Lehmannaudio

Black Cube Linear USB Headphone Amplifier

Norbert Lehmann is a highly skilled and very talented engineer who operates from what must be the world's best address for an audio company: Mozartstrabe, Koln, Germany. I do wish, however, that he didn't have such a penchant for naming his products 'Black Cube.' At least the original 'Black Cube' was black, even though it wasn't a cube, but this latest 'Black Cube' is neither black nor a cube!

Even its name is not completely descriptive because, in addition to being a headphone amplifier, and a DAC that will convert your digital audio files to analogue (via a USB interface), the Black Cube Linear is also a high-end preamplifier (albeit one that has only a single input, so if you want to access multiple signal sources, you'll have to add an outboard passive switch.)

The Equipment

The Black Cube Linear USB Headphone Amplifier/Single-Source Preamplifier (which hereafter I will refer to as the Black Cube Linear, rather than continue to use its full title, for the obvious reason) is surprisingly large and heavy. One reason is that Lehmann has decided to integrate the power supply into the case, whereas with many of his other designs, he provides a completely separate power supply. I suspect there are a number of reasons for this, not least being the fact that recent improvements in power supply technology now mean that it's possible (though by no means easy, and certainly expensive!) to build a power supply that's quiet enough to be in close proximity to low-level voltages without introducing noise.

Another reason for designing an internal power supply is no doubt the popularity of Lehmann's products in the professional audio field, where almost everyone uses headphones whilst monitoring, and thus has need not only of state-of-the-art headphones, but also a state-of-the-art headphone amplifier to drive them! (About which more later…) In a professional situation, where you have equipment strewn everywhere about the studio, you just don't want a two-box solution, particularly if the power supply has been separated from the low-voltage electronics because it's noisy! A professional would immediately realise that if the Black Cube Linear's power supply is quiet enough to be contained within the case, the Black Cube Linear itself won't introduce any noise into the recording chain.

You really only need take a passing glance at the Black Cube Linear to see immediately that it's very obviously been built by an engineer. Who else would be game enough to have the very large volume control knob protrude through an equally large hole on the front panel with such a fine tolerance? Who else wouldn't care that in order to attach such a large-sized knob (which makes the volume so easy to adjust in tiny, yet precise increments) a large grub-screw hole would need to be clearly visible on the upperside when the volume is set between 7 o'clock and 9 o'clock and also between 3 o'clock and 5 o'clock? And who else would have made the chassis entirely out of 2mm steel and the front panel from 4mm thick anodised aluminium, then held everything together with stainless steel and blackened high-tensile steel nuts and bolts, all with hex-heads?

Flip the Black Cube Linear upside down and you'll see even more 'Engineer At Work' signs in the form of two pairs of DIP switches (used to adjust the gain individually for each channel between 0dB, 10dB and 20dB) and the fact that the operating instructions (as well as the labelling for the rear panel input and output terminals) is also underneath, neatly printed on aluminium 'stick-on' patches.

I'd judged the Black Cube Linear a work of art even before I pulled out my trusty hex key to remove the ten bolts that would give me access to the secrets of the interior but ten screws and 100 turns later, I was even more impressed. Firstly, the two 6.5mm headphone jacks on the front panel that appeared to be black plastic actually turned out to be Neutrik's top-line gold-plated phone jacks. Id already picked the volume control as one of Alps' finest, just from the perfectly symmetrical rotation and the way it glided around freely as I turned it, yet stopped without any backlash at any point I released it, but it was nice to have my hunch confirmed. Then there's the shielded Sedlbauer Polytronik 30VA toroidal transformer that feeds the two Vishay 4,700µF/40V capacitors and discrete rectifier diodes. Although the left and right channels share the same power supply,

everything from there on is completely dual mono—though of course they're contained on the one PCB. All amplification is via pre Class-A, with no global feedback applied. The DAC is a Burr-Brown PCM2702E.

The rear panel is equipped with a standard 3-pin IEC mains socket with integral fuse, four gold-plated RCA terminals (two of which are unbalanced line inputs, and the other two unbalanced line outputs), a USB connector, and a 3.5mm stereo phone socket (so you can connect an iPod). This 3.5mm stereo socket is just paralleled with the RCA inputs, so you can't use both at the same time. There are also two tell-tale LEDs on the rear panel: one red, the other green. These show the status of the USB connection. If the Black Cube Linear detects a valid data stream coming in via USB, the green LED will light. If the red LED glows, it means the Black Cube Linear can't make a link with the computer. If both LEDs remain off, it means the Black Cube Linear has made a valid USB connection with the computer, but there's no audio coming down the USB pipe. If you have both the USB and the analogue inputs connected, the Lehmann will always auto-switch to the active input. If both inputs are active, the Lehman always gives priority to the USB input.

As you may be able to tell from one or more of the photographs accompanying this review, the Black Cube Linear's case is disproportionately deep. The specifications say 280mm, which would be deep enough, but that's just the chassis. If you include the gold-plated RCA terminals on the back, the depth increases to around 290mm, and if you add in the volume control, it becomes almost 315mm. The chassis is 118mm wide at the front panel (though only 114mm across the chassis itself, back from the front panel) and stands 52mm high on its four rubber feet. The unit weighs 1.5kg.

Why Use A Headphone Amplifier?

When considering why you'd want to use a headphone amplifier, first ask yourself whether you'd consider connecting a pair of speakers rated at 50-ohms to your amplifier, the Owner's Manual for which more than likely suggests you connect speakers with a nominal impedance of between 4-ohms and 8-ohms, or maybe, at a stretch, 16-ohms. Most likely you wouldn't even contemplate connecting a pair of 50-ohm speakers to your amplifier, yet if you connect a pair of headphones to the headphone socket on your amplifier, you could be looking at a 'mismatch' of equal—or even greater—severity. Some headphones require the headphone output circuit to produce almost seven volts to give acceptably loud reproduction. This could mean power consumption of almost 3-watts. Few (if any) of the standard headphone circuits fitted to amplifiers or receivers will deliver either of these extremes. Then there's simply the question of the quality of the audio path. If an amplifier manufacturer is going to try to cut costs, the headphone circuit is always the first one on the chopping block. Manufacturers that really care about audio quality often remove the headphone output entirely rather than provide an inferior one. Others just put in the cheapest 'off-the-shelf' circuit they can and hope that their customers aren't really that interested in listening to their music via headphones.

So far, my discourse has presumed you're not listening to music stored on a computer.

If you are trying to listen to computer music files, the problem is magnified even more, because not only is the computer headphone output not optimised for quality headphones (and the headphone amplifier inside the computer the cheapest possible that will do the job), but also the quality of the audio signal is compromised (that's actually the technical term: I'd prefer to say 'completely destroyed!') by the digital 'hash' generated by the circuitry inside the computer.

If you'd like a full and detailed explanation of all the issues, I'd suggest you should read the truly excellent and very accessible 'White Paper' on the subject published by Norbert Lehmann. You can find it at www.lehmannaudio.com/download/info/pdf_print/EN_techletter_headphone_amplifiers.pdf

> "Manufacturers that really care about audio quality often remove the headphone output entirely"

Use and Listening Sessions

Headphone devotees will know that headphones are ruthlessly revealing of many audio nasties, but the one they are best at revealing is high-frequency hiss, because hiss that's often completely inaudible when listening via speakers can be made cruelly audible when listening via headphones. So the first thing I did with the Black Cube Linear was to check for hiss, simply by plugging my headphones into the front-panel socket and then, with a CD paused, turning the volume up to maximum. I couldn't hear anything. Not a sausage. This is one quiet headphone amplifier! I then repeated the exercise using the USB input. Again, nothing. Zip. Zero. Nada. I couldn't

Lehmannaudio Black Cube Linear USB Headphone Amplifier

Brand: Lehmannaudio
Model: Black Cube Linear USB
Category: Preamplifier/Headphone Amp/DAC
RRP: $1,849 ($1,449 w/o USB)
Warranty: Two Years
Distributor: Syntec International Pty Ltd
Address: 60 Gibbes Street
Chatswood
NSW 2067
T: 1800 648 628
T: (02) 9910 6700
F: (02) 9910 6710
E: info@syntec.com.au
W: www.syntec.com.au

hear hiss or hum. I was very surprised that the USB input didn't even buzz the tiniest bit, because I was expecting at least something, though I was very happy to have my expectations shattered in such a pleasant way.

It wasn't until I started listening to the Black Cube Linear that I discovered the difference between the two headphone sockets. Plug into the left-most socket and the signal from your loudspeakers will instantly cease (assuming that you have wired the Black Cube Linear so that it's in the source line-input, or in a pre/power amplifier loop). Plug into the right-most socket and you can listen to both the headphones and your speakers simultaneously. Why would you want to do this? I often do if I'm reading and listening to music in the background, because my favourite reading position isn't in the 'sweet spot' between the speakers, so by wearing headphones, I get a perfect stereo image, and the bass from the speakers is 'depthier' than I get from my headphones, resulting in a far more immersive experience, particularly when I am playing at very low volume levels… as I usually am when I am reading. You can use both outputs simultaneously, to drive two pairs of headphones, but unless the headphones are identical, the volume level will be different in each pair. Even if the headphones are identical, so the volume levels are the same, it's unlikely any two people would want to listen at the same volume in any case. Still, I'm sure it's handy to be able to accommodate a second listener from time to time…

I started listening to the Black Cube Linear with a pair of open-back headphones also made in Germany: Beyer DT990s. These aren't exactly a huge favourite of mine, but they're so famous that I couldn't resist picking up a damaged pair for $5 at a garage sale, taking advantage of the fact that the seller obviously didn't know what they'd cost retail, and that unlike many headphones, you can get spare parts for this model, so I was easily able to restore them to 'as new' condition. As it happened it proved to be a good choice to start, because they sounded much better through the Black Cube Linear than I'd ever heard them sounding before, and that includes through my own headphone amplifier, the Perreaux Silhouette SXH2 (which I also picked up 'pre-loved', though not at a garage sale). It's difficult to describe 'better' because the Perreaux is no slouch, so I'm not talking chalk and cheese here, but I thought their sound through the Black Cube Linear was clearly smoother and more relaxed, with a slightly more urgent sense to the bass. The only area where I thought the two level-pegged was the treble, where both allowed the Beyers to give their typically pure, silky-sounding best.

Then, equally deliberately, I listened using my Koss r/80 headphones, purchased brand-new without the benefit of a reasonable audition, or even having read an independent review (yes, I know, I know…). The two things the Koss headphones do have going for them is that they're very comfortable and that if I ever jump up and down on them in a fit of rage for having purchased the things in the first place, Koss will happily replace them for free! I'd like to be able to say there was a fairy-tale ending, as in a frog turning into a princess, and that the Black Cube Linear transformed their sound from something quite bass-heavy and dull-sounding into taut, tight, bass and crystal clarity at the top end but alas, it was not to be. It appears that even the Black Cube Linear cannot turn a sow's ear into a silk purse. Which is not to say there was not an improvement. I thought the r/80s sounded more dynamic than usual, and the bass, although still too heavy for my liking, was more clearly delineated, making it easier to follow the bass lines.

I thought I would wrap up my review by evaluating the Black Cube Linear with my usual ear-warmers, which are my much-loved and much-used Sennheiser HD650s, which are simply stunning-sounding headphones. If you can ever get to listen to a pair of these, I'd recommend you do, even though they will spoil you for anything else. It also helps that they're so superbly comfortable that you can easily forget they're there—but also means you need to be careful because at the price, you wouldn't want to forget you're wearing them and walk away, running the risk of damaging them when the cord runs out! Their liquid midrange sound was made even smoother and more fluid by the Black Cube Linear, and the music seemed to have more 'space' around the notes, so that the sound was effortless. I'd always appreciated the HD650's dynamics, but the Black Cube Linear took them to the next level, improving both the 'attack' of transients, but also imbuing the recovery period with equal speed. It meant that even when I was playing quite loudly, there was never any sense of the music being loud: just of the music being powerful and dynamic.

Almost wrapped up, I should have said. I'd been so carried away by the Black Cube Linear's performance in a conventional analogue chain that I'd completely forgotten its USB capability. I am still in the process of transferring my CD collection to hard disk, not so much because I plan to listen to them played back from hard disk (at least not so far as any serious listening is concerned!) but so that in the event of a burglary or a house fire, I will at least have a copy of my music collection (the sum of twenty years of serious collecting and a record of my changing musical tastes) tucked away somewhere safe. Listening to some of my favourites via the Black Cube Linear I can see that at some point in the future, I might have to consider the possibility of serious listening via a computer drive, but on the current evidence, that time is yet to come. I should note at this point that you can buy a Black Cube Linear without USB (not surprisingly known just as the Black Cube Linear), for just $1,449, which is a not-insignificant saving if you think you're really not going to get the use from the USB circuit.

Conclusion

If you are starting out to put together a high-end audiophile system, the Black Cube Linear USB is an absolute bargain, because in one fell swoop (and for just $1,849!) you're scoring a high-end preamp, a high-end headphone amplifier and a high-end USB audio interface. So all you have to do is add a CD player, a power amp and a pair of speakers and you're away, with a system that will be the envy of all!

Chris Croft

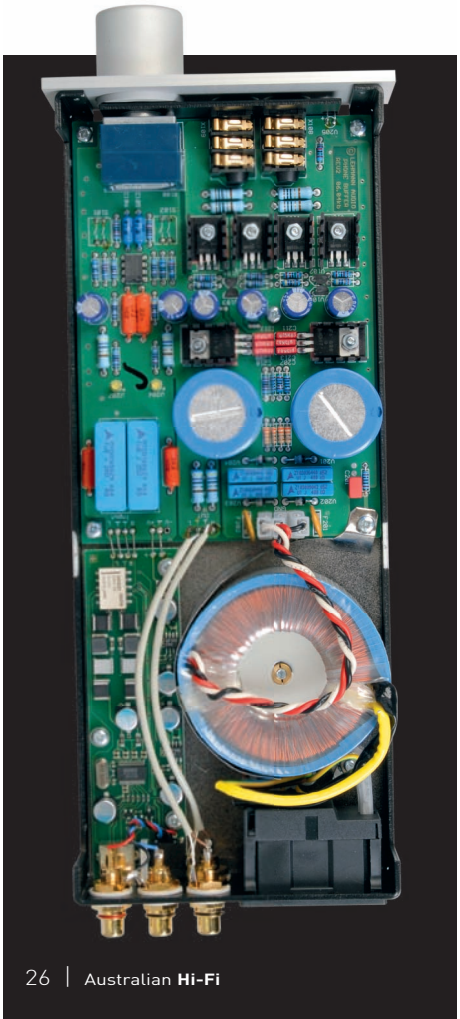
LAB REPORT

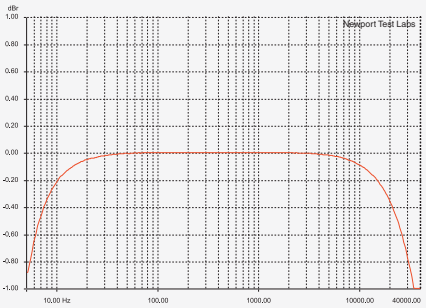
Readers interested in a full technical appraisal of the performance of the Lehmann Audio Black Cube Linear USB should continue on and read the LABORATORY REPORT published on the following pages. All readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific sample tested.

Test Results

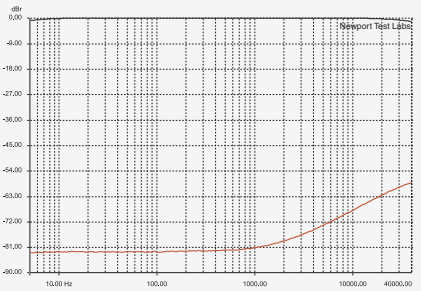
The frequency response of the Black Cube Linear proved to be highly linear, and very extended, reaching up to 70kHz at the high end, and down to 2.8Hz in the bass, –3dB. The 1dB down-points were at 4Hz and 34kHz, giving a normalised frequency response of 4Hz to 34kHz ±0.5dB. You can see from *Graph 1* that the main deviation in level was at the upper end of the audio spectrum, with the response rolling off 0.1dB at 10kHz, to -0.35dB at 20kHz. At the opposite end of the spectrum, the response was down just 0.05dB at 20Hz and 0.2dB at 10Hz. Note that *Newport Test Labs* decided to use a 'worst-case' 20dB gain setting of the Black Cube, as this involves the most circuitry. You could expect even better performance if you can get away with using the 10dB or, even better, 0dB gain settings on the Black Cube.

Newport Test Labs again used the 'worst-case scenario' for channel separation. The frequency response of the left channel is graphed and runs across the 0dB reference point at the very top of the graph, though it's only just visible due to the vertical scaling, which in *Graph 2* is 9dB per vertical division, compared to just 0.2dB per vertical division in *Graph 1*! You can see that channel separation starts at 84dB and remains at around this level until it starts diminishing at 700Hz to be 81dB at

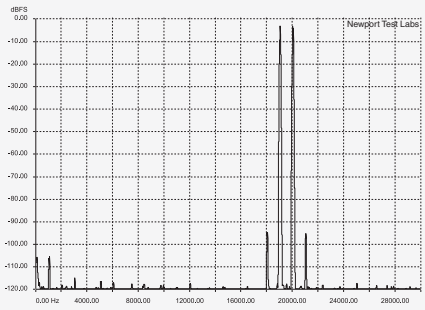




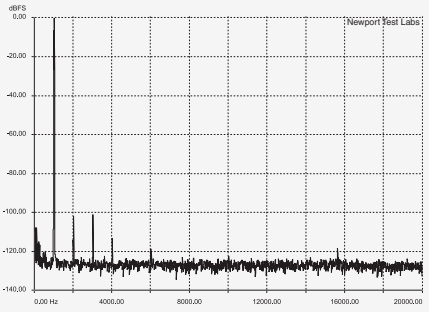
Graph 1: Frequency response of line input at 2V output when driven by 500mV input, using 20dB gain setting. [Lehmann Black Cube Linear USB]



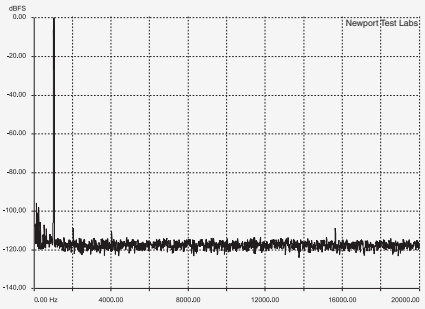
Graph 2: Channel separation 500mV input/2 volts output. [Lehmann Black Cube Linear USB]



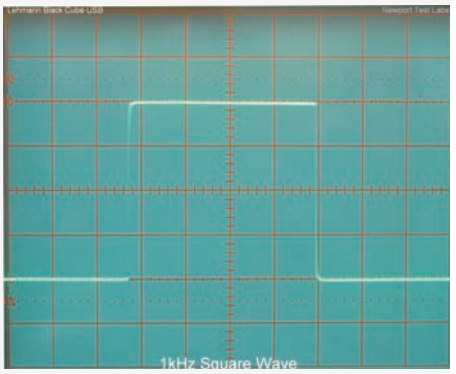
Graph 3: Intermodulation distortion (CCIF-IMD) using test signals at 19kHz and 20kHz, referenced to 500mV Input/2 volts output, 20dB gain. [Lehmann Black Cube Linear USB]



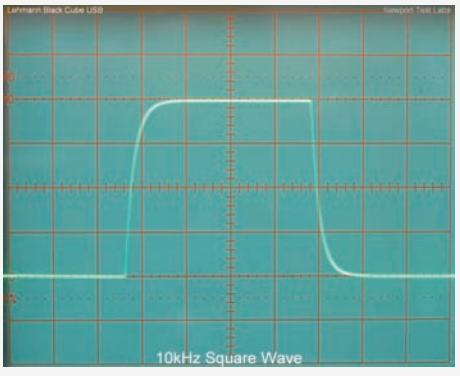
Graph 4: Total harmonic distortion (THD) at 1kHz using 20dB gain setting with 500mV input and 2 volt output. [Lehmann Black Cube Linear USB]

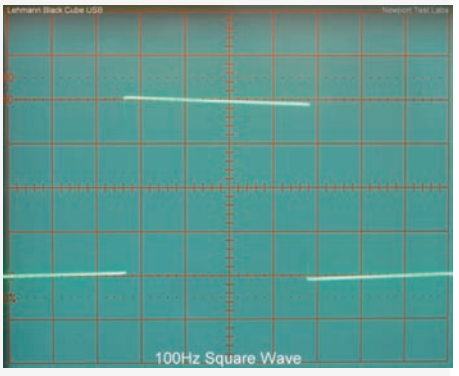


Graph 5: Total harmonic distortion (THD) at 1kHz using 20dB gain setting with 500mV input and 500mV volt output. [Lehmann Black Cube Linear USB]



"You could expect even better performance if you can get away with using the 10dB or, even better, 0dB gain settings on the Black Cube."





1kHz and 62dB at 20kHz. This is clearly superior performance

Graph 3 is highly significant, because it shows that intermodulation distortion (in this case, CCIF-IMD) is vanishingly low. The two signals that should be there are at 19kHz and 20kHz. There are high-frequency sidebands, at 18kHz and 21kHz, but they're both at –95dB, equivalent to 0.001% distortion, but these are not so important as the lack of regenerated difference signal at 1kHz. There is a very small signal, as you can see, but it's at –105dB—far too low to be of any significance at all.

Ordinary harmonic distortion varies a little with gain settings and voltages, but is always very low. *Newport Test Labs* tested many variations to reach a 'worst-case' result, which was in this case the 20dB setting with a 500mV input and a 2 volt output. You can see in *Graph 4* that there are second and third harmonic distortion components at –102dB (0.002%), a fourth harmonic at –113dB and a sixth at –120dB. Such low components would not be audible, but even if they were, the even-order harmonics (second, fourth and sixth) would tend to complement the audio signal, rather than detract from it.

The final graph (*Graph 5*) using the same 20dB gain setting and 500mV input as *Graph 4*, but this time the gain has been reduced to unity, so the output is also 500mV. You can see the distortion components have largely disappeared, with just second-order and fourth-order harmonics at –110dB (0.001%). You should note that on both graphs, the tiny blip in the noise floor just to the left of the 16kHz graph line is the line frequency of a near-by computer monitor, and so should be ignored.

Channel balance of the Lehmann Black Cube was measured at 0.4dB, with overall THD+N at 0.001%. Signal-to-noise ratio, measured using the 20dB gain setting, 500mV input and referenced to 2V output, came in at 93dB unweighted, improving to 100dB with IHF A-weighting. The gain settings were very slightly different to specification with the lab measuring 0.28dB low for the '0dB' setting, 0.61dB high at the '10dB' setting and 0.28dB low at the '20dB' setting. These differences are so slight that measurement error could be a factor, and are immaterial in any case, since these are used only for 'rough' set-up, just setting the stage for the volume control to do its stuff.

Although there is no stand-by mode, the fact that the Lehmann Black Cube Linear draws a miserly 9.36-watts should encourage you to leave it on continuously, because it won't impact on your power bill and will certainly improve performance in the long run.

Steve Holding

Lehmann Audio Black Cube Linear USB - Test Results		
Test	Measured Result	Units/Comment
Frequency Response @ 1 watt	4.0Hz–34kHz	–1dB
Frequency Response @ 1 watt	2.8Hz–70kHz	–3dB
Channel Separation	84dB/82dB/64dB	(20Hz/1kHz/20kHz)
Channel Balance	0.04dB	@ 1kHz
THD+N	0.001%	20dB Gain Setting
S/N Ratio (unweighted) (20dB Gain Setting)	93dB	dB re 0.5Vin/2V out
S/N Ratio (weighted) (20dB Gain Setting)	100dB	dB re 0.5Vin/2V out
Input Sensitivity (20dB gain)	00.0mV/000mV	For 2V out
Maximum Gain at 0dB/10dB/20dB Settings	-0.28/10.61/19.72	dB
Power Consumption	9.36	watts
Mains Voltage Variation	238–250 volts	Min–Max