymbal and treble information is clearly and sweetly reproduced. If that ceramic driver was breaking up or resonating somewhere,

it was certainly well beyond the upper threshold of my hearing.

Of course such a high-quality tweeter and midrange combo should be very adept with the human voice and the Small Reds did not disappoint. From Chris Jones to Patricia Barber and on to Janis Ian, the vocal range was never reproduced in any way other than very realistically and such that it was totally 'present'. It always lacked harshness, grain and brightness. Vocals enjoyed a natural and almost spot-lit facsimile that was very appealing to motivate long listening sessions without fatigue of any kind.

The Small Reds were more than capable with large-scale works too, defiantly so for their size in fact. Mercury Living Presence's 'Hi-Fi à la Española' had the sense of scale required to realistically and satisfactorily replay such a work. The Small Reds won't do the massive scale of a WATT/Puppy or indeed other large and more expensive speakers but they go quite a long way towards them—especially for their size. Similarly belying their dimensions, the Small Reds' soundscape is generously large and deep, with accurately placed images.

Unlike an increasing number of contemporary speakers (especially those at the top end of the market) the Small Reds are very forgiving. Even though they can offer oodles of musical detail, they do so in a much more listenable manner that won't have you reaching for either the volume control or the CD case. In this sonic buffet I point the finger at the chef's wise selection of ingredients—Visaton tweeter and SEAS Nextel midrange—and skilful seasoning with an expertly executed crossover design.


KONKLUSION

Legend Acoustics' range of speakers is an ever-growing labour of love for designer/proprietor Dr Rod Crawford. Over the years, the product portfolio from this Tasmanian-based manufacturer has expanded to include speaker solutions for all facets of audio reproduction, from reference-quality transducers (the Ultima range of which the Small Red is part) to high-quality monitors, centre-channel speakers and powered subwoofers. What's more, Crawford borrows from a variety of cabinet loading principles to include reflex-loaded and sealed designs, dipoles... and now... an isobaric.

The Small Reds can only be called small



They still managed to dish out a realistic whack that rattled nearby windows. This was superb performance from a speaker this size

in physical stature: Their sound is anything but. If you're after compact speakers that can provide a much larger sonic picture than their size would suggest and deliver the sort of bass commonly associated with mid-size floorstanders, you're looking at the Legend Acoustics Small Reds. That they also excel in many other important sonic criteria is an extra dollop of cream. Small? No way!  **Edgar Kramer**

Readers interested in a full technical appraisal of the performance of the Legend Acoustics Small Red Loudspeakers should continue on and read the LABORATORY REPORT published on the following pages. Readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific sample tested.

LABORATORY TEST RESULTS

Graph 1 shows the averaged result of nine individual frequency response sweeps, measured at a distance of three metres from the Legend Acoustics Small Red loudspeaker, with the central grid point exactly on-axis with the Small Red's Visaton tweeter (with the protective metal mesh grille still in place). You can see the resulting response is extremely linear—that is to say, 'flat' right across the region graphed (20Hz to 10kHz), rolling off only at low frequencies, with the roll-off commencing just above 100Hz, which is excellent for such a small enclosure. Note also that the roll-off slope is not particularly steep, at around 6dB per octave, so that the response is just 6dB further down at 50Hz than it is at 100Hz, for example (and a good example, in this case, because that's exactly what the trace in Graph 1 does). Note that this graph is completely unsmoothed, though some smoothing is inevitably introduced by the averaging process itself, as the nine graphs are processed into just the one, single trace.

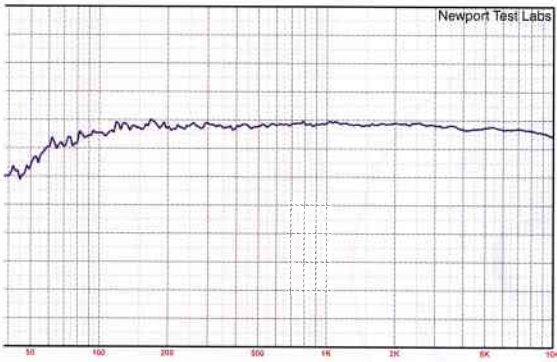
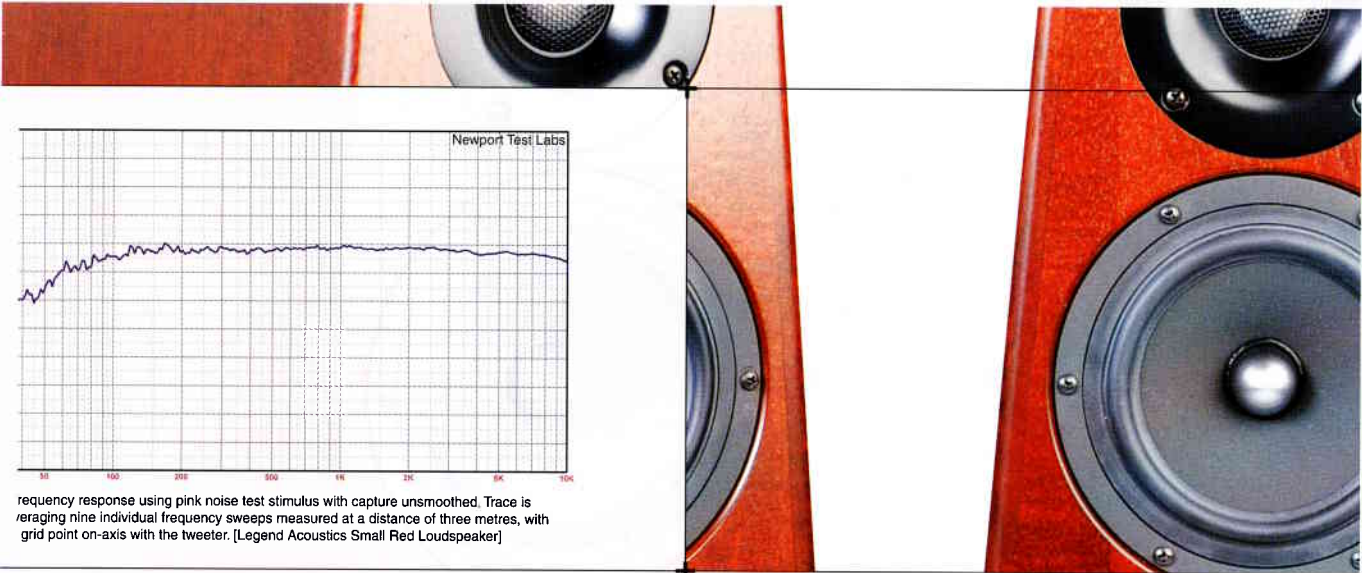
As you should have noted from the upper graph limit of Graph 1, that graph doesn't show the high-frequency performance of the Legend Acoustics Small Red loudspeaker: this response is shown in Graph 2, which shows the upper part of the midrange driver's response and then

the tweeter's response out to 30kHz. Let's first deal with that high-frequency peak above 20kHz. The first thing to note is that it looks a little bigger than it actually is due to the 5dB roll-off in the tweeter's response between 10kHz and around 17kHz, after which the response picks up again to be at around the nominal '0dB' (reference level) at 20kHz. This puts the top of the peak at around +8dB (at 23kHz). Such resonant peaks are fairly typical of hard-dome tweeters, and I have to say that I'm not too concerned about it, firstly because the peak is not overly high, and secondly because it's well above the upper limit of most people's hearing. If you're over 30 years old, your hearing probably tops out at around 16–17kHz, and if you're older (or go to a lot of rock concerts) you could subtract 1kHz for every additional ten years older you are than this! Between 400Hz (the lower graphing limit for this particular test) and 10kHz, the Small Red's frequency response falls easily within ± 3 dB limits, which is excellent. I was initially intrigued in the slight 'bump' in the response at 2.5kHz, which seemed to be crossover-related, but when I looked at this frequency area on Graph 1, the averaged response is perfectly flat, so it's probably only in the direct on-axis response and is ameliorated off-axis, and so it 'averages out' with multiple frequency response runs.

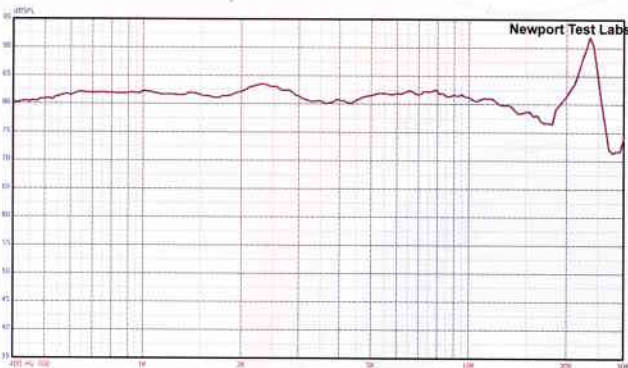
Nearfield testing by Newport Test Labs shows that Legend has been able to extract some seriously deep bass by using two bass drivers in an isobaric configuration (Graph 3). Note that the two traces have not been normalised for the differences in radiating area, which appears to put the nominal crossover at around 150Hz, when it's actually a little higher, at 220Hz. More importantly, you can see that the bass driver's output peaks between 70 and 90Hz, then rolls off smoothly either side, at 9dB per octave with decreasing frequency, and at 6dB per octave with increasing frequency. The midrange driver is rolled on very smoothly and once it reaches its maximum output, exhibits an extraordinarily flat and extended response, so flat that it's within ± 1 dB all the way up to 2kHz, after which it's rolled off by the crossover. Note that the small 'suck-out' between 800Hz and 1kHz is actually a measurement error, caused by the fact that the microphone could not be properly positioned relative to the cone due to the

unique design of the midrange driver, (unique in that it does not have a dustcap, and it's the over the dustcap that the microphone should be positioned to give an accurate, glitch-free response!)

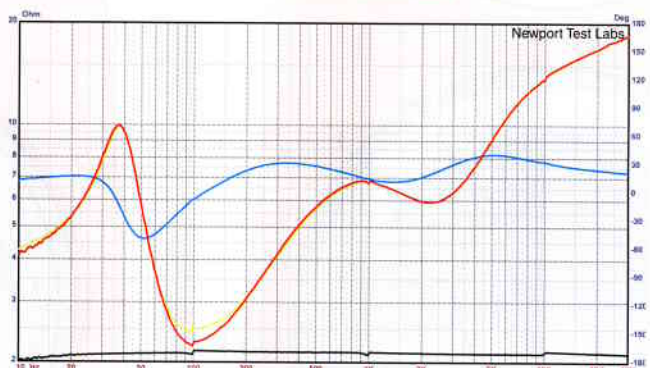
The impedance modulus of the Legend Acoustics (Graph 4) shows that it will present a difficult load to the driving amplifier, with the impedance plummeting to below 4 Ω at 54Hz to a minimum of about 2.2 Ω at 100Hz, after which it continues to stay well below 4 Ω all the way up to 290Hz. If you look at the graph, you can see that other than at the bass driver's resonant peak at around 37Hz (where the impedance is 10 Ω), the impedance stays below 8 Ω (and often a long way below 8 Ω) all the way up to 4.3kHz. This effectively means the Small Red will require the driving amplifier to deliver considerable levels of current. Normally I would bring up a speaker's sensitivity later in my analysis, but this time I will point out at this juncture that Newport Test Labs reported that using its test methodology, it rated the sound pressure level of the Small Red at just 83.5dB SPL at a distance of one metre for a 2.83V input. This puts the overall efficiency of the design quite low, which in turn means that in order to generate high in-room sound pressure levels, the amplifier will need to deliver high voltages as well as high current, so it's a double-ask. In other words, you WILL need a high-power, high-current amplifier. I would also personally recommend an amplifier with a conventional output stage, as some Class-D designs do not like driving speaker impedances of around 2 Ω . The phase angle is well-controlled, reaching a maximum swing of -60° at 55Hz, at which point the impedance is 4.5 Ω . The pair-matching of the left and right speakers is excellent, as you can see by the way the red (left speaker) and yellow (right speaker) traces are virtually indistinguishable from each other over almost the entire measurement range. The small error between 70–200Hz is exaggerated because the impedance is so low at this point. Note also that the glitches in the impedance trace at 100Hz, 1kHz and 10kHz are related to the test equipment switching measurement ranges at these three points, and nothing whatsoever to do with the Small Red. I note this particularly so I can make a point of pointing out that there are no resonance-



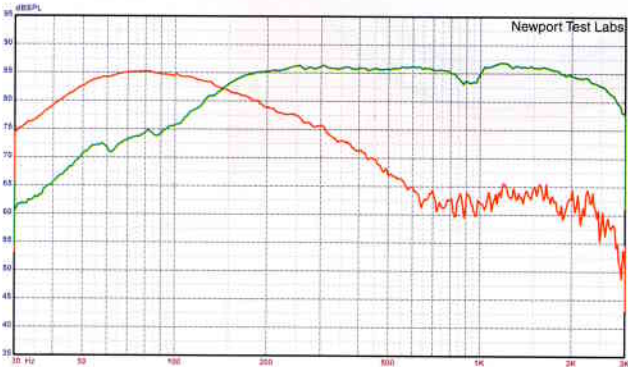
frequency response using pink noise test stimulus with capture unsmoothed. Trace is averaging nine individual frequency sweeps measured at a distance of three metres, with grid point on-axis with the tweeter. [Legend Acoustics Small Red Loudspeaker]



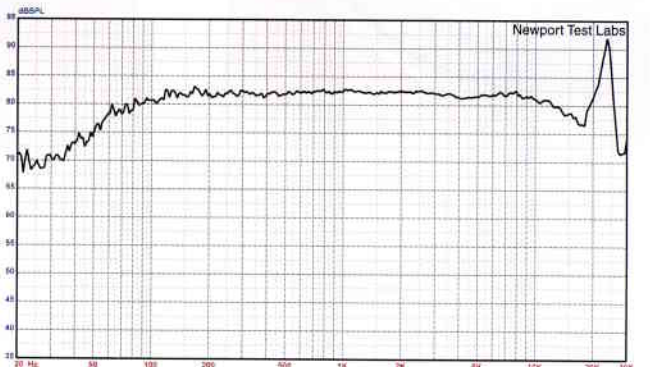
Graph 2. High-frequency response, expanded view. Test stimulus gated sine. Microphone placed at three metres on-axis with centre of tweeter. Lower measurement limit 400Hz. [Legend Ac Small Red]



Graph 4. Impedance modulus of left (red trace) and right (yellow trace) speakers plus phase (blue trace). Black trace under is reference 2-ohm precision calibration resistor. [Legend Acoustics Small Red Loudspeaker]



Graph 3. Low frequency response of bass driver (red trace) and midrange driver. Nearfield acquisition. Note anomaly on midrange response (See Copy). [Legend Acoustics Small Red]




Graph 5. Frequency response. Trace below 5kHz is the averaged result of nine individual frequency sweeps measured at three metres, with the central grid point on-axis with the tweeter using pink noise test stimulus with capture unsmoothed. This has been manually spliced (at 5kHz) to the gated high-frequency response, an expanded view of which is shown in Graph 2. [Small Red]

related 'glitches' on the impedance traces at all, so the performance of the Small Red cabinets themselves is exemplary.

The final graph (Graph 5) is a composite, showing the overall performance of the Small Red design. On this graph, the unsmoothed low-frequency pink noise response has been spliced at 5kHz (via post-processing) to the unsmoothed high-frequency response, acquired using the

gated sine method. This shows not only that the overall response measured extends from 55Hz to 22kHz ± 3 dB, which is excellent, but also that the response is perfectly balanced, in that it doesn't tilt up or down to emphasise one end of the spectrum at the expense of the other. In other words, an ideal result. So far as the low-frequency performance is concerned, I don't think I've ever seen such an extended low-frequency

response from any loudspeaker with the Small Red's internal volume (and external dimensions), so this is definitely a first, and certainly 'proof of performance' for the 'isobaric' concept—at least as implemented by Legend Acoustics. That said, don't expect to see a rash of isobaric designs from other manufacturers: they're difficult to design, difficult to build and expensive to implement!  Steve Holding