darTZeel NHB-108 model one

Audiophile's technical manual

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Audiophile's technical manual

1. Introduction

Thank you for studying this manual, demonstrating proof of your interest in the darTZeel NHB-108 model one.

First of all, please do not think for a minute that we consider audiophiles differently from music lovers. We know perfectly well that audiophiles love music too, and we are very happy with this.
It is however true that music lovers are generally less inclined to enjoy the technical and performance side of the music, hence the existence of the *Music lover's manual*.

In the light of what follows, you will better understand why our technical choices during the design of the darTZeel NHB-108 model one led to what one could call a truly exceptional machine.

We trust that you will derive great pleasure from reading this manual, and that we succeed in communicating some of the burning passion that has been boiling inside us for more than 25 years.

Enjoy your reading!

2. Genesis of NHB-108

The NHB ("**N**ever **H**eard **B**efore") project began in summer 1984.
Crazy about audio since childhood, we gradually developed the idea of designing a power amplifier.

Even though the NHB-108 model one is the fruit of a single man, the moral, financial and professional support from family and friends over all these years has played a huge part in this endeavor.

At the time it was only a dream, and we are grateful to every gal and pal who has been involved in it and contributed to its achievement.

In the '70s and '80s, here in Europe, Japanese electronics were queens and kings of the market. Very rare, and above all virtually unknown, was the real high-end audio gear coming from USA or elsewhere. The finish was already very good, but the sound quality did not come up to scratch, simply because it was not one of the original design goals! Only a few companies were able to offer real breakthrough products. Not all of them are still in business, Alas!

The more the years passed, the more our desire for designing a new machine became tangible. In mid spring 1984, we produced a first digital power amplifier in a school lab, as a diploma project.
Paradoxically, the innovation here was not the fact that the amp was digital, but that no feedback whatsoever was used. The output stage was totally open-loop.

The sonic result was so astounding that we immediately started the NHB project, although its code name did not come until later.

The initial idea was to design a new very powerful digital amplifier, totally open loop if possible, with the purest sound reproduction we could attain, without any other consideration, especially the price factor.

The main problem at the time was that the technology did not yet offer the monochip solution, so we had to build the circuit entirely in hybrid technology, using mainly discrete devices. The odd thing is that even in this early 21st century, we have still not surpassed the speed of those old circuits.

Another problem then arose. Our circuits were much more complex than a single modern IC, and of course they were not very reliable either. We especially encountered several performance consistency problems from sample to sample, and we gave up for a time. Some years

later, new ICs allowed further investigation, and we built several prototypes. We quickly noted, however, that digital had some limits when pushed hard.

We used a sample frequency of 500 kHz at the time, corresponding to a theoretical bandwidth close to 250 kHz, far higher than all competitors, even in the analog domain. But – alas – even with such a high sample frequency, the actual measured bandwidth was strongly dependant on the loudspeaker impedance.

Another problem, jitter, already well known in labs at the time, was difficult to cure, to say the least. The signal to noise ratio was just above our minimum criterion.

Since pure sound was the only goal, then noise, if at acceptable level, could have been tolerated by us. On the other hand, interdependence between load impedance and frequency response was not our cup of tea. Not by a long chalk.

End of the digital trip.

It is interesting to note that several manufacturers offer digital amplifiers, with greater or lesser success. The theoretical limits remain the same, even if better managed than in the '80s. Analog fortunately does not have to cope with such limitations.

After several months of deep thinking, circuit designing, and circle squaring attempts, the project was revived (in 1990) on brand new bases. The gear would be fully analog, moderately powerful, and as close as possible, philosophically speaking, to the signal treatment used in its digital ancestor.

Two new prototypes were built on the basis of existing designs; even though heavily modified to suit our tastes, they produced unexciting results. Then we asked ourselves what is the point of producing nice looking gear if the sonics bring nothing new under the sun?

In 1992, we decided to develop a revolutionary design from scratch. This ultimate quest (for ultimate sound) lasted over 5 years, with more disappointment than joy. But the fun was always here.

Countless schematics were studied, scrutinized and hooked together until we obtained, in mid 1995, what we could tained, in mid 1995, what we could call the first theoretical design corresponding to our aims.

From 1995 to 1999, on that first elementary circuit basis, dozens of different versions were simulated, some of them being built and listened to.
By 11 November 1999 the definitive circuit was built and assembled. This was the very first darTZeel machine, the NHB-108 model zero.
The results, sonically speaking, were outstandingly better than expected. It seems that this design was the right one. So much so that most of our test listeners said that this product *must* be put into production, even on a very small scale.

The darTZeel NHB-108 model one was born.

3. Criteria

Your darTZeel NHB-108 model one is not an ordinary machine and this is no doubt one of the reasons why you purchased it.

The entire concept is based on just three criteria:

- Simplicity
- Purity
- Reliability

These words can often be deceptive. Easy to pronounce, conjuring up elegance and fascination, they nevertheless constitute very tough technical challenges, since their respective meanings are not at all easy to reconcile.

Nothing is eternal. As for the darTZeel NHB-108 model one, not enough time has yet elapsed for us to assert such a claim.

What we do assert is that *everything* has been taken into account so that you can benefit from your machine for a long time. *A very long time*.

You will discover that more often than not, simplicity means long lasting. Sometimes, it also means purity, whether of sound or of form.

Welcome to darTZeel.

4. Structural aspects

It would be all too easy to compare the darTZeel NHB-108 model one and wristwatches, both being made in Switzerland. There are no springs, cogwheels, or hands in a NHB-108 model one. Here, everything is a tad… bigger.

4.1. The case modules

The case of your machine is exclusively machined from AW-5754-ALMG3 alloy aluminum, offering a remarkably even surface and hardness.

Every item is CNC machined from the billet in order to ensure a very high density and outstanding rigidity, thus considerably lowering all unwanted resonances.

The elements are finished in the three hard anodized darTZeel colors, namely electric blue, blazing red, and gleaming yellow. This unique finish gives to the darTZeel NHB-108 model one its inimitable appearance.

The three main elementary modules are the mother plate, the transformer platforms and the heat sinks. They are tightly assembled together with non-magnetic, stainless steel screws.

Each basic module is first carefully hand assembled, and individually tested. Only then is it dated and signed before being fitted.
If you dismantle your darTZeel NHB-108 model one, you will see that modules are not assembled in a hurry. Some of them are installed with several weeks elapsing between construction and assembling.

In line with this non-stress approach, we take all the time necessary to achieve the best job we can. If our tests show that a component is out of specification – this can sometimes occur *after* its assembling – the entire module is dismantled, checked, and reassembled before being tested a second time.

The darTZeel NHB-108 model one housing features a 25mm false bottom, sandwiched between the 6mm thick mother plate module and the 4mm thick bottom plate. All cables and wires are routed in this sandwich, minimizing the influence of electromagnetic fields.
Furthermore, such an arrangement is of extreme rigidity ensuring exceptionally good mechanical coupling between the mother plate and heat sinks modules.

4.2. Divide to conquer

The inside of the darTZeel NHB-108 model one is divided into four distinct volumes. The left and right channels are insulated from each other, as are their respective power supplies. This unprecedented construction allows extremely low crosstalk behavior across the whole audio frequency range. You are either true dual mono, or you are not. The darTZeel NHB-108 model one definitely is.

The two front compartments are devoted to the power supplies, and are themselves divided into a two-storey structure. The Crowbar elements and the soft start circuitry are located on the lower level, while the suspended toroidal transformers are fixed on the 6mm thick, upper decks.

We insist on the fact that in the final assembly process, all parts are first carefully aligned before being tightly screwed together. This additional precaution adds still more rigidity, and the entire case then behaves as a single block. As a free bonus, the case is thus virtually dust proof.

4.3. Eliminating vibrations

The fastening of the power supply transformers was carefully thought out as regards noise reduction and trouble-free life. A specially developed suspension ensures that even in case of failure, the transformers will not fall off.

So, in 40 or 50 years, when the rubber absorbers have become – perhaps – worn out, they will withstand their last trip to the factory for their replacement.
The same is true for the silentblocs used for suspending the lighter audio and monitoring circuits.

These various suspensions, tuned on different resonance frequencies, are coupled quite tightly to the chassis, absorbing especially the medium and high

frequencies, most important in terms of sound reproduction accuracy.

And while on this subject, have you ever heard an amplifier *singing*? This can occur when the transistors of the final stages and/or the power transformers are not properly decoupled.
They start to vibrate at the excitation signal frequency – in this case the music – this vibration interfering with the *electrical* origin of the signal. You can hear it if the amp is hooked to a dummy load, since in normal use, loudspeakers fortunately mask this disconcerting internal "singing".
No such mechanical singing on the darTZeel NHB-108 model one! The electric signal is transmitted stage to stage, from input to output, free from any mechanical disturbance, internal or external.

The darTZeel NHB-108 model one stands on 3 pads incorporating rubber inserts. Oddly enough, *very few* manufacturers rely on 3 legs instead of four. We can recall that the Lunar Explorer Module (LEM) also had three legs, but that is another story after all.
Weighing around 30kg, the darTZeel (not the LEM) needs to have a good stable base. Those three pads are evenly located around the horizontal center of gravity of the amplifier, ensuring excellent stability on virtually any surface.

The absorbing rubber pads dampen the lower frequencies, thus forming the ideal complement to the suspensions described earlier. In the case where you would want to use 2, 3, or even 4 stacked darTZeel NHB-108 model one units, we have designed special pads of different diameter to maintain the very same vibrational absorption behavior. These pads are easy to install and can be purchased separately.

4.4. Everything is transparent

The darTZeel NHB-108 model one cover is made of 8mm thick tempered, bronze-smoked glass. It harmonizes magnificently with the colors of the housing, and gives an inimitable touch.

The glass is held by a single, central screw, and rests on a foam rubber seal, giving to the darTZeel NHB-108 model one its dust proof quality. Your machine will therefore remain as new for years to come.
The reason why we did not choose a metal cover is not so obvious as it might appear. It is true that to look through the glass of the darTZeel NHB-108 model one is a pleasure for the eyes. Look at those Moon-crescent shaped bar busses, and tell us frankly what you feel…

There are also a couple of technical advantages that glass has over metal.
Its crystalline, inert structure, combined with the rubber foam seal, functions as an internal noise killer.
And contrary to metal, glass is totally transparent to magnetic fields, thus avoiding the inherent magnetic loop that metal would induce over the power supply transformers. Last but not least, the internal housing is much less polluted by magnetic ghosts.

4.5. TIO, Totally Identified Object

It is however the final touch that makes this darTZeel NHB-108 model one, now installed in your listening room, *your* darTZeel NHB-108 model one:

We refer to the identification plate, fully described in the *Owner's manual*.

Made from 24k gold plated brass, it is a unique handmade piece, just like the machine on to which it is affixed.

Your name is engraved in gold letters, thus amalgamating the destiny of the darTZeel NHB-108 model one with your future unforgettable musical moments.

We proudly congratulate you!

5. The audio electronics

Simplicity.

The whole darTZeel NHB-108 model one electronic concept could come down to this single word.
Simplicity does not mean simple, however.

Purity

Total cancellation or absence of harmonic distortion does not mean "purity", alas.
You certainly know that most musical instruments are very rich, harmonically speaking. Thanks to these harmonics, we can distinguish between a saxophone and a flute.
Did you know, though, that the level of these natural harmonics can easily reach 20 to 40% of the fundamental note, depending on the instrument played? But do we say that an *instrument* distorts?

5.1. What is distortion?

In the audio world, any signal change is called "distortion". A lot of different kinds of distortion exist, but we mostly speak about "**T**otal **H**armonic **D**istortion", or THD. THD is so well known that we more than often forget that other ones do exist.

Negative Feed-Back, NBF, is a smart electronic trick used for diminishing or even eliminating all type of distortions, and can be roughly described as follows:

At the amplifier input we put a signal having an inverse deformation from the one it naturally produces at its output. So, the new output signal will be "purified" since the 2 inverse deformations will cancel each other.

This is what the theory says.

Now let us see what actually happens in practice. We will discuss only the best-known distortions, given that their behavior is simpler to explain.

5.1.1. Keeping in harmony

Let us take an amplifier especially designed to produce exactly 1% of THD. Then let us feed it with a recorded musical instrument. We shall suppose that this instrument is moderately rich harmonically, say around 20%.

Now, let's be a bit optimistic and suppose that the speakers we will use are truly perfect, without a single trace of any distortion.

Well, now, let us try figure the THD we will have at the output of the amplifier. We could be tempted to say "21%, since 20 plus 1 makes 21, no?"
Okay… So then, which "golden ears" could notice the THD difference between 20 and 21%? Who could swear that the amplifier does add distortion?

In fact the distortion change is even less than this. THD, like most other non-correlated physical phenomena, does not increase in a linear fashion. The "total" THD is equal to the square root of the sum of the squared individual THDs.

A little equation is even better than a less-than-clear definition:

$$THD = \sqrt{(HD_1)^2 + (HD_2)^2 + ... + (HD_n)^2}$$

In our particular case, we only have 2 terms, so the equation becomes:

$$THD = 100\sqrt{\left(\frac{20}{100}\right)^2 + \left(\frac{1}{100}\right)^2} = 20.025\%$$

And now? *Who* could distinguish between a 20.000% harmonically rich musical instrument, and another one producing 20.025%? Not us for sure.
And the very next note, how rich is it? And the next one? Oh! The song has already finished? What sort of music was it?...

Even though in reality THD is a bit more complicated than this, we can still see that *a posteriori*, it does not have the importance that was attached to it for decades – quite the contrary.

If at darTZeel we could completely eliminate THD while maintaining our 3 main criteria, then maybe we would do so. Maybe. Just for the beauty of the gesture.

Some amplifiers available on the market claim extremely low THD figures, at the very limit of instrumentation measurement, assuming this result necessarily leads to outstanding sound purity. We take this with some caution, since it recalls for us the 70-80' Japanese philosophy, by which "performance" implies "quality". We have to be fair by acknowledging that such designs can be liked and even loved by audiophiles. The world is big enough for multi musical tastes.
The idea is very nice indeed, and we do admire such a philosophical approach, even if it is not ours: the problem is that those designs are highly sophisticated – too much for our ears – involving lots of added transistors, op amps, and higher than reasonable NFB, leading finally to altered sound structure.
These electronics can be considered as very pure and detailed for the first listening hours or days, but once noticed, their sonic signature becomes harder and harder to bear.

So if THD does not seem to be a determinant factor in the accuracy of the reproduced sound, we have to look elsewhere.

5.1.2. Inter Modulation Distortion

Now, let us listen to two flute players. The flute is well known for its less rich than usual sound - harmonically speaking, of course! A kind of exception confirming the rule.
If each player produces a different, sustained note, what will we hear? One intermediary note, two distinct notes, or more than this?

In theory we should hear 2 distinctive notes. In theory only? Well yes, because in practice our hearing is not perfect. Truly wonderful indeed, but less than perfect.
Without entering into details, we can nevertheless say that in fact we will not only hear 2 distinctive sounds, but also combinations of those primary notes.

We beg musicians and music lovers to forgive us, but for a while we need to replace notes by frequencies. Not very musical, but much easier for the purposes of our explanation.

If the first flute plays a 1,000 Hz tone, and the second one a 2,500 Hz tone, we will not only hear those two discrete tones, but also the following combinations:

2,500-1,000=1,500 Hz, also called the beating frequency, and also the mirroring part, say 2,500+1,000=3,500 Hz. Fortunately, those combinations are of much less amplitude than the discrete notes themselves. But that's not all! We will also hear the *harmonics* of these combinations! So, frequencies of 1,500, 3,000, 4,500 Hz, but also 3,500, 7,000 and 10,500 Hz will be perceived. Once again, their level will be very low compared to the 2 initial notes played.

It seems hardly believable, but it is true… In practice, though, this is far less embarrassing than you might think at first glance. As said above, the relative level of those "ghosts" is much lower than the basic notes. The result will be heard as if the flutes had some *tremolo*, or vibrating behavior, a very easily perceived phenomenon. And the combination's harmonics will add some "warming" factor, or on the contrary some "coldness" or "dryness" to the perceived sound, depending on how they will combine together.

So you can see that IMD is even less easy to understand and quantify than THD. And how can we appreciate IMD, can we hear it, at what level does it become a nuisance?

Well, the first thing we can admit is that it is not musical instruments that generate inter modulation effects, but our own hearing – brain included – that is the cause. Some acousticians say than our internal ear can "produce" inter modulation artifacts at levels between 25 to 40%! Of course the brain then does some necessary "correction".

However, this kind of "correction" cannot be compared with an electronic chain, say the microphone and analysis system. So, we feel very uncomfortable about advancing any IMD value from external origin for which our ear is sensitive. In practice it seems that IMD less than 2%

(3 to 5% for THD) is considered as not disturbing, even not audible in a musical context, judging by the Single Ended Triode aficionados or by all the psycho acoustical experiments conducted over the past few decades.

By way of conclusion, it appears that IMD, while perhaps more disturbing than THD, remains practically harmless, provided the levels are not outrageously high.

Okay. Now bring on the next suspect…

5.1.3. Temporal Distortion

In the 'seventies, the famous Matti Otala highlighted a new kind of distortion, not so easy to measure, but clearly audible, called **T**ransient **I**ntermodulation **D**istortion, TID (also called TIM, for **T**ransient **I**nter **M**odulation).

TID occurs when the negative feedback (NFB) loop is in a state of overflow, something that arises more often than you might think since the NFB correction always applies *after* the phenomenon to be corrected appears. During these very short instants, the amplifier can produce more than 100% THD and/or IMD.

At darTZeel, we prefer to call it **T**emporal **D**istortion, or TD, because this is obviously what it actually is. It is one of our favorite subjects for discussion, since it is here that we can find the key to the problem.

Since the CD came on the scene, lots of water has flowed under bridges. In the 'nineties, a big bug reared its ugly head on the "perfect sound for ever" road. Its name is "Jitter", and it is, more scientifically speaking, an "uncertainty of chronometer precision".
Jitter is nowadays well known, and well explains why temporal errors, even when small, lead to amplitude distortion. Effectively, a "0" or a "1" not arriving on time will be translated into output amplitude which will not be proportional to the input amplitude of the signal. We all know how jitter "sounds", when not cured.

Thanks to – or because of – this famous jitter, a truly digital calamity, we can better understand that temporal distortion will alter the precious and delicate analog, musical signal. In the analog world, though, TD is more subtle and more difficult to treat and cure.

In the darTZeel NHB-108 model one, everything has been done to preserve the temporal integrity of the music.

There are two principal means for reducing, or even eliminating, TD.

The first is to use several small but local NFB loops, instead of a bigger and slower, global NFB loop. This approach greatly improves signal transfer speed and propagation delay time.
The second is based on the principle that temporal error is equivalent to *phase shift*. So if one can enlarge the frequency response by a factor of ten (say 200 kHz), phase shift will be also greatly reduced.

Ideally, the best would be to apply both means described above. The only problem is that they contradict each other. High bandwidth generally requires higher global NFB, while low NFB leads to poorer frequency response.

Here is where the darTZeel NHB-108 model one comes in, the first very low NFB *and* high bandwidth power amplifier. No global NFB is used, and both 1st and 3rd stages are even open loop! So what about the frequency response? Everything is okay up to the Megahertz range (1,000,000 Hertz), say *fifty* times the audio range!

5.2. What application field?

The electronic schematics of the darTZeel NHB-108 model one's audio circuit, as we will soon see, is astonishingly simple.

"It's because the NHB-108 has high THD and IMD values", would say our well-meaning detractors.

If you have read us from the beginning, you are now perfectly aware that harmonics are not directly responsible for the sonic signature of an amplifier.

The apparent simplicity of our audio circuit has been effectively made possible through our choice of semiconductors technology.

If the THD and IMD produced by the amplifier are kept low enough, say lower than the audibility threshold, then no further correction will be needed, and the audio circuit can remain simple.

At the start of this new century, 3 main technologies coexist in the construction of transistors, these being in chronological order:

- Bipolar, in the early 1950s.
- Field effect, in 1962.
- IGBT, a mix of the previous two, in the 'eighties.

At darTZeel, we strongly believe in new technologies. On the other hand, we readily admit that nothing can replace experience.

So, "our" winner is…

Bipolar technology!

5.2.1. IGBTs

For your own information, we are ready to tell you an old secret. What does the word "transistor" mean?
It comes quite simply from the contraction of *transfer* and *resistor*.

IGBT stands for "Insulate Gate Bipolar Transistor". It behaves like a bipolar transistor at its output, while being driven like a FET at its input.

IGBTs are mostly used in power applications, like inverters, switching power supplies, heart defibrillators, and… for some audio power amplifiers.

We do not have any preconceived notion about the use, and more specifically, the sound of IGBTs. Results can vary with the samples used.
Their linearity is close to FETs, which is, alas, not enough for us.
IGBT technology is by far the youngest, and we lack time to fairly judge them as to their long-term sound quality, reliability and availability.
So for now, and maybe for still a little while, we will probably not use them directly in audio applications.

5.2.2. FETs

FET stands for "Field Effect Transistor", of which there are two main categories. For small signals, they are called as is, FETs.
For power applications, their most common name is MOSFET, which stands for "Metal Oxide Silicon Field Effect Transistor". They behave similarly to FETs, but their internal structure may vary.

FETs are being used more and more, for several reasons, including the most obvious one:

It is commonly accepted that they perform very closely to vacuum tubes (or *electron tubes* or *valves*). Tube lovers generally like MOSFET amplifiers due to their similar behavior.

Here, we are forced to say that we do not share this point of view. Not entirely, at any rate…

It is true that the sound of MOSFETs tends to be soft and warm, a bit like those found in tubes. But their electrical behavior is not similar, simply because they are not made of similar materials.

The only true similarity is that MOSFETs – and FETs of course – are voltage driven, like tubes. Apart from that, they are in two different worlds, vacuum for tube, silicon for FETs.

Conduction in any type of transistor always acts in a solid, here the metallic silicon, hence their name of "solid-state" devices.
In a vacuum tube, electrons move in… a vacuum.

Coming back to FETs, what is their sound? For most designs, we would say that it is only a matter of taste. We are convinced that one can design a "standard", good sounding machine in the 3 technologies mentioned above, and even with the fourth - tubes - with virtually the same sound.
Obviously, if you like *music*, you definitely need a darTZeel NHB-108 model one.

Yet, and contrary to common belief, MOSFETs are less linear than bipolar transistors available today. MOSFETs often need more sophisticated added

circuitry to make the best of their possibilities, and that means a longer and more complex signal path, and hence a reduced resolution.

MOSFETs are also slower, in absolute terms, than bipolars, and are much harder to drive in pulse mode.

Reproducing very fast transients requires a lot of instantaneous current drive, not easy for the power supply to properly feed, so temporal integrity could suffer.

5.2.3. Bipolars

These have been in existence for more than fifty years. The industry knows them very well. Today's bipolars are better than ever. Ultra linear and extremely fast, they are perfectly suited for very high-end audio applications.

Their excellent linearity makes it possible to minimize the number of peripheral components, thus obtaining a straightforward signal path, with many less superfluous correction circuits.

In the darTZeel NHB-108 model one, the audio signal travels through only 6 transistors, from input to output, maintaining low THD and IMD levels, and without using any global NFB, the output stage even operating in a totally open loop! The *slowest* transistors used have a bandwidth of more than 30 MHz, much higher than for a MOSFET. This extreme intrinsic speed allows a total phase respect across the whole audio range, without *any* static or dynamic deformation. In brief, no Temporal Distortion.

In terms of music, these breakthrough advantages bring you closer to the musicians. Now you can share the emotion of the violinist, the fire of the conductor or the sweetness of the flutist.

Words are however not enough to describe what a single bipolar transistor pair is capable of. The best is still to invite your friends home, making them understand, share and believe *your* ears.

5.3. The circuit of darTZeel

5.3.1. Criteria of choice

Simplicity.

The audio circuit of the darTZeel NHB-108 model one uses only 14 transistors in all, including current sources.
Only three different bipolar transistor devices are used, all of the same brand.

Purity.

The version **A** of the darTZeel NHB-108 model one takes unprecedented care of the precious musical signal:

No connector, switch, relay or fuse whatsoever is located in the signal path. Even better, we did not use *any* of these devices except in the AC mains input.

No current limitation, allowing unbeatable dynamic range when in cooperation with the single output pair devices.

No output DC voltage drift compensation, offering a truly breathtaking sound, from whispers to loud shouts.

Only a single, small, local symmetrical DC NBF, leading to extremely wide bandwidth, included in the very low frequencies, without addition of any multi polar phase shift.
The use of a very compact printed circuit board (PCB) reduces track lengths to the strict minimum.

Reliability.

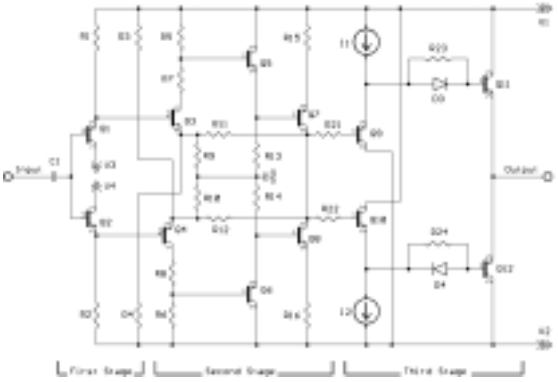
The darTZeel NHB-108 model one does not use any "exotic" or "esoteric" component. Each element was chosen for its intrinsic sound qualities, its long-term availability, and for its long life. No compromise was conceded as to the build quality of any part or component. Some of them were tested for *15 years* in our lab before being selected.

5.3.2. darTZeel schematics

For the most curious readers, we give hereunder the functional diagram of the darTZeel NHB-108 model one.
Connoisseurs will appreciate how simple it is, so different from the common belief of "bigger is better".

For once, we give the description in French, which is, after all, the very original text. A translation can be provided on special request.

This schematic is multi patent protected



Description du circuit:

3 étages, en technologie discrète, se décomposent ainsi :

1er étage, étage d'entrée. Cet étage, dépourvu de toute contre réaction, amplifie en courant le signal d'entrée, de telle sorte qu'il ne subisse aucune charge susceptible de le déformer. La simplicité apparente de ce premier étage (1 seul transistor par polarité) permet des vitesses de commutation très élevées, sans rotation de phase notable dans le spectre audio.

2ème étage, étage d'amplification, amplifie en tension le signal à la valeur nominale requise. Cet étage comporte 2 demi contre réactions locales, implantées de manière symétrique. Cette contre réaction symétrique s'effectue sur tout le spectre de fréquence, y compris le courant continu, afin d'apporter une réponse parfaite dans le grave.
La configuration de ce circuit permet une propagation de groupe homogène sur tout le spectre audio, grâce à la faible valeur de la contre réaction.

3ème étage, étage final de sortie, dépourvu de toute contre réaction. Cet étage amplifie en courant le signal issu de l'étage précédent, permettant ainsi d'alimenter un haut parleur. Le courant de repos des transistors de sortie est ici défini par une tension de jonction base-émetteur, et non par un courant de polarisation. Ce système élimine le besoin d'une régulation thermique. En effet, lorsque les valeurs initiales ont été fixées, tout échauffement des transistors de puissance entraîne également un échauffement des transistors drivers. La tension VBE chute aussi bien dans les drivers que dans les éléments de puissance, garantissant un équilibre thermique stable. Ce montage permet également des bandes passantes très étendues, sans déphasage important.

The above description is an extract of the original patent text, and is condensed to cover other applications, even in the non-audio field. The darTZeel preamplifier circuit is directly derived from the darTZeel NHB-108 model one schematics.

If you have any specific questions about this circuit, please do not hesitate to contact us at info@dartzeel.com

5.3.3. Component layout

In analog, especially in audio, the layout of components is of paramount importance in the signature they can print onto the musical signal. A transformer too close to input circuits, or a power supply located too far from output devices, are just some examples among others. These parameters are difficult to cope with, particularly when cost considerations come into the picture.

The internal volume was exploited down to the last cubic centimeter. Output power devices are located less than 10 centimeters from the huge crescent-like bus bars. All the energy coming from the capacitor reservoir can then effortlessly flow to the output bipolar transistors.

Also, the Power Nose – please read the *Owner's manual* for more about the terminology we use – does not directly switch the AC mains, but drives static, semiconductor relays. This approach allows freedom from any electromagnetic disturbance from AC, and also to soft start the amplifier. The switch is also subject to less wear, since no spark can appear at its contacts, extending its lifespan close to one *million* ON-OFF operations.

We also placed inputs connectors very close to the entry PCB points, altering as little as possible the still unamplified incoming music.

Dozens of other small things have been thought about and implemented. We would need too much space to describe all of them; furthermore, such a description would be much too boring. Please believe us, we have done our best to look after the precious and delicate musical signal, leaving as little as possible to chance.

5.4. Symmetrically balanced?

The following could seem contradictory sometimes. It is mainly due to the terms "balanced" and "symmetrical", or "unbalanced" and "single ended".
In French, these terms lead to even more confusion, since both "balanced" and "symmetrical" are translated by "symétrique".
So, you will not feel less comfortable than our French-speaking friends. Feel free to contact us at info@dartzeel.com if you need explanations in greater depth.

It is absolutely fascinating to note that some technical choices only serve fallacious sales arguments, and to our regret, audio is no exception to the rule…

Most high-end power amplifiers, especially flagship models, offer balanced inputs, described as being the very best, technically *and* sonically speaking. As often as not there's no option as regards balanced inputs: in fact there's nothing else!

For the darTZeel NHB-108 model one, our approach has been almost the opposite. To minimize the cost? Could you even believe that?

Maybe the time has come to refresh our memory to some extent…

5.4.1. From the microphone…

A balanced line is in fact a transmission line without reference to ground. Imagine that instead of transmitting the signal between one wire and ground, we use *two* wires. A 3rd cable, earmarked for ground, is of course also present, even though not necessary for the signal right now.
This transmission mode finally leads to external noise and disturbance cancellation.

In pro audio engineering, balanced lines are *de rigueur* and massively used. Unbalanced links are very rare indeed! The reason is very easy to understand:

Microphones generate very tiny electric signals, and very long lengths of cable run from the studio to the mixing console. In these conditions, it is primordial for the signal to be free of any hum and/or noise.

Also, in concert performances, mixing consoles are generally located quite far from the stage, and balanced lines are welcome. A technical trick, using that 3rd, ground wire, also makes it possible to carry the phantom power supply feeding electrostatic microphones.

So now you have understood that balanced links are used especially in professional applications.

5.4.2. To the loudspeakers…

Let us quit the studio and come back to the high-end, musical world.

Basing themselves on what they consider to be the real benchmark, audio companies equip their flagship machines with the balanced lines described above, using the well known XLR connectors.

Most of the time they offer "fully balanced" topology from input to output, claiming that the sound will remain unaffected since it is immune to external disturbances.

Technically speaking, fully balanced topology is relatively easy to achieve. It suffices to double the entire electronics, in a mirroring fashion, assigning a new channel path for the inverted signal. Of course this simplicity has a price, in fact *double* the price. Finally, the balanced signal is amplified and routed to the loudspeakers.
Come to think of it, are loudspeakers balanced or not balanced? That is the question!

5.4.3. And into the air…

Once in the air, the musical signal is traveling on its last trip before delicately tickling your eardrums.

How exactly does music propagate itself in the air?
Music is a matter of vibration, and propagates in the shape of *waves*. Any wave, to be propagated, needs a medium. No medium, no wave, no sound. Just try playing trumpet on the Moon. Not an easy task, even if your name is Armstrong…

What about *radio* waves? What medium do they use, in the vacuum of intersidereal space? Well, write us, and we will send you the *Physicist manual*, as soon as we have got round to writing it…

As for *acoustical* waves, it is a much easier phenomenon to describe, and especially understand, since it is part of our daily life.

The medium can be water in the case of mermaids singing… er, sorry, when *whales* sing. Or when more human, technological things such as sonars, hydrophones and the like generate and detect acoustical waves.

The medium can also be *steel*. The hammer hitting the string, in a piano, generates a pulse which creates a propagating wave *in* the string, making it vibrate. Then this vibration will be transmitted into the air.

Air: this is the ultimate medium where man-made music propagates. Music is spread in wave form, the latter being described by a physical law, called "wave propagation theory". We will not enter into the details, but mention just one crucial and essential point:

Acoustical waves do not *move* air.

When we read in some high-end magazine that such and such a flagship loudspeaker can blow out a candle while reproducing a trumpet or a saxophone, this is just metaphorical.

The sound is produced by the *vibration* of air molecules, step by step. Yes, you did read correctly. It is *vibration*, not *movement*.

If you know a friend who plays trumpet or saxophone, just put your hand on the bell and you will only feel vibration, not a single tiny puff of wind. By the way, you would never think about a piano being able to stir up air to produce wind, would you?

These vibrations have a purely single-ended behavior, since they are produced around a point of equilibrium, where vibrations are zero.

To cut a long story short, we can say that the whole acoustical chain is single-ended. The only moment when the acoustical signal could be balanced is when it travels into the electric wires. In the air, sound is unbalanced, asymmetric, single-ended, as you prefer.

Why then, this obsession to balance a naturally unbalanced signal? Is it not against nature?

Furthermore, where is the real advantage in running the loudspeaker in balanced mode? To our knowledge, there is *no* balanced crossover in the market!
Has any manufacturer already told you that there is no such thing? Okay, now you've been told.

5.4.4. Via the darTZeel

In the version **B** of the darTZeel NHB-108 model one, we have also installed balanced inputs. Did we do this just in order to be "with it"?

First, we want to stress that we use *floating* balanced inputs. This means that rather than doubling the whole electronics, as seen above, we use high quality input transformers. Of course the use of transformers is much more expensive, but the resulting performances are far superior.

Speaking of external disturbance immunity, transformers are much better than full balanced topology. The common mode rejection (this is the name given to that kind of immunity) can be – wait for it – no less than *five thousand* times better when using transformers instead of full balanced circuits. Another, unbeatable, advantage is that they offer true electrical isolation – called *galvanic isolation* – between the line and the gear, providing outstanding safety in professional use. Last but not least is the fact that all the above-mentioned qualities are defined at the building stage, meaning that performances will not decrease over the years or even decades to come. This is not by any means the case in full balanced versions.

In conclusion, we cannot resist insisting on the fact that a full balanced solution utilizes twice the number of components, implying a more complex signal path, less reliability, and furthermore, especially in power amplifiers, an output impedance *twice as high* as with single-

ended topology, and requires a higher output stage NFB to compensate.

Now that you have read these simple but demonstrative explanations, do the words "full balanced" still mean "absolute superior sound" for you?

All this explains our choice for using, as a matter of course, transformers of the highest quality for our XLR inputs in the version **B**.

We said above that by very nature, music is part of a single-end world. More than 100 years ago, designers chose floating balanced lines – full balanced was not ready yet – for long distance links for the sole purpose of minimizing external disturbances.

Electric signals were therefore transmitted in a balanced way, the equipment working in single-ended mode.

The darTZeel NHB-108 model one version **B** offers this very same possibility to professional users wanting to link their remote consoles to the NHB-108 model one, without having to use poor quality Balun-DI devices.

Despite what all our esteemed competitors might think, we assert *and* corroborate that the one and only means of processing, amplifying and broadcasting a musical signal without altering it, even in the slightest, is simply to use the single-ended mode.

But only in a special way, though…

With short cables, say less than 10 meters, symmetrical - balanced - transmission does not have any justification but marketing. A given gear "singing" better in balanced mode only reveals poor design in some part of the circuit, which can be partially masked by internal disturbance cancellation.

Over longer lengths, external disturbances like hum, RFI and so forth take on a greater degree of importance.

The disturbances' intensity can be figured out by computing the RMS signal to noise ratio, in decibels.
A balanced, high quality, *floating* line can reach more than 120 dB of rejection, or -120dB relative to the signal, which represents one part per million, 1 ppm, a truly remarkable performance.

In full balanced mode, the result is far inferior, and in practice is barely better than -60dB, 0.1%. This may seem small, but just keep in mind that this implies component tolerances tighter than 0.5%, a truly demanding task. Professional consoles capable of such results are truly high-end by their 6+ figures price.

It is very important to point out that balanced lines, whatever they may be, are not impedance matched. *This means that even though they are fairly immune to external disturbances, they alter the musical signal proportionally to their length.*
Just ask a sound engineer if he is happy to use a cable 100 meters long when 10 meters are plenty enough.
Just ask him if high frequencies do not suffer from very great lengths, of the order of 100+ meters.

The 50Ω links used in the darTZeel NHB-108 model one, and described hereunder, behave differently…

5.5. darT *to* Zeel 50Ω

The darTZeel NHB-108 model one is equipped with 50Ω BNC connectors.
After a lot of research, we concluded that the *one and only* means for transmitting an electrical musical signal with no alteration or losses over a long distance is impedance matched lines, from end to end.

We have already mentioned that the darTZeel NHB-108 model one was thought up without any compromise in mind, especially regarding its cost price.
We confirm this once again, of course, but the purpose here is just to say we pursued this quest of sound purity simply because no other amplifier could bring us what we were looking for. So we designed the darTZeel NHB-108 model one.

As for electric transmission lines, we didn't want to reinvent the already existing wheel. Perfect impedance-matched lines have been in use for almost a century. And so have coaxial cables.
Impedance matched links are utilized everywhere when high tech performance is needed. Radio applications, radar, microwaves, computers, and all such preci-

sion technologies use impedance-matched links. So why not audio?

The great advantage of impedance matched-links is their virtual absence of losses, whatever their length.
For those of you who want to know everything about matching impedance in audio links, do not hesitate to contact us at info@dartzeel.com

Propagation time delay is preserved in DC up to several GHz in such lines, and no other link from any make can claim this, unless perfect impedance matching is achieved.

So the darTZeel NHB-108 model one is fitted with such inputs, here called "Zeel 50Ω", while the darTZeel preamplifier has "50Ω darT" outputs.

These inputs/outputs use 50Ω coaxial cables fitted on BNC connectors.

External disturbance immunity of a coaxial link depends on the cable itself. It can vary from -50dB to -100dB or more, the latter being greatly superior to the full balanced mode, and all this, please bear in mind, *without any sonic alteration*.

You can use very affordable off the shelf RG58U cable, and will be very surprised by the result. Many shorter but much more expensive cables do not do better! And when there is a big length increase, there is no shadow of doubt, darT *to* Zeel 50Ω is simply unbeatable. Trying and hearing is just believing.

The optional coaxial cable delivered with the darTZeel NHB-108 model one is furthermore of the high-end grade, silver plated pure copper, designed for hyper frequency applications. You will at least discover what resolution *really* means…

As stated above, one of the main advantages of darT *to* Zeel links is that you can locate the power amplifier as far as you want from the preamplifier. No more treble roll off, harsh or fuzzy. No more sluggish low end.
The theoretical length limit is… infinite! In practice, we recommend not to use lengths greater than 10 kilometers (we are *not* joking here, for once.)

This new way of linking is still in its infancy as regards audio, even if some of our esteemed competitors disagree. darTZeel will also offer in the near future, for professional applications, darT *to* Zeel *floating* balanced links.

Are you looking for darTZeel sound integrity in concerts and pro audio studios? You can have it just for the asking.

6. Onboard safety

A power amplifier like the darTZeel NHB-108 model one cannot but offer the highest quality level when it comes to monitoring and protection.

Purity.

But we did not call this part of the darTZeel NHB-108 model one the "protection circuit", by far preferring "supervision system", or "monitoring circuit", as you prefer. Indeed, this very sophisticated module is kept *totally* outside the signal path, electrically and physically, again so as not to disturb the delicate musical message.

Reliability.

The supervision system is based on a 100% analog design, making it independent from any problem or bug coming from a microprocessor.
The vital passive components have been selected for their extremely long life, greater than 40 years in continuous use. Your loudspeakers – and yourself – can rest on both ears, for quite a while.

6.1. Crowbar circuit

You will have read this odd name several times in the *Owner's manual*, maybe without having a clue about what it really is.
This circuit has been well known for decades in industrial power electronics. By power electronics, we mean powers ranging from 50 to 200 *kilowatts*, like in on-line inverters used for mainframe computers or in hospital surgery "white" rooms.

On these powerful machines it is not always easy to suddenly cut off the power supply without causing electrical damage. Inductive loads can release huge energy transients which need to be properly directed.

Generally the best solution is to insert a fuse – rather a big one of its kind – between the supplies and the loads. In case of emergency, you only need to *short circuit* the power at the load terminals. But this is easier said than done: the sudden, huge current peak generated, well supported by the power inverter, immediately melts the fuse, shutting the load down. If the fuse is located at the input of the inverter, the *entire* supply system will be stopped.

It is such a circuit that we have installed in the darTZeel NHB-108 model one. When an anomaly or a faulty condition is detected, the Crowbar circuit, consisting mainly of a power thyristor, is activated. The Crowbar shorts the power supply, melting – actually evaporating – the mains fuse of the channel concerned.

The principal advantage of such a Crowbar circuit is that it can be kept *totally* outside the audio signal path, thus completely avoiding any influence on the music.

Its caveat? The price. Thyristors like those we use in the darTZeel NHB-108 model one can short peak currents of around 1,400 amperes. They cannot be considered as being "cheap" parts.

6.1.1. Crowbar activation

In the *Owner's manual*, we often mention that the Crowbar can be triggered, in cases where you have not followed the instructions for use.

To dissipate any remaining doubt from your mind, we would like to mention hereunder the faulty conditions which will trig the Crowbar:

- Using less than 4Ω nominal loudspeakers, while the speaker's impedance selector is on **Hi** position.
- Short-circuit at speaker terminals.
- Output DC voltage drift greater than 2 volts at speaker terminals.
- Powering ON the darTZeel NHB-108 model one while speakers are not hooked to the speaker terminals.

6.1.2. Crowbar cycle

For those who want to know better when and how the Crowbar acts, here are some further explanations…

When one of the following elements and/or signals, or a combination of them is detected, namely:

- An output DC voltage drift greater than 2 volts at speaker terminals;
- A permanent output current greater than 5 amperes, while the power supply impedance is on **Hi** *and* output voltage swing is no greater than 60 $Volts_{p\text{-}p}$;
- A permanent output current is greater than 12A;
- A peak, transient output current greater than 25A and longer than 25ms;

Then the power thyristor, paralleled with the total supply voltage, is trigged, i.e. put into conduction. The huge, abrupt short-circuit current peaks to around 350 amperes for 6.5 ms, completely releasing the filtering capacitors' storage energy, through an appropriate, custom designed choke absorber.

This sudden current rise at the transformer's secondary windings also implies a very high current at its primary windings, proportional to the inverse ratio of the primary to secondary voltages. This current is at least 20 times greater than the nominal value of the fuses. The metal in the latter literally evaporates instantaneously against the glass envelope, as testified by the latter's black silver color.

While you are replacing the melted fuse with a new one, the Crowbar circuit will have reset itself in the meantime, and will now be ready to work again, just in case. It is important to note, however, that if a newly replaced fuse is blown at power ON, you *must* follow the *Owner's manual* instructions, that is to say unplug your darTZeel NHB-108 model one and contact our customer service at troubles@dartzeel.com

Never, ever, replace faulty fuses by values different than those originally indicated in the *Owner's manual*.
RISK OF FIRE!

6.2. Supervision system

6.2.1. Current sensing

Most available amplifiers, if not *all*, use an output current limitation circuit, protecting the output stages against any possible overload.

This current limitation generally takes the form of one or more transistors that will shunt the incoming signal to ground when the current has reached a defined value. The current sensing is taken through one of the emitter resistors of the output stage.

Although very efficient, this type of protection is unfortunately located in the very heart of the amplifier, and cannot be kept apart from the signal path.

Other manufacturers, in order to avoid such an intrusive protection circuitry, just insert some fuses either in the rail supplies, or even worse, directly in series with the output speaker terminals. Of course this solution is by far the least expensive, but is sonically a true disaster. Any given fuse behaves as a non-linear resistor. Its resistance is substantial, and is thus not very compatible with high quality reproduction. Last but not least, fuses inserted in this way do not react quickly enough, leading to damaged components.

Purity.

As you might have guessed, in the darTZeel NHB-108 model one we have used a somewhat different approach.

Rather than limiting the output current, we far prefer to measure in real time the *output power dissipation*. It is finally the output stage's temperature that defines its working range. An output device does not fail because the current is too high, but simply because the *temperature* caused by this current rises too much.

So, our monitoring circuit compares the instantaneous power dissipation with the value that the output stage can handle. There is no thermal inertia here, since we just measure the right thing at the right place. A premiere in the audio field, we can modestly say…

We then measure voltage *and* current passing *through* the output devices. Without adding any disturbance in the signal path? Yes, indeed.

As for measuring the voltage across the output devices, it can be done quite easily without altering the signal. Good news. For the current, however, it's quite another story.

Keeping in mind *not* to harm the audio signal, which is *music* after all, we use a special Hall effect electromagnetic sensor. The speaker wire goes through it, coupled magnetically.

This sophisticated current sensor has the enormous advantages of presenting an extremely light load, in the region of 10,000Ω (compared to the 8 ohms of a speaker), of *not interrupting* the signal path, and of being truly linear from 0 Hz to more than 150kHz, well above what is needed for music.
Its main drawback? The price, once again.

Simplicity.

To put it briefly, the monitoring circuit allows unlimited peak currents for the time necessary to produce any transient generated by instruments such as the piano or drums.

By using such a sophisticated supervision system, a *single output pair* bipolar device can safely manage the demanding task, ensuring the sonic purity laid down in the specifications.

6.2.2. For *its* eyes only

The monitoring circuit not only takes extreme care of both your amplifier and loudspeakers. It can also anticipate.
The darTZeel NHB-108 model one's eyes, better described in the *Owner's manual*, are also controlled by the monitoring circuit.
Apart from their – we hope – aesthetic appeal, they warn you when limit conditions occur. With some experience, you will be able to use them as a thermometer. Sorry, this *is* a joke.

7. Power supplies

7.1. From mains to loudspeakers

More and more, audio manufacturers are insisting on the quality of the power supplies. They are quite right!
After all, the electric energy fed to your loudspeakers comes from the power supply and nowhere else.

The audio circuit itself is really just a sort of regulator for this energy.
The better the quality of the source energy, the easier the task of modulating it into sound waves.

This modulation is truly the audio signal you listen to. It is this same signal that will deliver the energy supply to your loudspeakers, which in turn will excite the air molecules to vibration, producing that magical feeling we audiophiles call "music".

In your darTZeel NHB-108 model one, the power supplies are not really standard ones. The amplifier is a *true* dual mono. We apologize about stressing the word "true", but much too often this description is abused.
The darTZeel NHB-108 model one has 2 fully independent power supplies, one for each channel. The two channels are fully insulated from each other. The crosstalk figure speaks for itself, at more than 90dB separation across the entire audio spectrum.

Toroidal transformers, each of 300VA, are wound on 450VA cores. Magnetic fields are thus reduced to the point that no core saturation can occur, ensuring clear power output under any dynamic conditions, without induced hysteresis distortion.
Cores are grain oriented, and primaries are electrostatically shielded from the secondaries, keeping RFI away. The entire units are impregnated in epoxy resin, eliminating possible winding vibration.
As seen above, the transformers are also suspended. Their residual mechanical noise is so low that even in *very* quiet listening rooms, you will not be disturbed anymore.

Immediately after the rectifier bridges, the DC sources are filtered by 6 paralleled, 22mF, capacitors for each rail, totaling a whopping storage energy of 230 joules per channel. Not so bad for a 100 watter…

The copper bus bars, CNC machined in 5mm-thick blocks, connect the filtering capacitors' leads together, creating as it were a low impedance power supply “on the spot”. The output transistors are located only a few centimeters away from the power supply: hence no problem in case of high current demand.

Our power supplies are filtered only, avoiding any dynamic limitation for which regulated supplies are often responsible. Fully regulated supplies have very low output impedance through high feedback regulation (NFB everywhere!). When huge dynamic changes arise, the NFB is in a state of overflow and the output impedance suddenly increases dramatically, causing dynamic compression. Does this remind you of something?

7.2. Voltage or current?

For purity reasons invoked earlier, the output stages of darTZeel NHB-108 model one only have a single bipolar pair of output transistors.

The vast majority of amplifiers of over 50wpc use paralleled transistors, from 3 to 24(!) – or even more – pairs. The purpose of this parallelism is to obtain a greater output current, as required by low impedance loudspeakers.
This method is much cheaper than the solution used in the darTZeel NHB-108 model one*, power transistors being much less expensive than in the past.*
But parallelism has numerous drawbacks, as follows:

- *The need to match components for even heat spreading.*
- *The signal path is divided into multiple parallel paths, leading to TD (Temporal Distortion) by degradation of propagation time delay uniformity, each path not being of the very same length.*
- *Much longer mean path length, considerably increasing the output im-*

pedance, and hence the need for a greater NFB at output stage. This also induces TD.
- *Much greater physical volume and area, limiting the high frequency response because of higher RFI sensitivity.*

And this list is unfortunately not exhaustive.

Without special precautions, the use of speakers with nominal impedance of 4Ω or less on a single output paired stage can cause excessive dissipated heat, outside the safe working range of the output devices.

We gave great thought to this and finally came up with a solution, allowing the use of 2Ω, or even 1Ω loudspeakers, if you can find some, without loss of power or quality.

Power transformers have 4 identical secondary windings. Depending on whether they are connected in series or parallel, the result is a big voltage or a big current.

For loads between 4Ω and 8Ω, the current remains fairly low, around 7A RMS, corresponding to about 200 watts under 4Ω, but the voltage needed is relatively high, in the region of ±50 to ±60 volts for delivering a comfortable 150 watts under 8Ω.

Conversely, 200 watts under 1Ω need an RMS current of 14 amperes, but with only 14 volts RMS as an output voltage, allowing power supply rails of about ±25 to ±30 volts.

By switching the secondary windings accordingly, the power transfer is optimized and the power transistors in the output stage remain within their safe working range.

So we can only use one single output transistor pair per channel. The signal path is shorter, uniform, and only passes though one silicon junction at a time.
Music is thus reproduced with unprecedented ease, purity and fidelity, simply impossible with more complex designs.

7.3. Received idea

This chapter devoted to power supplies would not be complete without the following little addition, small in size but of great significance…

It is usually admitted in the audio world, particularly in the high-end manufacturers' community, that output current availability is of paramount importance, to the point where one praises machines capable of outputting dozens, or even hundreds, of amperes.
What nonsense!

Until the contrary is proven, as far as we know voltage and current are in a certain relationship, as clearly stated by Mr. Ohm's law:

$$V = R \bullet I \qquad I = \frac{V}{R} \qquad R = \frac{V}{I}$$

It is of course the same equation, just written in its 3 most usual forms.

Now, let us take an ideal amplifier, capable of delivering *exactly* 250 watts/8Ω, 500 watts/4Ω, 1000 watts/2Ω, and a whopping 2000 watts/1Ω.

The currents needed to deliver these abundant and generous powers are, respectively, of 5.6A, 11.2A, 22.4A and 44.8A.

Yes, we have to admit that the last figure is quite high… So, this amplifier can deliver roughly 45 amps under 1Ω.
Now say that you own speakers having an impedance of 6Ω, much easier to drive than 1Ω. How many amperes will this imposing amplifier deliver to your loudspeakers? 45 amperes with a big smile? Not at all!

Given Mr. Ohm's law, the amplifier will deliver at its best 333 watts, say 7.45A under 44.7volts.

So you can see that in the *real* world, you just need 7.5 amperes, not 45. Let us confess that for 333(!) watts, this is quite reasonable…

Do you now better understand why "Lots of Amperes" does not necessarily mean "Superb Bass"?

8. The sound of darTZeel

It is always hard to define objectively what we perceive subjectively, isn't it? How to enjoy an excellent glass of wine, if not sharing it with friends?

We could say that the darTZeel NHB-108 model one offers an outstanding temporal linearity, allowing true three-dimensional re-creation.

We also could say that the bass is deeper than the Mariana Trench, with every nuance incredibly rendered.

We could add that voices are so sweet and timbres so accurate that you will turn your head, believing that someone has just entered the room.

We could even conclude that no cymbals can be better reproduced than through our machine.

Instead, we will just invite you to take a seat and listen to some good music…

After all, if you read this manual, you certainly already *own* a darTZeel NHB-108 model one, and you know better than anyone what we are talking about. So why do we need to produce any further advertising? In fact, just for the fun of it. And music is fun too, isn't it?

9. Reliability

9.1. Quantified longevity

"How long does a darTZeel NHB-108 model one last? Before first failure?"

Well, let's us try to see a bit more clearly, and seek a better understanding of the different causes of failure…

Assuming that the first possible failure will be due to the weakest component, we could be tempted to install only the longest lasting components.

Is the first criterion, "Purity", compatible with "Reliability"? If a component lasts twice as long as another, but sounds twice as bad, what would be the lesser evil?

Before giving a firm answer, it is interesting to ask ourselves what are the most influential parameters affecting the life span of a given component. Several studies show that one key factor is *heat*. This might seem obvious, and we have all experienced once in our life the consequence of leaving our beloved CDs – or cassettes for the most experienced of us – under our car's rear window on a hot summer's day…

What is far less known is the mathematical relationship between expected lifespan and high temperature exposure.

Many studies have shown that for each 5°C increase, lifespan is halved! Sorry about not converting into Fahrenheit - the law doesn't work out so easily. Sometimes the metric system is not so bad, especially when one wants to launch a probe to Mars… But that's another story.

Back to *our* story. If a component lifetime is given for 10 years at 20°C, it will only last *one day* if permanently exposed to 80°C! This very same component will last for *40 years* if ambient temperature is only 10°C…

This law does not take all parameters into account, but it is close enough to reality to rely on it when designing electronic circuits.

We see then that while it is very important to chose components designed to resist high temperatures, it is always preferable to stop the problem at source, by simply ensuring that components do not overheat.

In continuous round the clock domestic use – but is this still domestic use? – provided you respect the location advice mentioned in the *Owner's manual*, the darTZeel NHB-108 model one stabilizes at around 50°C on its heat sinks. As bipolar transistors can work as high as 120°C, the margin is comfortable here.
The internal temperature, on the mother plate module, is around 40°C. At this crucial place are installed the very expensive filtering capacitors. Do not be worried too much: at 40°C, 24/24, their estimated span life is… 40 years.

Just imagine: a poorer design – we will not mention any name – subject to an internal temperature of 60°C would imply a change of capacitors every 2 and a half years!

Furthermore, in normal use, say if you sometime power OFF your machine, life span can be easily doubled, or even quadrupled.

As soon as we realize that working temperature is the most long lasting factor, it becomes easier to choose components for their sonic attributes first.

Another factor, even less known but very interesting, is that of sustaining bias powering. A given component, being active or passive, lasts longer if some voltage, however low it is, remains applied to its terminals. For electrolytic capacitors, this small "polarizing" voltage even keeps their internal electrolyte in perfect chemical working condition, greatly reducing the "warming time" usually needed with other gear.
All these reasons led us to keep the darTZeel NHB-108 model one powered at around 5 volts (instead of 60), even when shut OFF, by pressing the Power Nose. Your amplifier is then always gently permanently energized, extending even further its life span, and attaining much more quickly the full performance the amplifier can deliver to your ears.

It is also the reason why you can still hear some music through the darTZeel NHB-108 model one even when it is powered OFF. Incidentally, the fact that the amp can sing with such a low voltage demonstrates how simple the audio circuit really is…

In case you are worried about this, the power consumption of the "power OFF" mode is around 2 watts. It represents around $5.33 per year, assuming that a kilowatt/hour costs $0.33. This means $160 after 30 years. It is not too high a price to pay compared to changing the capacitors more frequently! Bear in mind that producing new capacitors pollutes more than keeping them energized… With all sonic benefits.

9.2. Long term availability

9.2.1. Spare parts

To own a darTZeel NHB-108 model one must not only give you musical pleasure. You must also benefit from a first class customer service, whatever the problem encountered. Whether it is a failed component, or a broken heat sink due to an unfortunate accident – not dropped on your feet we hope – all parts need to be available, at anytime.

If, as we think, your machine only requires maintenance every 30 or 40 years, we will ensure that parts availability will last far beyond that.

We at darTZeel, always stock all "non perishable" components in sufficient quantity for – very – long term operation.

Semiconductors and passive components with no instable material inside are stocked, and will be available at any time, in brand new working condition.

As for electrolytic capacitors, however, their preservation is much more delicate when one tries to stock them for 30 or 40 years in brand new working condition, their life span being limited even when not in use.

Fortunately, we have chosen industrial models, of the highest quality, from one of the world's biggest and longest established manufacturers. We can bet that they will still be there in 100 years, and that they will continue to offer equally outstanding capacitors, or perhaps even better ones.

Furthermore darTZeel keeps permanently in touch with the industry, with the aim of anticipating any shortage or ending of production as regards every component entering into the building of the darTZeel NHB-108 model one. In the worst case, "perishable" stock will be renewed accordingly in order to offer maximum availability at brand new specifications. Our wish is to be capable of offering you true and full customer service for at least 120 years after your purchase date.

9.2.2. Self-preservation instinct

One hundred and twenty? Are they kidding at darTZeel's? Or are they just being pretentious?
Yes, we only said that it is our wish. But here again, we have done our very best to make our wish a reality.

In order to keep our word and offer full maintenance of your darTZeel NHB-108 model one, we have stocked the following items:

- 1 fully assembled darTZeel NHB-108 model one, fully tested and in working condition, powered OFF but maintained "energized".
- 1 darTZeel NHB-108 model one in the form of pre-assembled and tested modules.
- Spare parts representing 2% - but a minimum of 5 complete sets – of all mechanical and CNC machined components.
- A total number of transistors equaling 120% of the number of complete machines sold, ensuring another entire electronic life to each darTZeel NHB-108 model one sold.
- A number of electrolytic filtering capacitors equal to the number of darTZeel NHB-108 model one units sold and reaching their 25th working year.
- All diagrams, electronic and mechanical drawings, in paper and computerized versions.
- The entire and detailed list, continuously updated, of components suppliers, CNC makers, and all other components involved in the darTZeel NHB-108 model one construction.
- A complete computer system, continuously updated, allowing retrieval of the above-mentioned data at any time.
- A fully detailed manual explaining how to use and to work with all the above.

All these items have been put in a nitrogen-filled container, in a safe area.

In the improbable case of darTZeel's disappearance, or if we ourselves can no longer intervene, you will be given a copy of these documents.

In such a sad case, our notary office will directly contact every owner with appropriate instructions.

Life is such a wonderful thing that we strongly hope that we will be able to serve you for many decades to come.

10. The next darTZeel

Now that we are almost at the end of this manual, we do think that you have a better idea about our philosophy.

We just hope that we have not frightened you by our unusual way of thinking. After all, if you proudly own one of our machines, it is because you have trusted us. We just say: "You were right!"

Nevertheless, do not believe that we set such a high level for the darTZeel NHB-108 model one that no one could ever improve it.

Obviously we do not want nor even need to change our product line every year, or even every 5 years, but this does not mean that we will rest on our laurels.

The design of the darTZeel NHB-108 model one incorporates the best that this beginning of the 21st century has to offer.
We sincerely think that at the time of going to press it is not possible to go much closer to the sonic truth than that which the darTZeel NHB-108 model one is already capable of providing.

As the years go by, technology will relentlessly improve. We will endeavor to determine to what extent we can go even further.

Each time we can make a leap forward, we will do so.
Every darTZeel NHB-108 model one can be easily upgraded at any time. So whenever an improvement becomes available, every customer can enjoy it at an attractive, real world price.

At the time of writing, we think that a significant update could take place every 3 years, *on average*. These updates will be of two different kinds:

Music Lover updates, where sonic aspects only will be improved.

Audiophile updates, where sonic and/or technical improvements will be offered.

Of course every single owner will be kept informed about any significant new development concerning the darTZeel line.

11. Keeping an open door

Well, now we have reached the end of the *Audiophile's technical manual*.

Is it too technical? Not audiophile enough? Please do not hesitate to tell us. We will be pleased to read your complaints, and we will take them into account for future manuals.

Any suggestion or criticism concerning the darTZeel NHB-108 model one, a particular manual, or any other point, can be emailed to:

info@dartzeel.com

We wish you very long and happy hours of music listening with the world's first "emotional amplifier".
One of our very first customers described the darTZeel NHB-108 model one in such a way. We have to admit that we fell in love with this description...

And now...

Music!

For darTZeel,

Hervé Delétraz

12. Special adjustments

12.1. Output DC voltage drift

Caution! The procedure described below can present some risk, since the darTZeel NHB-108 model one must remain powered ON.
WE DECLINE ANY RESPONSIBILITY IN THE EVENT OF ELECTRIC SHOCK DUE TO INCORRECT MANIPULATION.

WARNING! ONLY A QUALIFIED PERSON OR A TECHNICIAN CAN SAFELY PERFORM THIS ADJUSTMENT.

When darTZeel NHB-108 model one's eyes are blinking, it means that an output DC voltage greater than ±0.6 volt is present at the terminal speaker outputs. An adjustment is then necessary.

Before doing any task, it is important to ensure that:

- Ambient room temperature is between +15°C and +35°C.
- The darTZeel NHB-108 model one is properly vented, as described in the *Owner's manual*.
- The loudspeakers are connected to the speaker terminals!
- The darTZeel NHB-108 model one has been in idle state for a minimum of 2 hours, allowing an optimum distributed heat across the entire housing.

To make this adjustment, you need the following tools:

- A No. 4 flat blade screwdriver for removing the glass cover; this tool is supplied as standard with the darTZeel NHB-108 model one.
- The 2 suction cups supplied with the darTZeel NHB-108 model one. Please do not forget to slightly wet them, to get firm vacuum on the glass.
- A No. 0 flat blade screwdriver for adjusting the 12-turn trimmer; this tool is supplied as standard with the darTZeel NHB-108 model one.
- A universal DMM (Digital Multi Meter), not supplied.

Procedure:

1) Using the DMM, check that the DC output voltage is more than ±0.6 volt. In practice the value is generally negative.
2) Before opening the glass cover, locate the trimmers, using a pocket torch if need be; the trimmers are close to the RCA input connectors.

   On left channel, the trimmer is located on PCB solder side, between PCB and heat sink. A clockwise rotation induces a *negative* voltage shift.

   On right channel, the trimmer is located on PCB component side, oriented toward the inside of the machine. A clockwise rotation induces a *positive* voltage shift.

   When adjusting, it is important to turn the trimmer's screw slowly. Please allow 5 seconds at least after each tuning step, to wait for the value to stabilize.
3) Connect the DMM to the left output, and open the glass cover.

   DO NOT FORGET THAT THE AMPLIFIER IS POWERED ON!
   NEVER TOUCH THE COPPER BUS BARS, WHICH ARE AT A POTENTIAL DIFFERENCE OF 115 VOLTS DC.
   A SHORT CIRCUIT INDUCED BY THE SCREWDRIVER WILL PARTIALLY **EVAPORATE** THE BLADE BY INSTANTANEOUS MELTING OF THE METAL OF THE LATTER!
4) Within the next 2 minutes, set the DC voltage drift at -300mv (-0.3V).
5) Connect the DMM to the right output, and perform, within the next two minutes, the same tuning as for left channel.
6) Put back the glass cover, without screwing it yet. Wait for one hour.
7) Then measure again the output voltages. They should be between -300mV and -400mV.
8) Power the amplifier OFF, and wait for one or two hours for total cooling down.
9) Power the darTZeel NHB-108 model one ON again, and recheck the outputs. DC drift should not be greater than +500mV when ambient room temperature is +22°C.
10) If everything is okay, you can screw on the cover glass.

Voltage values are those obtained in average conditions. It is possible that they vary much less than mentioned, having less DC drift from cool to warm operation. If so, you can adjust these values a bit tighter.

Conversely, it could arise that you may have to work closer to the critical 600mV, say +590mV at cold start, and -590mV at warm cruise, for example.

The final goal is only to maintain outputs within the voltage range mentioned above. It is not necessary to symmetrically adjust between cold and hot values.

The measured output DC drift *does* fluctuate very slowly around the set value. This is a normal behavior and cannot be interpreted as a failure.

If you are unable to find a tuning value between cold and warm points, please check that the ambient room temperature does not vary over too wide a range. If this is the case, we strongly recommend using the darTZeel NHB-108 model one version **B**.

12.2. Monitoring circuit

The monitoring circuit, also called supervision system, includes a trimmer for clipping threshold adjustment. We do *not* recommend altering the tuned value, unless you happen to note that a mono input signal will trig both eyes with more than 0.8dB difference. Please feel free to contact us in case of doubt.

On later machines, bearing a serial number different to **TZ-UA1081.xxxX**, additional trimmers will be included on the PCB.
Do not alter these trimmers! The warranty could become totally void!

12.3. Version B

On the version **B**, it is possible to disable the DC output drift compensation.

Likewise, if you only use XLR floating balanced inputs, it is possible to install jumpers in order to bypass the commutating relays. This would help improve the sound quality slightly.

At the time of writing, the additional circuit of the version **B** is not yet ready, so we cannot describe this bypassing procedures in detail.
As soon as the optional version **B** circuit becomes available, a new release of the present manual will be printed and sent to all darTZeel NHB-108 model one owners, having either the **A** or **B** version.

12.4. Future developments

As and when further developments take place, such as improvements, updates, modifications, or simply some new advice, this chapter will be supplemented.

Thank you very much for having read us through to the end!
Now you have earned a rest, a quiet moment to listen to some nice music!