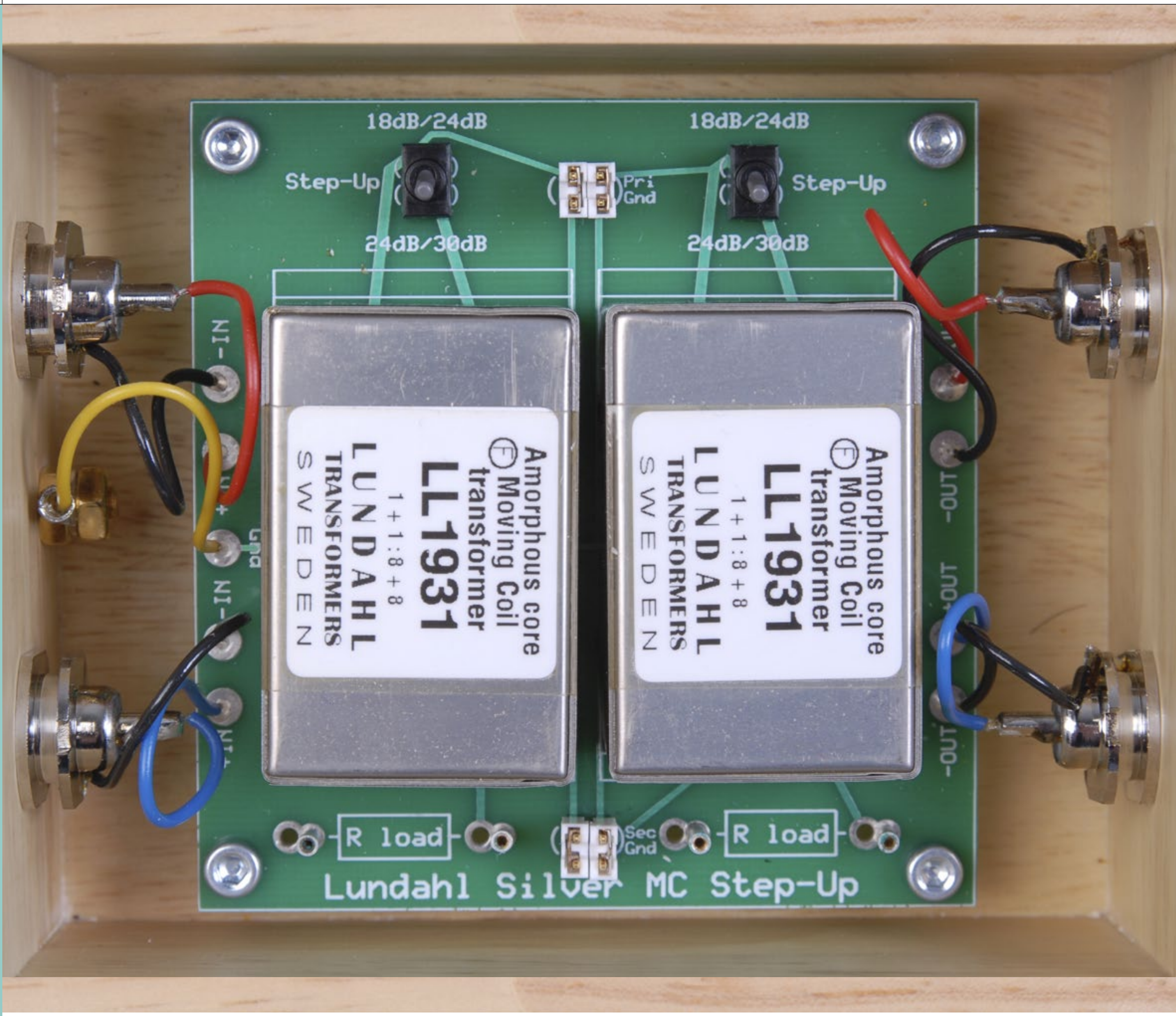


LUNDAHL
LL1931 MOVING-COIL

STEP-UP TRANSFORMER

Lundahl isn't exactly a household name amongst audiophiles, yet you'll find the company's transformers in many of the world's best-performing high-end audiophile products. Yet despite having been in the transformer and coil winding business since 1958, when the company was established in Sweden by Lars Lundahl, the company only started building consumer products in 2009. Until then, it had built products specifically for other manufacturers, which used its coils and transformers in industrial, electronics, aerospace and professional audio applications.

THE EQUIPMENT

We initially thought that the sample we were provided for review was a prototype, since all the circuitry was housed in a small (120×80×100mm – HWD) wooden box with a hinged lid that's kept in place when it's closed by two magnetic catches. But no, it turned out that we'd been loaned a full-fledged production sample—this is exactly what you'll receive when you buy one. Although it's very practical (as you'll discover later), it's rather left-field, so it's likely to be something you love or hate. Many people would prefer a classic case, such as those used by Rothwell for its MCL step-up transformer (which, incidentally, uses Lundahl transformers!), which has a conventional chassis and faceplate, and the input, output and ground connections on the rear panel.

Obviously, it's a step-up transformer, which steps-up the voltage from a moving-coil cartridge so it can drive a standard moving-magnet phono stage, but it's a step-up transformer with a difference, because buyers can customise every aspect of it.

For example, our review sample was supplied with a pair of Lundahl LL1931 transformers (one for each channel). These use Lundahl's uncut amorphous cobalt core and dual-coil structure and the coils are wound with high-purity copper wire made by Cardas. According to Lundahl, the dual-coil structure improves a transformer's immunity to external magnetic fields, but to be on the safe side, the transformers are also encapsulated in a mu-metal shield/case.

However you can specify these transformers to be wound with pure silver wire instead, in which case the transformers in it will be LL1931Ag types. You can also specify the transformer core material, so if you'd prefer your step-up transformer with a mu-metal laminated core, rather than a strip-wound amorphous cobalt core, you can. You can also specify whether you'd like the mu-metal core wound with copper or silver wire. In this case, the transformer designations become LL1933 and LL1933Ag respectively.

All four step-up transformers are intended for medium-to-high output moving coil cartridges and so have selectable coil winding ratios of 1:8 and 1:16. If you need even-higher turns ratios, Lundahl can oblige, with transformers wound with 1:32 and 1:64 ratios. Once again, you can specify core and wire types, with the transformers being types LL1941, LL1941Ag and LL1943 and LL1943Ag.

Once you have established which configuration best suits your needs, you still have configurable options, because you can choose between two gain settings (18dB or 24dB in the case of our review unit, but 24dB/30dB with different transformers) via micro-switches and, via links on the circuit board, different grounding arrangements as well. You can also ensure the Lundahl is providing the exact load for the phono stage you're using, with the particular cartridge you're using, because there are tubular posts on the PCB into which you can insert resistors (one for each channel). You can use these posts as 'temporary' connections while you ascertain the correct value of resistance, then, once you've determined that, you can solder the resistors permanently to the PCB using the thru-holes alongside the posts. (Or, if you'd prefer not to do any soldering, you could just leave the resistors press-fitted into the posts.)

Our review transformer had a gold-plated ground terminal, but did not have gold-plated RCA terminals for its inputs and outputs. We would have preferred these, but presumably they're available as an option, or you could easily change them yourself.

WHY USE A TRANSFORMER?

You're probably asking yourself why you'd use a transformer to step up the output from a moving coil cartridge when most people use active, powered devices. It would be a good question, and it can be answered with just a single word: noise. Any powered device needs power (dah!) and that power usually comes from the 240V mains—a voltage source that is a perfect conduit for picking up electrical noise from other sources and channelling it directly to the power supply of the device that's stepping up the voltage from the moving-coil cartridge.

> **You're probably asking yourself why you'd use a transformer to step up the output from a moving coil cartridge...**

The available power solutions—battery power, super-quiet filtered power supplies, and so on—are usually expensive, sometimes extraordinarily so. And if you go with one of the less expensive battery-powered solutions, the lack of power (you're usually looking at around nine volts) and the requirement for minimal current drain (to ensure adequate battery life) usually ends up compromising the quality of the audio circuitry, so you get limited bandwidth, low overload margins, reduced channel separation, higher distortion (both THD and IMD) and increased noise.

A transformer, on the other hand, has none of these problems, mostly because it does not require any power at all. The voltage in one coil of wire (the primary winding) causes magnetic flux that induces a voltage in another coil of wire (the secondary winding). There is no electrical connection between the two coils, and no other components: just two coils of wire. If the coils each have an equal number of turns, the voltage induced in the secondary coil will be equal to that of the voltage in the primary coil. If the secondary has twice as many turns as the primary it will double the voltage, so for example if there's one volt introduced to the input of the primary winding, there'd be two volts produced at the output of the secondary winding. If the secondary coil has half the number of turns, the voltage would be halved—so in our example, you'd end up with just 0.5 volts at the output of the secondary coil. When the voltage is increased, the transformer is called a 'step-up' transformer (which is the case with the transformer in this review). Conversely, when the voltage is reduced, the transformer is called a 'step-down' transformer.

Although step-up transformers are completely noiseless and have an extremely flat frequency response, they do have the problem that the impedance of the primary coil is much lower than the impedance of the secondary coil, because in order to have double the number of turns on the secondary side, you obviously need twice the length of wire that was used on the primary side. But this impedance change is not just double, as you'd expect. Increasing the voltage in the secondary by a factor of 10 (an increase of 20dB) sees impedance increase by a factor of 100. In other words, the increase in impedance is equal to the square of the increase in voltage. You also get a reduction in current in the secondary coil, compared to the primary.

But there's yet another advantage of using a transformer rather than an active step-up device, which involves the type of distortion produced by both (and all step-up devices will introduce distortion to the audio signal. Whereas an active device has a fairly constant resistive input impedance, the input impedance of a step-up transformer is frequency dependent. This has the effect that any harmonic distortion produced by a step-up transformer is highest at the lowest frequencies and drops as the frequency rises, whereas in most active step-up devices distortion increases as the frequency rises. (There are, of course, exceptions… but they're usually very expensive exceptions!)

TRANSFORMERS AIN'T TRANSFORMERS

Just as Sol here in Australia used to say 'oils ain't oils' when promoting a particular brand of engine oil, Per Lundahl in Sweden, if presenting a similar advertisement, would probably say 'transformers ain't transformers'. There are many cheap step-up transformers available (most of them made in China) and they're cheap not only because the materials used are not of a high standard, but because of the way they are wound. To see the difference you could use a piece of string and a piece of dowel. Rapidly wind the string around the dowel within two pencil marks 2cm apart. Have a look at the result. That's how cheap transformers are wound. Now unwind the string, and wind again, slowly, making sure that each wind is tight up against the other, before winding a second layer.

This is how more expensive transformers are wound. Now unwind the top layer, and wrap an insulation layer around the first layer before winding the second layer. This is how Lundahl transformers are made. In practise, it's even more complicated, because you're winding two coils—primary and secondary—at the same time, and with Lundahl, its complicated even further because it uses a 'dual coil' structure, where each transformer is built up from two coils, each coil with both primary and secondary windings, which improves magnetic immunity (because any voltage induced by an external magnetic field is cancelled) and also reduces the transformer's own stray magnetic stray field. Finally, the transformer's common-mode rejection ratio (CMRR) is improved, particularly if windings are used in parallel across the two coils.

IN USE AND PERFORMANCE

We obviously had only the one transformer, but we were interested as to whether there would be any audible differences between transformers that were identical other than the one having an amorphous core and the other a mu-metal core. According to a report published by Kevin Carter, of K&K Audio, who is a long-time Lundahl enthusiast, who'd compared the Lundahl LL1931 amorphous core transformer used in our sample phono step-up transformer with an LL1933 mu-metal transformer, there *is* a difference.

His conclusion was that the LL1933 provided a very open and detailed picture of the space that was recorded, providing a very high level of detail recovery. 'A particularly memorable example of this "see-through" quality was evident on a solo violin recording where the performer's breathing was readily audible during playback of the performance with the amorphous core transformers, but was only evident with the mu-metal core transformers if the listener really focused on hearing the breathing. The breathing sounds were there with both transformers, but there is less of an emphasis on detail and more upper bass/lower midrange warmth with the mu-metal transformer,' he said. 'The brush strokes are broader with the mu-metal core transformer and they convey more "body", whereas the amorphous core transformer offers finer brush strokes, which results in hearing more of the details while listening to the whole.' So it would seem to us that Carter preferred the sound of the amorphous core transformer… which is nice because it's the lower-cost option.

We started our listening sessions with our favourite moving-coil cartridge, the Denon DL-103

Before you can even start using the Lundahl MC transformer, you have to determine the value of the load resistors you need to put into the PCB. If you use the 24dB gain setting this means the transformer is multiplying the voltage 16x, which means the impedance ratio would be 256 (16 squared). Assuming the impedance of the MM input into which you're plugging the Lundahl is 47,000Ω (which it most likely is) we have to divide this impedance by the impedance ratio to get the actual load presented to the cartridge. In this case, it would be (47000/256) or 183Ω. Let's imagine that this was a little too high for our cartridge, which worked best with a 150Ω load. We then have to add a resistor to the PCB to get a matching load. In this case, the resistor would have to have a value of 285kΩ. Because the value of the resistor will vary with the gain setting and the load preferred by the particular cartridge you're using, there are lots of variables. We've included two tables here for the most common cartridge loads and gain settings. If you need a combination not listed, send CDA Professional Audio your load requirement (and the input impedance of your preamp) and they can tell you the correct resistor(s) to insert at the load points. Remember it's more important to get the load matching correct than the gain (at least within reason!) so work out which gain setting best suits your cartridge, and only then work on optimising the load.

We started our listening sessions with our favourite moving-coil cartridge, the Denon DL-103. It's our favourite for many reasons. First, and most importantly, it's a great-sounding cartridge. Second, it has a square body, so it's a snap to align. Third, it tracks better than most MC cartridges triple or quadruple the price. Fourth, it's tough, almost impossible to break, having been designed from the start to be able to be back-cued. Fifth, it's a 'classic', having been in continuous production since 1963. And sixth, it's the best value-for-money moving-coil on the market.

You can buy one for less than $400 here

in Australia. Yes, it has a spherical diamond, but diamonds aren't forever (at least not where phono styli are concerned), so when it comes time to re-tip, you can re-tip with any shape you like. Stereophile's Stephen Mejias is also a fan. Back in 2010 he said of the DL-103 that it's 'a music-lover's friend, an audiophile classic, a man's cartridge. All the cool guys have one. At least one. Really cool dudes have like three or four. Sometimes, you even meet a girl who uses a Denon DL-103, but she is invariably extremely hot. Her name is Charlie or Ingrid or Scarlett, or some crazy shit like that. She owns more records than you do. She'll eventually want to move your furniture. If you're smart, you'll let her. And when you're done moving furniture, you'll sit down with a glass of gin and a smoke, and you'll drop the needle on Dexter Gordon's *Our Man in Paris*. You'll take the stairway to the stars and spend a night in Tunisia.'

Played through the Lundahl, we have to say that we've never heard the DL-103 sound better… and that's saying something. It's always been a 'warm-sounding' cartridge, one that tends to give our albums an added touch of tonal richness—which is one of the other reasons we love it—and through the Lundahl, that character was still present, but seemed to be a little more on the 'neutral' side. And whereas in the past the lush sound could sometimes obscure the finer musical details, when played through the Lundahl we heard both the lush sound—slightly tempered—AND the fine musical detail.

The DL-103's sound has never come up short in the deep bass department, but when played through the Lundahl, the sound was definitely 'bassier' and bass lines seemed to come through more solidly than when we used either Denon's own transformer (the AU-300LC) or a solid-state device. These improvements were also noticeable at the other end of the audio spectrum, with the extreme highs sounding super-smooth, with excellent extension, but no 'glariness'.

As our time with the Lundahl came to a close, we switched cartridges on it, pulling our revered Ortofon Cadenza Blue first from our home safe and then from its cotton-swathed protective packaging. Yes, the Cadenza Blue sounds better than the DL-103, but the Blue set us back more than two grand, so it only ever gets used on virgin vinyl (with the first play also used to create a FLAC copy), and then only when we want to indulge in some serious listening, and always only with close-to-virgin vinyl. Once the vinyl is worn, it's always back to the good 'ol DL-103.

If you're lucky enough to have heard a Cadenza Blue, you'll already know why we bought one, but we have to say that if you haven't heard it with the Lundahl, you really haven't heard it. The already-superb dynamics? More superb. The soundstaging? Wider, deeper and taller. The detailing? Makes CDs sound lame. We didn't listen long, but certainly long enough to drive home the point that the Lundahl let the Cadenza Blue sound its best… and its best is certainly magnificent. So magnificent that if it wasn't so delicate, such a bastard to align, and so expensive to re-tip, we'd probably listen to it more often.

CONCLUSION

Lundahl's company slogan is one of the best we've ever heard. It is: '*If you can hear it, it's not ours*.' We agree. If you invest in a Lundahl moving-coil step-up transformer you will be hearing not the sound of the step-up device, but the sound of your cartridge, with nothing added and… just as importantly, nothing taken away.

Readers interested in a full technical appraisal of the performance of the Lundahl Moving-Coil Step-Up Transformer 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.

CONTACT DETAILS

Brand: Lundahl
Model: LL1931 Amorphous Core
RRP: $1,067
Warranty: Three Years
Distributor: CDA Professional Audio
Address: Unit 17. 69 O'Riordan Street
Alexandria NSW 2015
T2: (02) 9330 1750
E: info@cda-proaudio.com
W: www.cda-proaudio.com

- Flat response
- Gain settings
- Low noise

- Enclosure
- Connectors

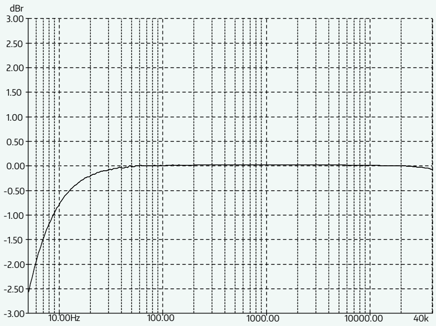
LABORATORY TEST REPORT

Newport Test Labs measured the frequency response of the Lundahl Moving-Coil Step-Up transformer using the 24dB gain setting and found it extended from 9Hz to 110kHz –1dB, exceeding Lundahl's own specification. Part of this extended response is shown in Graph 1, where you can see the response is just 2.5dB down at 5Hz and 0.2dB down at 20kHz. From 50Hz up to 20kHz it's absolutely ruler-flat along the 0dB reference grid before it starts to roll-off slowly at 35kHz to be 0.1dB down at 40kHz, which is the extent of the graphing limit. Separation between the two channels was measured as being 84dB, which was maintained across the audio spectrum.

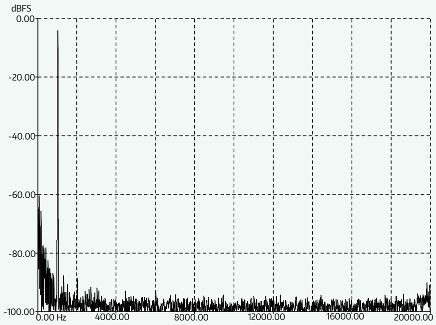
THD+N is shown in Graph 2, for a 1kHz test signal. You can see there's a second harmonic distortion component at –90dB (0.0031% THD) and that's about it.

REQUIRED CARTRIDGE LOAD	RESISTOR VALUE (18dB GAIN)
600Ω	221kΩ
400Ω	60k4Ω
300Ω	34kΩ
200Ω	18k2Ω
100Ω	8k06Ω
80Ω	6k34Ω
40Ω	3k24Ω
20Ω	1k78Ω

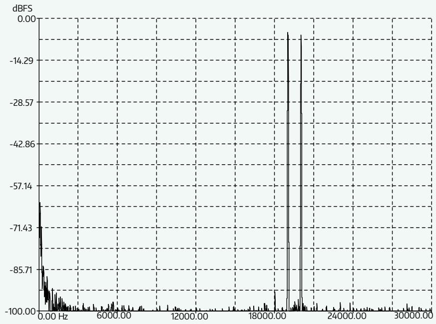
REQUIRED CARTRIDGE LOAD	RESISTOR VALUE (24dB GAIN)
160Ω	348kΩ
140Ω	165kΩ
120Ω	90k9Ω
100Ω	60k4Ω
80Ω	37k4Ω
60Ω	24k3Ω
40Ω	13k7Ω
20Ω	6k34Ω



Graph 1. Frequency response.



Graph 2. THD+N.



Graph 3. IMD (CCIF)

It appears there is a 6th-order component, but it's down at –95dB (0.0017% THD), which means it's essentially buried in the noise floor at –100dB. There is some low-frequency noise, as you can see from the left end of the graph, which is mostly induced hum, since the transformer was being tested in a laboratory environment, which is electrically very noisy, but even in this noisy environment, overall signal-to-noise was measured as 72dB A-weighted, almost all of which was low-frequency. Above 200Hz, noise was more than 80dB down and above 1kHz, essentially 100dB down.

Overall, superb measured performance from this Lundahl moving-coil step-up transformer

Intermodulation distortion (CCIF IMD) was almost non-existent, as you can see from Graph 3, as measured by *Newport Test Labs*. The two test signals at 19kHz and 20kHz dominate the graph, of course, but there's only a single high-frequency sideband, at 18kHz, that's 91dB down (0.0028%).

There is a regenerated signal at 1kHz, but it's around 90dB down (0.0031%). *Newport Test Labs* measured the gain of the LL1931 transformers as 17.76dB in the 18dB gain setting, and at 23.36dB in the 24dB gain setting, with both channels being identical, which is significant sign of transformer quality. Winding transformers to this level of gain accuracy is a stunning achievement. The difference in level between Lundahl's stated gain and *Newport Test Labs'* measurements, on the other hand, are not at all significant because they would be due to the lab using a different input and output loads to those used by Lundahl when testing.

Overall, superb measured performance from this Lundahl step-up transformer.

Steve Holding