

Detailed Technical Description
about the
CanEVER Audio LaScala PowerAmp
or
How to design the “perfect” Amplifier

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Introduction:

The “perfect” amplifier is basically impossible to design, but with the required engineering skills gained from a strong background in vintage amplifier design AND a deep knowledge of recently developed components as well as modern circuits, it is possible to get very close to an amplifier which works *almost* perfectly.



Fig.1: The ZeroUno PLUS – a Tube Preamp with integrated DAC introduced in 2017

CanEVER Audio, with its smart engineering approach, has already proven that introducing highly competitive products in the overcrowded market of High End Audio is possible. The ZeroUno DAC, introduced in 2016 and the ZeroUno PLUS, shown for the first time at the High End Show in Munich 2017, are perfect examples of this. Both products are a combination of a high quality DAC including full MQA decoding *and* a preamp, with an intricately designed tube output stage working as a current source! While the ZeroUno DAC is a preamp accepting input from digital sources only, the ZeroUno PLUS comes with a top class analog preamp built in, in addition to the ZeroUno DAC circuit.



Fig.2: The LaScala Power Amp in two Cabinets for Power Supply and Amplifier

The CanEVER Audio LaScala PowerAmp is one of the few audio amplifier designs, which consequently follows the most important results in research about audio amplifiers in engineering history. It is the result of over 30 years of research and experience gathered in the design and building of amplifiers based on single ended, push-pull and hybrid circuits, using tubes and/or transistors.

First of all:

The *CanEVER Audio LaScala PowerAmp* is a TRIODE VOLTAGE AMPLIFIER followed by a CURRENT MOSFET BUFFER!

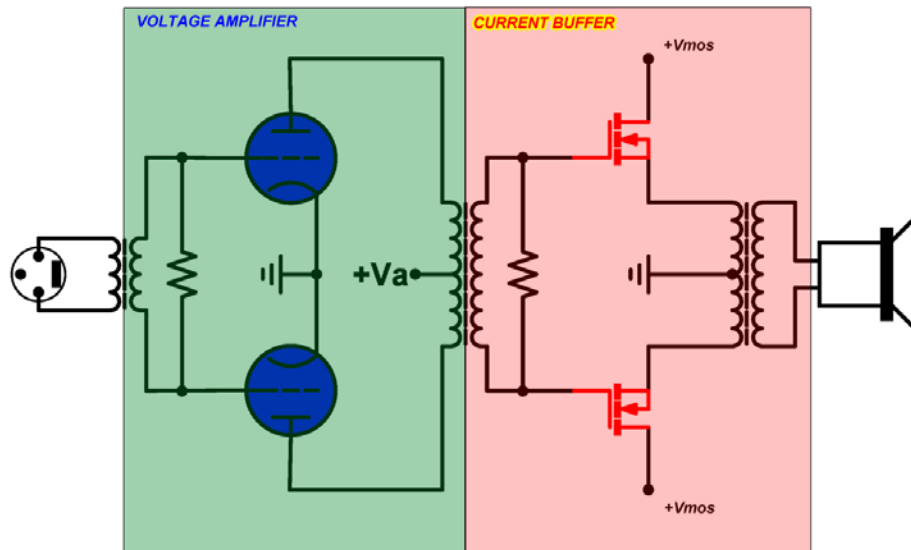


Fig.3: The basic Circuit of the *LaScala Power Amp* (one channel)

Why is this important?

The triode voltage amplifier is responsible for the voltage swing and the damping of the signal at the output.

The MOSFET current buffer is responsible for the interaction with the loudspeaker impedance, avoiding irregularities at the load of the triode stage, with the impedance itself. So, the voltage amplifier is loaded with a very high impedance to preserve the sound quality.

To design the “correct” amplifier, it is important to understand how the load connected to the amp is working. The load of an audio amplifier is a loudspeaker. Each driver inside a loudspeaker follows the laws of physics – not the “ideas” of more or less talented people designing amplifiers. These laws of physics “command” any kind of speaker driver to move as a function based on the CURRENT of the input signal. This means, that the movement of the cone is directly proportional to the applied CURRENT.

How does this affect the sound of my loudspeaker?

It is very important to understand, that a loudspeaker does NOT represent a pure resistive load to the connected amplifier. In fact, the loudspeaker represents a complex load called IMPEDANCE. This impedance is dramatically irregular, with maxima and minima along the band of frequencies that the loudspeaker is radiating.

Once the output VOLTAGE of an audio amplifier is proportional to its input signal, coming from the various audio sources in an audio system, this VOLTAGE has to be “converted” into CURRENT to drive the speaker. The IMPEDANCE CURVE (impedance vs. frequency) of the loudspeaker influences this “conversion” strongly. Especially when this impedance becomes very low. In many modern speakers, the impedance can get as low as 2 Ohms!

Even for a non-engineer, it is easy to understand that under these conditions, the movement of the loudspeaker cone will become “corrupted”. The result is ALWAYS a colored sound radiated from the speaker. There is no escaping it!

This situation changes completely, if the loudspeaker is driven by current!

In this case, the output CURRENT of the amp is directly proportional to that of its input signal and makes the cones of the speakers move in direct proportion to the applied CURRENT. The cone is moving proportionally to the original audio input signal, no matter what crazy “roller coaster” function its impedance curve is riding.

The result is a clean sound representing the original audio signal and not “modulated” by the impedance of the loudspeaker.

There is only ONE correct implementation of an audio amplifier and this is an amplifier with a CURRENT OUTPUT. One of the very rare amplifiers on the market today following this design principle is the *CanEVER Audio LaScala PowerAmp*!

In the initial design phase of a power amplifier, choosing which type of audio circuit to implement is one of the most important and basic decisions, that needs to be made. For CanEVER Audio, it was clear from the beginning: Class A mode was essential in order for the sound of the amp to be as natural as possible. To reach a clean sound - free from any distortions - the decision to use a fully symmetric design was the only choice possible. To obtain the best performance in channel separation and power handling, the power supply and the amp itself are designed in a dual-mono configuration, in which the power supply and the amplifier come in two separate cabinets.

Other important aspects of the *LaScala PowerAmp* design are the absence of coupling capacitors in the signal path as well as any kind of feedback loops.

The Power Supply:

As with any other electronic device, the power supply is the heart of a power amplifier. Without a properly designed power supply, a power amplifier will never reach its full potential.

The primary design goals for the power supply of the *LaScala PowerAmp* were to create an extremely clean DC as well as fast current delivery, even while performing the most demanding dynamic musical program.

The *CanEVER Audio LaScala PowerAmp* comes with a very special DUAL MONO power supply (one per audio channel) in a separate cabinet. Here you can see the basic circuit of the power supply:

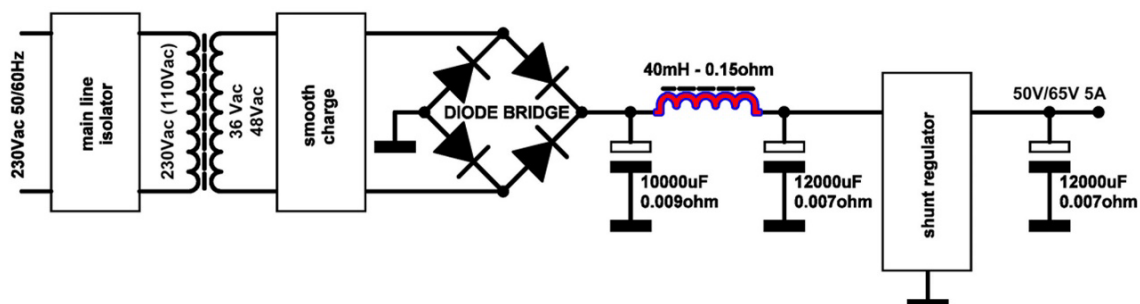


Fig.4: The Circuit of the Power Supply

The two channels of the amp make use of two separate power transformers, each preserving a power reservoir of 900VA – in total: 1800VA!

The type of diodes forming the rectifier bridge represent the latest technology. They have no recovery time at turn-off and their “ringing patterns” are negligible.

In the next step, the DC passes a CLC filter, where the inductor of that filter has a value of 40mH. The special winding of those inductors follow very strong tolerances, leading to a high bandwidth. The capacitors of the filter are high quality, long life, industry grade components, to manage high current in high temperature environments.

Finally, there is an active shunt regulator, which acts as a low pass filter based on a capacitance multiplier architecture representing a filter capacity of about 470.000uF.

Although it is not a quality spec per se, it is worth mentioning that the weight of the complete power supply of the *LaScala PowerAmp* alone is about 32kg!

How is the *CanEVER Audio LaScala PowerAmp* working in principle?

In a nutshell: This amp is a *push-pull amplifier* based on two “branches” of *single ended pure class A amps* for each audio channel, simply combining “the best of both worlds” in terms of circuits for audio amplifiers.

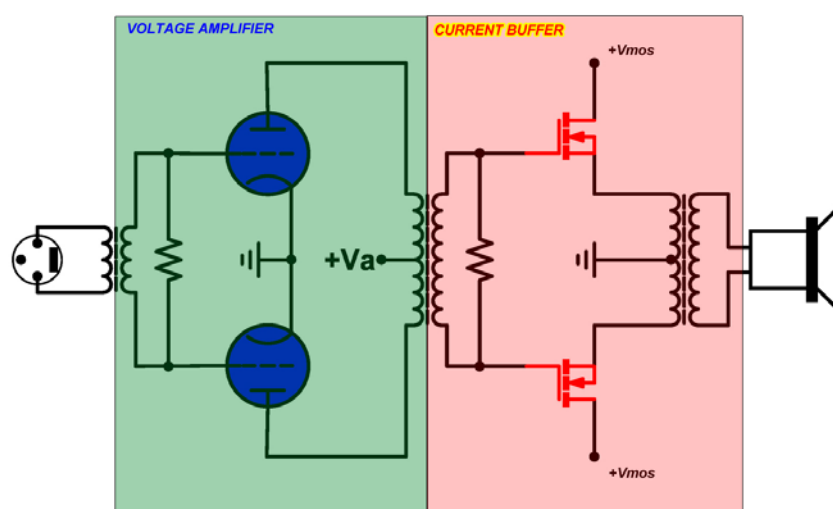


Fig.5: *LaScala Power Amp* (one channel)

Input Transformer (Phase Splitter) + Voltage Amp (Triode / Push-Pull) + Interstage Transformer + Current Buffer (MOSFET / Push-Pull) + Output Transformer

Directly connected behind the XLR input connectors for each channel, you can find a first transformer working as a phase splitter to create the two “branches” of the signal feeding the voltage stage of the amp. This stage more or less consists of one double triode 6N6P per channel. As this first stage is working as a voltage amplifier, the following stage is doing the current amplification.

The current amplification inside the *LaScala PowerAmp* works with a pair of last generation lateral MOSFETs, with a high linearity in the audio band. Using the MOSFETs as a current amplifier only avoid the driving complications of the MOSFETs in the classic configurations. In this way, the interface with the tube voltage driver is optimal.

The Interstage Transformer:

The interstage transformer separates the voltage driver stage from the current output stage. As there is no coupling capacitor, the dynamics of the audio signal are preserved. This transformer is wound up on a 75% nickel double C core to use in audio applications. It works as a phase splitter to drive the output stage. The special bifilar winding scheme creates a perfect symmetry on its secondary side – in other words, the interstage transformer creates two signals as a “mirror image” of each other. This allows the use of one pair of IDENTICAL N-Type MOSFET transistors, different from usual push-pull configurations, where the mix of not perfectly matched n-type and p-type transistors are standard.

Because of the configuration of the MOSFETs, the interstage transformer only has to transfer a voltage signal and not any current. The result is a dynamic, transparent and natural sound.

Why is this Type of Interstage Transformer so important?

Usually push-pull configurations make use of two “complementary” types of transistors – “N” type and “P” type. Unfortunately, the specifications of those devices are NEVER exactly complementary! This creates some very “nasty” types of distortions in a push-pull amplifier.

As the interstage transformer inside the *CanEVER LaScala PowerAmp* creates two “mirror images”, it is possible to use two power transistors of exactly the same type. CanEVER Audio uses two lateral N-channel MOSFETs of the latest generation. This type of MOSFET does not need any kind of feedback for the thermal stabilization!

Class A Mode:

As all stages inside the power amp are running in pure class A mode, no distortions are created in the crossover section. Specially designed BIAS control circuits manage the symmetry of the signals of the tubes and the MOSFETs. The result is a perfect symmetry in the processing of the audio signal, even if some SPECS of the active element are different. The BIAS for all stages is fix without feedback. The individual BIAS is independent from the power generated, the impedance of the connected loudspeakers and the processed audio signal!

The BIAS Control Circuits:

What makes the *LaScala PowerAmp* truly unique are the microprocessor driven “*Bias Control Circuits*”. These constantly control all stages of the amp. Without the firmware to run these microprocessors, a design like the *LaScala PowerAmp* would be impossible.

A basic problem in any push-pull configuration is that the two active components in these circuits (whether tubes or transistors) NEVER come with exactly the same specs, even if they were paired before and, last but not least, they always work at a different temperature because of the position at the heatsink. As a result, an amp like this creates additional distortion, which need to be avoided.

Inside the *LaScala PowerAmp*, the microprocessor-based BIAS CONTROL CIRCUITS manage the current and the voltage stage constantly, to make sure that all parts of the push-pull circuit always work in a perfectly balanced and symmetric way. Important: The BIAS CONTROL CIRCUIT does NOT affect the audio signal NOR create any feedback loop at the audio frequencies! It works below 0.1Hz, or, in other words, with a time constant of 10 seconds.

As a special feature, the microprocessors running the BIAS modules offer the functionality to switch the output power of the *CanEVER LaScala PowerAmp* between 50W and 100W per channel even while switched on. As the electric circuit is “floating”, it is possible as well to switch (bridge) the amp from 2-channel STEREO mode into one channel MONO mode. Of course, in this mode the *LaScala PowerAmp* delivers DOUBLE the output power compared to that in the 2-channel STEREO mode.

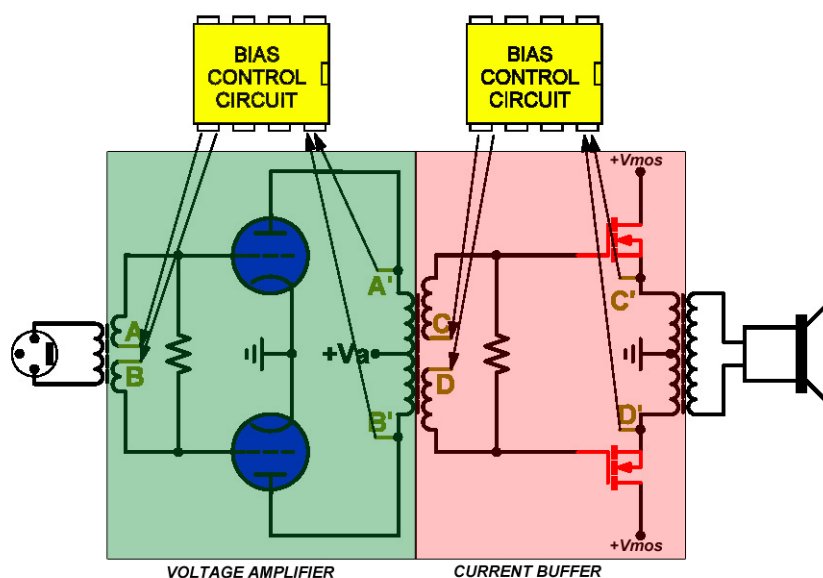


Fig.5: The BIAS Control Units inside the *LaScala Power Amp*

The result is a perfect symmetrical design with a minimal amount of components in the signal path, which minimizes odd order harmonics usually “hurting” our ears during listening.

A minimal number of parts in the signal path:

The *LaScala PowerAmp* is made of two amplification stages only – one for voltage and one for current. Please note that there is NO CAPACITOR and NO FEEDBACK implemented in the complete signal path!

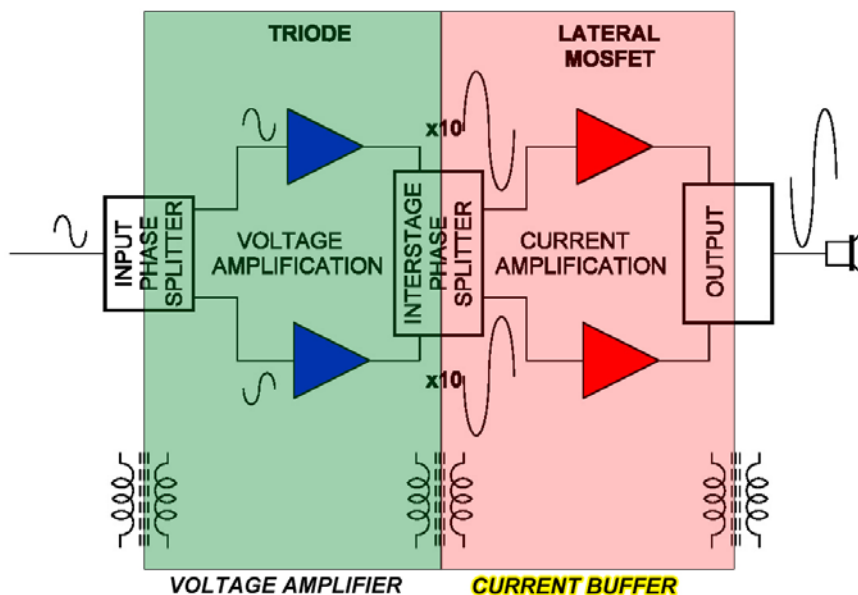


Fig.6: The Transformers inside the *LaScala Power Amp*

The Output Transformers

While standard in most tube amps (beside OTL designs), there are only a few companies worldwide using output transformers, in power amps based on transistor circuits.

Most experienced engineers know the benefits of using these transformers - once skillfully designed and wound – very well. However, to find a manufacturer skilled enough to produce them, with the same level of quality - especially with the high bandwidth needed - is not an easy task. Finally, the cost, weight and size prevent most companies from using such transformers.

The main purpose of the output transformers is their capability to “transform” the output impedance of the power amp to match with the impedance of the connected speakers. In tube amps, the output impedance of the circuit can be several hundred Ohms compared to the 4/8 Ohms of the speakers. In MOSFET based amps, there is still an output impedance of about 30/40 Ohms, which needs to be matched with that of the connected speakers.

Using an output transformer, the power transistors are loaded with a higher impedance than that of the loudspeakers. So, the power transistors work at a HIGHER VOLTAGE, but at a LOWER CURRENT with benefits in terms of distortion. Working at a lower current means less stress for the power supply and, as result of that, the rectifiers generate lower noise.

The output transformer substitutes the capacitor at the output, which is needed in almost all power amplifiers to isolate the power transistors from the loudspeakers.

The benefits for the sound are evident, because the sound energy transferred by a capacitor is less transparent than transferred by a transformer. The phase shift is also an issue to be taken into account and the matter was solved simply by designing the transformers with a bandwidth of a 75KHz $\pm$ 0.5dB minimum bandwidth.

Other well-known implementations based on transformers are the step-up transformers for MC phono cartridges or all-inductors, no-capacitors RIAA preamplifiers like the famous *Vendetta Research* phono stage, designed by John Curl over two decades ago, or tube amplifiers where the output transformer is the key building block.

As result of the impedance matching, based on output transformers, the MOSFETs can work at a higher voltage and a lower current! The less current the circuit draws from the power supply, the less distortions are created by the switching diodes of the bridge rectifier.

Furthermore, the output transformers, in a push-pull design, as that of the *LaScala PowerAmp*, effectively cancel any distortion created in the power supply by the design. This effect reduces the values needed for the filter capacitors in the power supply, which in turn, decreases the current needed for charging those caps, and leads to further reduction of noise created by this process.

Since the primary and the secondary windings of a transformer are not physically connected, no DC voltage can reach the output connectors of the amp. Therefore, a coupling capacitor, usually implemented at this point of the circuit to block DC from the outputs (even though having negative effects on the sound) is NOT necessary inside the *LaScala PowerAmp*!

How to avoid overheating?

Besides the many benefits regarding sound, an amplifier running in pure Class A mode gets very hot! To ensure a long lifespan for the electronics and a stable running amp, is a true challenge for the designer. That is why most Class A amplifiers come with huge heat sinks, which in many cases still get very hot and are unappealing to look at. For the *LaScala PowerAmp* the design goal was to use smarter solutions to reduce the heat from the amp.

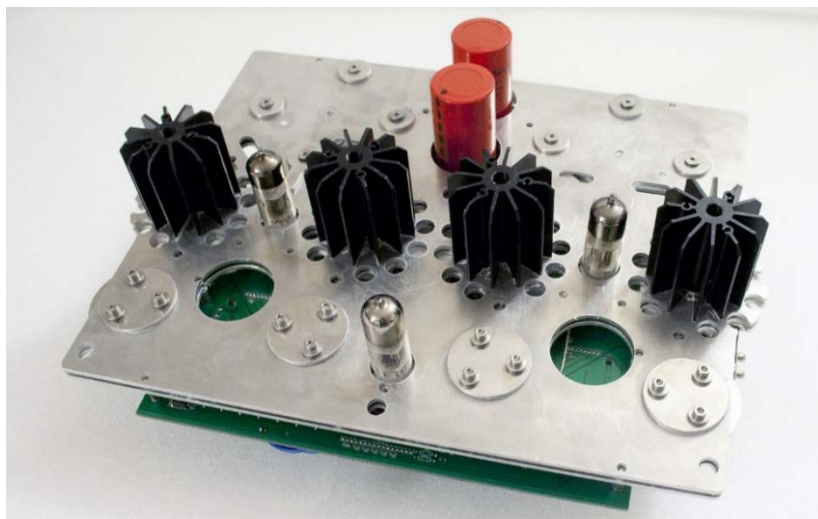


Fig.7: Heat Sinks on Top of the MOSFETs to cool the *LaScala PowerAmp*

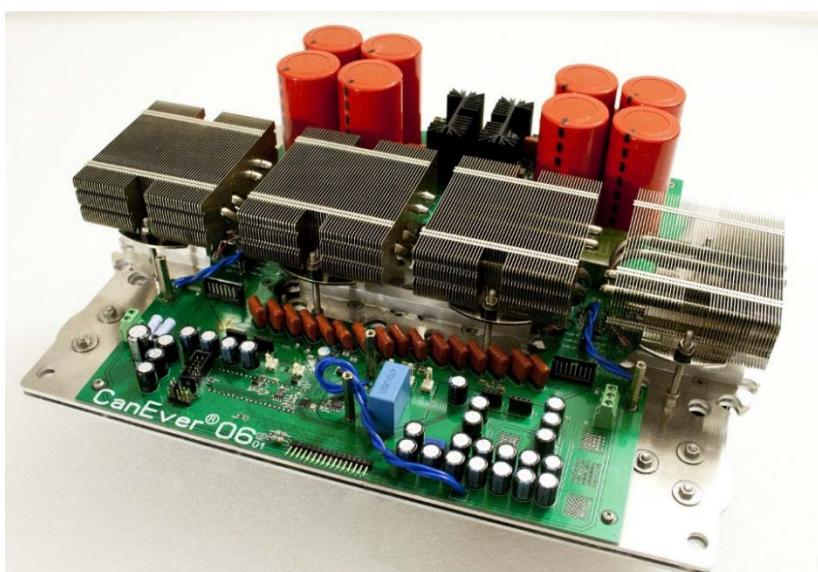


Fig.8: The MOSFETs glued to the Heat Pipes mounted upside down

The pictures above show a row of four heat pipes, including temperature controlled fans mounted from the underside, and four massive heat sinks mounted on top of the MOSFETs. Looking at the *LaScala PowerAmp* from the outside, only the heat sinks on top are visible. The elegant style of the cabinet gives no sign that a massive Class A amp is working “under the hood”!

Following below are two pictures showing one of four heat pipes, which cool each of power MOSFETs. The first picture shows the top side of the heat pipe showing the area where the MOSFET is glued to.

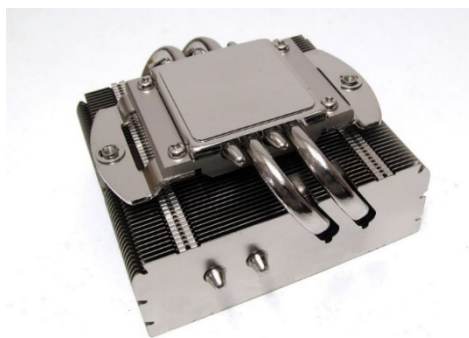


Fig.9: Top Side of the Heat Pipes

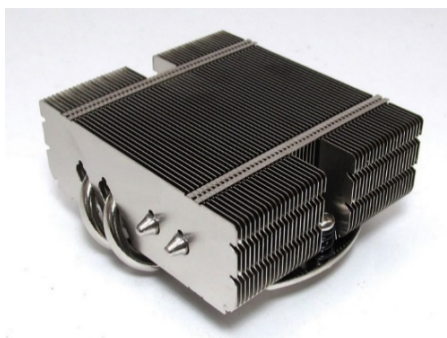


Fig.10: Bottom Side of the Heat Pipes

The second picture shows the bottom side of the heat pipe with its many narrow fins for effective heat dissipation.

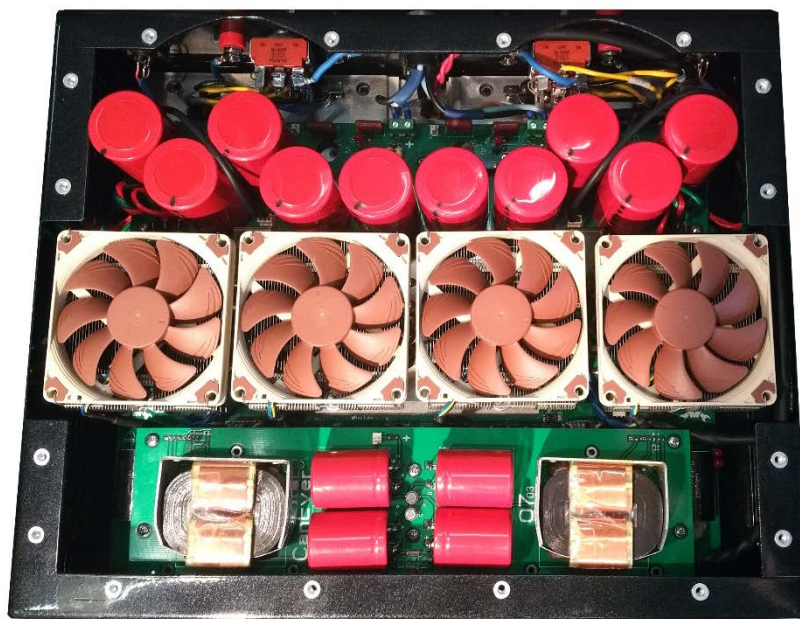


Fig.11: The low Speed Fans for the Air Circulation only

The amplifier can work also with the fans powered off by setting the related parameter at the menu. The fans let only the air moves around the heatsinks. It increases the chimney effect.

With fans powered off the *LaScala PowerAmp* works at 10°C higher temperature with a reservoir left of 35°C.

Conclusion

With the *LaScala PowerAmp*, *CanEVER Audio* has once again proven its skills in offering extremely innovative products to the world of high-end audio. Thanks to the ability to combine well-known and proven engineering concepts with innovative ideas, *CanEVER Audio* has been able to create a product with amazing sound quality, which is able to compete with the best amps on the market today.

For further information, please visit our website www.canever.eu or send us an e-mail, addressed to: sales@canever.eu

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[Current driving - The transconductance amplifier](#) - Measurements.

Pictures Gallery

The *LaScala* power amplifier – FRONT viewThe *LaScala* power amplifier – REAR view



The *LaScala* power supply – FRONT view



The *LaScala* power supply – REAR view



The *LaScala* interconnection cables



The *LaScala* – system view