CanEVER AUDIO®

CanEVER Audio® Olimpico PowerAmp

Detailed Technical Description

or

How to design the “perfect” Amplifier

Index

1. Introduction & Basic Design Information

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*

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 *Olimpico PowerAmp* in two Cabinets - Power Supply & Amplifier

The *CanEVER Audio Olimpico PowerAmp* is one of the few audio amplifier designs, that follows the most important and updated results in audio amplifiers research. 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 Olimpico PowerAmp* is a TRIODE VOLTAGE AMPLIFIER followed by a MOSFET CURRENT STAGE!

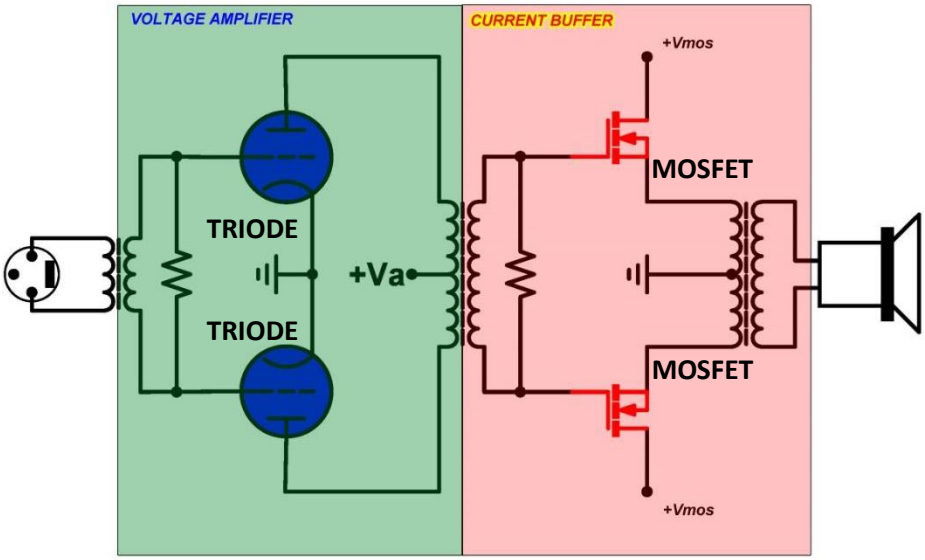


Fig.3: The basic Circuit of the *Olimpico PowerAmp* (one channel)

Why is this important?

The triode voltage amplifier is responsible for the voltage swing and the damping of the signal at the output. Since the MOSFET current buffer is responsible for the interaction with the loudspeaker impedance, the loudspeaker doesn't load directly the triode stage. Thus, the triode stage is loaded with the very high impedance of the MOSFET buffer, preserving the sound quality in its entirety.

To design the "perfect" amplifier, it is important to understand how the load connected to the amp works. The load of an audio amplifier is a loudspeaker. Each driver inside a loudspeaker follows the laws of physics – not some "creative ideas". These laws of physics "instruct" any type of speaker / driver to act directly proportional to the CURRENT of the applied input signal, or, as a complex function of the VOLTAGE of the applied input signal. The CURRENT mode is the natural working way because it is proportional, intrinsically linear.

How does this affect the sound of my loudspeaker?

It is of paramount importance to understand that a loudspeaker does NOT represent a pure resistive load to the connected amplifier but it is In fact a complex load called IMPEDANCE. This impedance is dramatically irregular, with maximum and minimum amplitude (ohms) along the band of frequencies that the loudspeaker is radiating.

Once the VOLTAGE output of an audio amplifier is proportional to the input signal, coming from the various audio sources in an audio system, the VOLTAGE has to be "converted" into CURRENT in order to drive the speaker. A classic VOLTAGE amplifier uses the IMPEDANCE of the loudspeaker to do this. But the IMPEDANCE CURVE (impedance vs. frequency) of the loudspeaker strongly influences this "conversion". 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 way out!

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 that 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 Olimpico 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 way to go.

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

2. The Power Supply

The *Olimpico PowerAmp* is the "brother" of the *LaScala Power Amp*, the award winning and top amp in the *CanEVER Audio* product line.

The power supply is the heart of any power amplifier. To reach the high demand of power instead of a classic linear power supply like implemented in the *LaScala Power Amp* , the *OLIMPICO Power Amp* uses an advanced high frequency switching power supply technology, specially tailored for audio use.

Fig.4: The Power Supply of the *Olimpico PowerAmp*

Usually the 'high frequency' power supplies are powerful, light, fast, efficient but not directly suitable for audio use, because they are designed for standard industry use.

The work of CanEVER Audio is based on years of experience designing switching power supplies and as a final result, it came up with a hybrid solution: A switcher working at high frequency (instead of basic diodes bridge working at 100/120 Hz) followed by a filtering section that is almost identical to that of the *LaScala Power Amp*.

This innovative approach merges the benefits of a linear power supply that is clean, smooth and lacking any residual or radiated noise, with those of a fast, light, powerful, compact, precise, stable and protected switching power supply.

The whole switcher is shielded in a 2 mm thick solid aluminum container also used as heatsink.

All electric parts of the switcher are sealed in an aluminum container, which then is drowned into anti vibration resin. This would in theory allow the unit to work even under water.

Fig.5: The switcher at the base of the *Olimpico Power Supply*

The switcher is preceded by a sophisticated mains input filter, with a CLC topology that isolates and cleans all the potential electric noise coming from the power line and, not less important, any emission of the switcher itself - if there are any.

In the next step of the design, the switcher is followed by the same active CLC filter designed for the *LaScala* power supply, including a capacitor bank of 470.000uF.

The switcher complies all the emission standards, including the European Electromagnetic standards, actually the most rigorous in the world.

The switcher works at 50.000 Hz, which is 1.000 times higher than the 50Hz, the mains frequency. This is the key point that allows all transformers and inductors used to become 1/10 of the standard size.

The mains filter, the switcher (essentially the aluminum brick in fig. 5), and the output filter section are enclosed in a still container (the black in fig. 5) to increase the whole noise isolation.

Fig.6: The *Olimpico Power Supply*

To ***power on*** the unit there are 2 switches:

1) the red mains switch at the back of the power supply puts the power supply in STANDBY mode. Once the power supply is in STANDBY a LED lights-up at the front.
2) A second switch is located at the front of the amplifier unit to finally power on the unit. In this case, the second LED at the front of the power supply unit lights-up.

There is also a microswitch at the back of the power supply to control an additional EMI (Electro Magnetic Interference) filter. It drains the common mode noise from the main power line (*if any*).

As standard the switch should be left in the downward position.

If troubles are experienced with a Residual Current Device (RCDs) of the mains system, this switch should be flipped upwards.

Fig.7: Some RCDs. Note: The T(est) button is always present.

An RCD controls the differential current between the 2 wires of the mains system (110Vac or 230Vac).

It is usually set at 0,03A (30mA) max. of difference between the neutral and live wire.

Due to the EMI filter's action, when there are one or more items already connected to the mains system - creating a dispersion to earth lower, but close, to 30 mA - plugging in the *Olimpico PowerAmp* might cause the RCD to switch off the power line. This might happen even when only a few mA are drawn by the EMI filter.

By flipping the microswitch upwards, the EMI filter gets disconnected and nothing is drowned toward earth by the Power Amp.

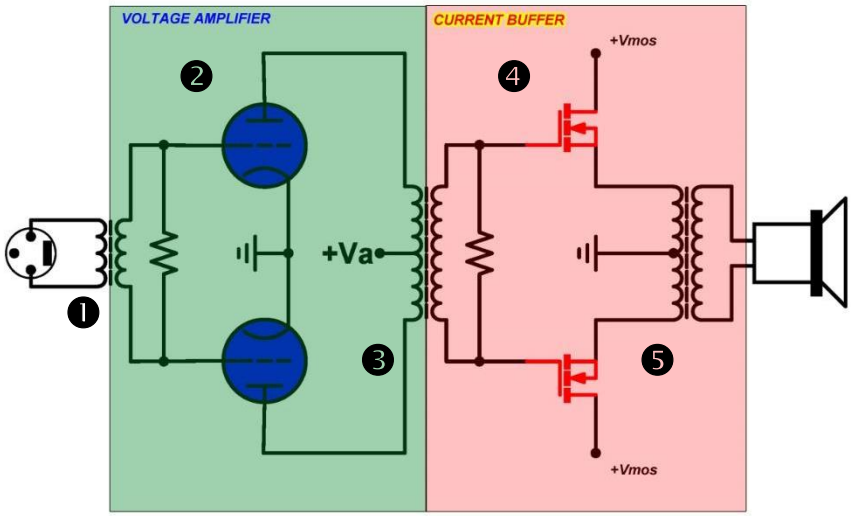
The best solution is a dedicated power line from the main switch of the house, leaving the EMI microswitch ON. Contact an authorized technicians once a service of the mains system of the house is needed.

The *Olimpico Power Supply* can source up to 550Wrms, in continuous mode.

The weight is "only" 7.4Kg against the 32Kg of the *LaScala* power supply.

3. Design Principles

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.



❶ Input Trafo (Phase Splitter) + ❷ Voltage Amp (Triode / Push-Pull) + ❸ Interstage Trafo + ❹ Current Buffer (MOSFET / Push-Pull) + ❺ Output Trafo

Fig.9: *Olimpico PowerAmp* (one channel) – no capacitors on the signal path!

Directly connected to the XLR input connectors for each channel, you can find a first transformer ① working as a phase splitter to create the two "branches" of the signal feeding the voltage stage of the amplifier ②. This stage consists of one double triode 6N6P only. As this first stage is working as a voltage amplifier, the following stage ③ is doing the current amplification.

In order to avoid the complications of the classic configuration of power stages amplifying both the current and the voltage at the same time, the output stage of the *Olimpico PowerAmp* uses two state-of-the-art lateral MOSFETs to amplify the current only.

Another aspect of using this approach is a simplified interface for the tube voltage stage ②.

The lateral MOSFETs are of high linearity thru out the complete audio band.

4. The Interstage Transformer

The interstage transformer ③ separates the voltage driver stage from the current output stage ④. 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 current 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 a pair of impossible-to-perfectly-match N-type and P-type transistors are in use. A perfect match is impossible because the N-type and P-type are different in their semiconductor structure.

Because of the configuration of the MOSFETs, the interstage transformer has only to transfer a voltage signal and no current. The result is a dynamic, transparent and natural sound.

The bandwidth of the interstage transformer is 75KHz ±1dB at 5Wrms.

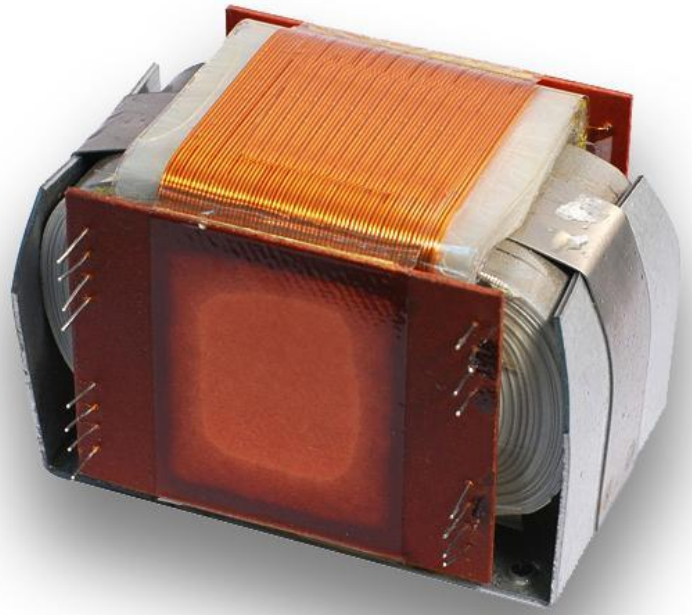


Fig. 10: The custom interstage transformer

Why is the 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 … distortions that are very well known to all the lovers of single ended amplifiers.

Since the interstage transformer inside the *CanEVER Olimpico 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.

Moreover, the lateral MOSFET does not need any kind of feedback for the thermal stabilization because they are intrinsically stable!

5. Pure Class A Mode

As all stages inside the *CanEVER Olimpico PowerAmp* 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 elements are different. The BIAS for all stages is fixed without feedback. The individual BIAS is independent from the power generated and from the impedance of the connected loudspeakers!

6. Minimal number of Parts in the Signal Path

The *Olimpico PowerAmp* consists of two amplification stages only – ② for voltage and ④ for current. Please note that there is NO CAPACITOR and NO FEEDBACK implemented in the complete signal path!

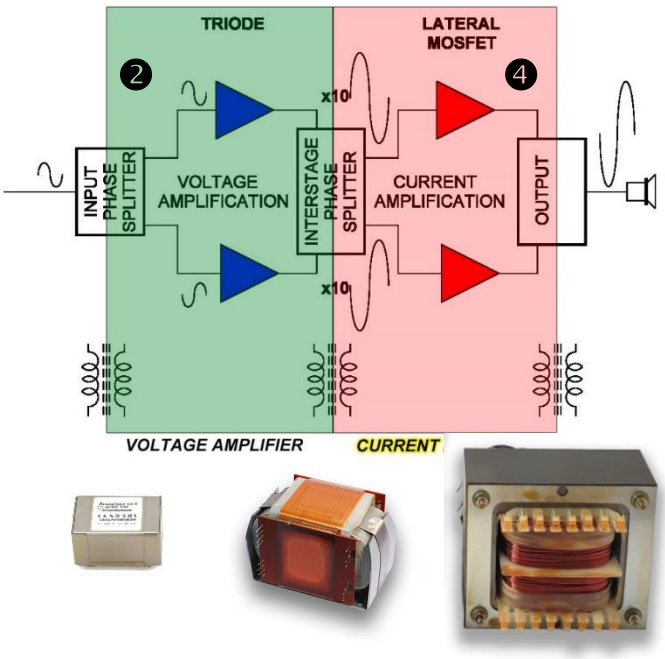


Fig.11: Different types of transformers inside the *Olimpico PowerAmp*

7. The Output Transformers

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

Most experienced engineers are very well aware of the benefits of using these transformers, once skillfully designed and wounded. However, finding a manufacturer who is skilled enough to produce them with a high quality, especially with the high bandwidth needed, is not an easy task. Last but not least, 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 a result, the rectifiers generate lower noise.

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 *Olimpico PowerAmp*!

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

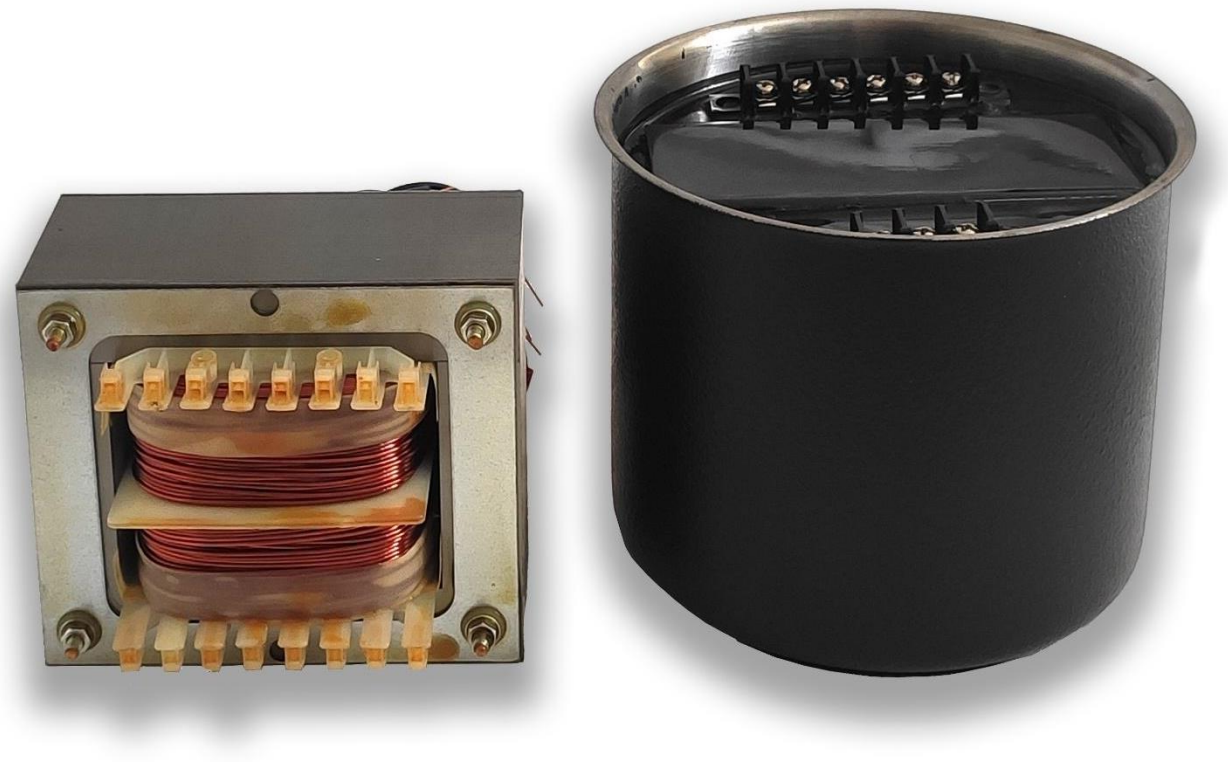


Fig. 12: Custom wound output transformer, (bare and potted)

The absence of the output capacitor introduces benefits in terms of sound quality, because the sound energy transferred by a capacitor is less transparent than that transferred by a transformer.

With the transformers the phase shift of the audio signal is also an issue to be taken into account, and the matter is solved by designing the power transformers with a 75KHz ±0.5dB minimum bandwidth.

As a 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 at the bridge rectifier.

Furthermore, in a push-pull design, as that of the *Olimpico PowerAmp*, the output transformers effectively cancel any distortion that the design creates in the power supply. 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.

The bandwidth of the output transformer is 100KHz.

Other well-known and well accepted implementations based on transformers are:

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

8. How to avoid overheating?

Though an amplifier running in Pure Class A mode grants many benefits regarding sound, it can get very hot!

Ensuring a long lifespan for the electronics and a stable running amp, is a true challenge for the designer, and that is why most Class A amplifiers come with huge heatsinks, that often overheat, and have an unappealing look.

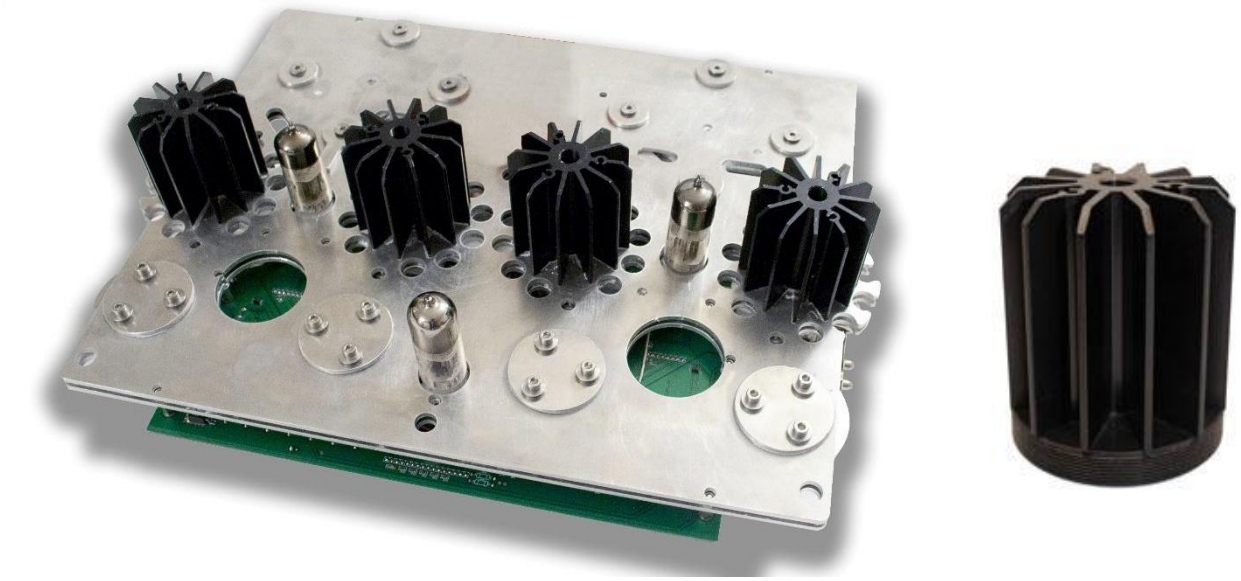


Fig.13: Heatsinks on top of the MOSFETs to cool the *Olimpico PowerAmp*

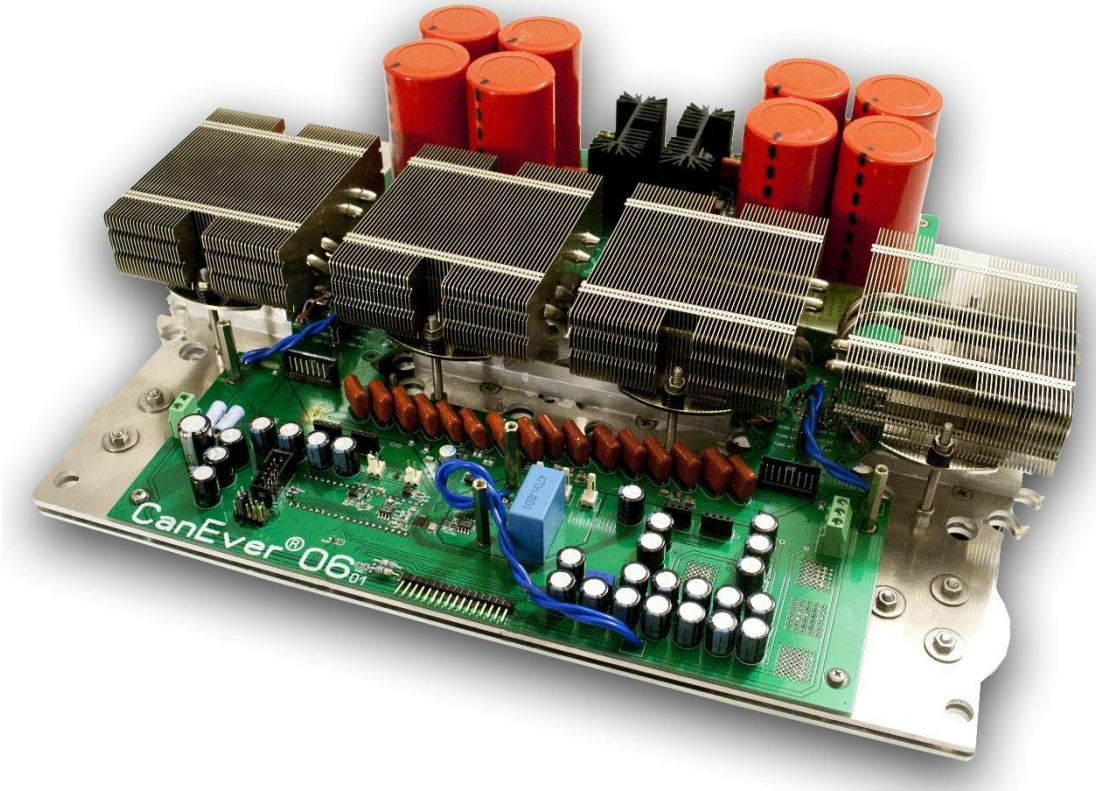


Fig.14: The MOSFETs glued to the heat pipes mounted upside down

The pictures above show a row of four heat pipes, including temperature-controlled fans mounted from underneath, and four massive heatsinks mounted on top of the MOSFETs. Looking at the *Olimpico PowerAmp* from the outside, only the heatsinks on top are visible. The elegant style of the cabinet gives no indication that there is a massive Class A amp working "under the hood"!

Following below are two pictures showing one of four heat pipes, which cool each of the power MOSFETs.

The picture in the middle shows the heat pipe and the area where the MOSFET is glued to.

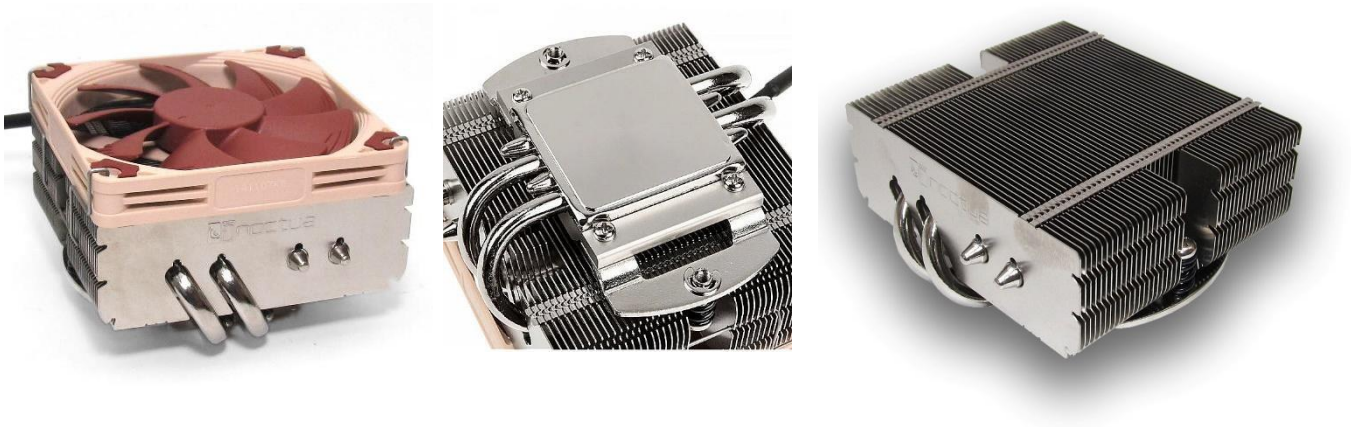


Fig.15: The heat pipes

The many narrow fins grant a very effective heat dissipation.

Fig. 16: Low-speed fans for the air circulation inside

The amplifier can work also with the fans powered off by setting the related parameter on the menu. The fans let only the air move around the heatsinks. It increases the so-called chimney effect.

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

9. Conclusions

With the *Olimpico 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 available 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

10. Bibliography:

Distortion reduction in moving-coil loudspeaker systems using current-drive technology, P. G. Mills, M. J. Hawksford, Journal of Audio Engineering Society 37 (3) (1989) pag. 129–148.

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Comparison Between Voltage and Current Driving Methods of a Micro-Speaker, Eric Sturtzer, G Pillonnet, G Lemarquand, N Abouch, Applied Acoustics, Elsevier - Volume 73, Issue 11, November 2012, Pages 1087-1098.

Current-Driving of Loudspeakers by Esa Meriläinen - Eliminating Major Distortion and Interference Effects by the Physically Correct Operation Method - Ed. Createspace, ISBN 1450544002, 2010.

Linear Audio by Jan Didden - Volume 12, pag. 183 - Book Review - Current-Driving of Loudspeakers by Hans Polak.

Current driving - The transconductance amplifier - Measurements.

11. Specifications

Tubes	Driver 2x 6N6P (6H6n/6H6pi) matched pair Shunt Regulator 1x 6N30P (6H30n/6H30pi)
MOSFET	2x N-Channel Lateral MOSFET ECW20N20 matched pair
Power	75 Wrms / 120 Wpeak (Optional bridge configuration delivering 150Wrms / 240Wpeak) Idle Power 600Wrms
Gain	7 dB (optional 14 dB) 2.45 Vrms input voltage needed for the maximum power output
Bandwidth	75KHz -2dB
Input resistance	55 kOhm
Damping factor	> 1000
Amplifier size	41.5(W)x35(D)x24(H) cm
Amplifier weight	28.6kg
Power Supply size	20(W)x31(D)x15(H) cm
Power Supply weight	7.4 kg
Shipping weight	52Kg – wooden box 63x54x47cm
Cables length	158 cm (connectors included)
Cables weigh	0.8 kg

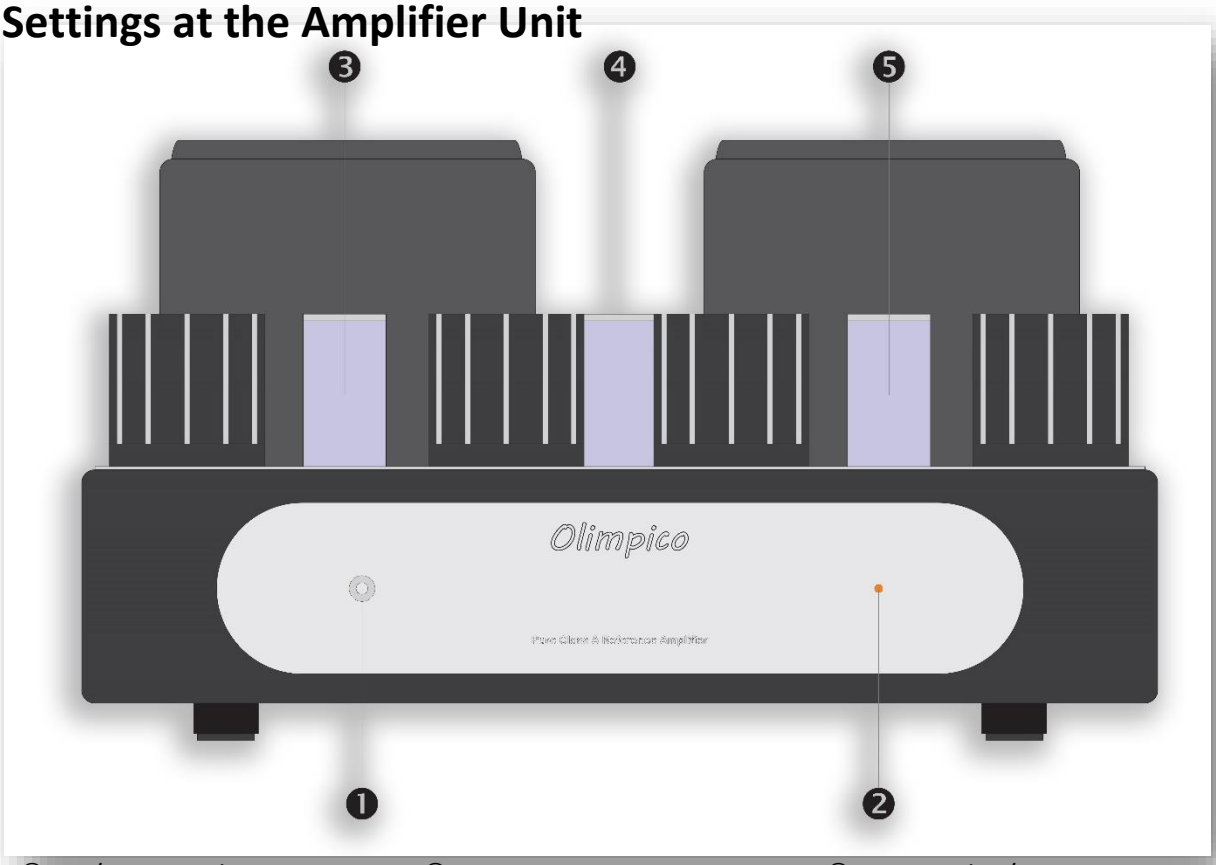
Description:

Stereo power amplifier operating in pure class-A mode.
Only 2 Triodes and 2 MOSFETs per channel for voltage and current amplification.
No feedback (no temperature feedback & no global feedback)
No capacitor in the signal path.

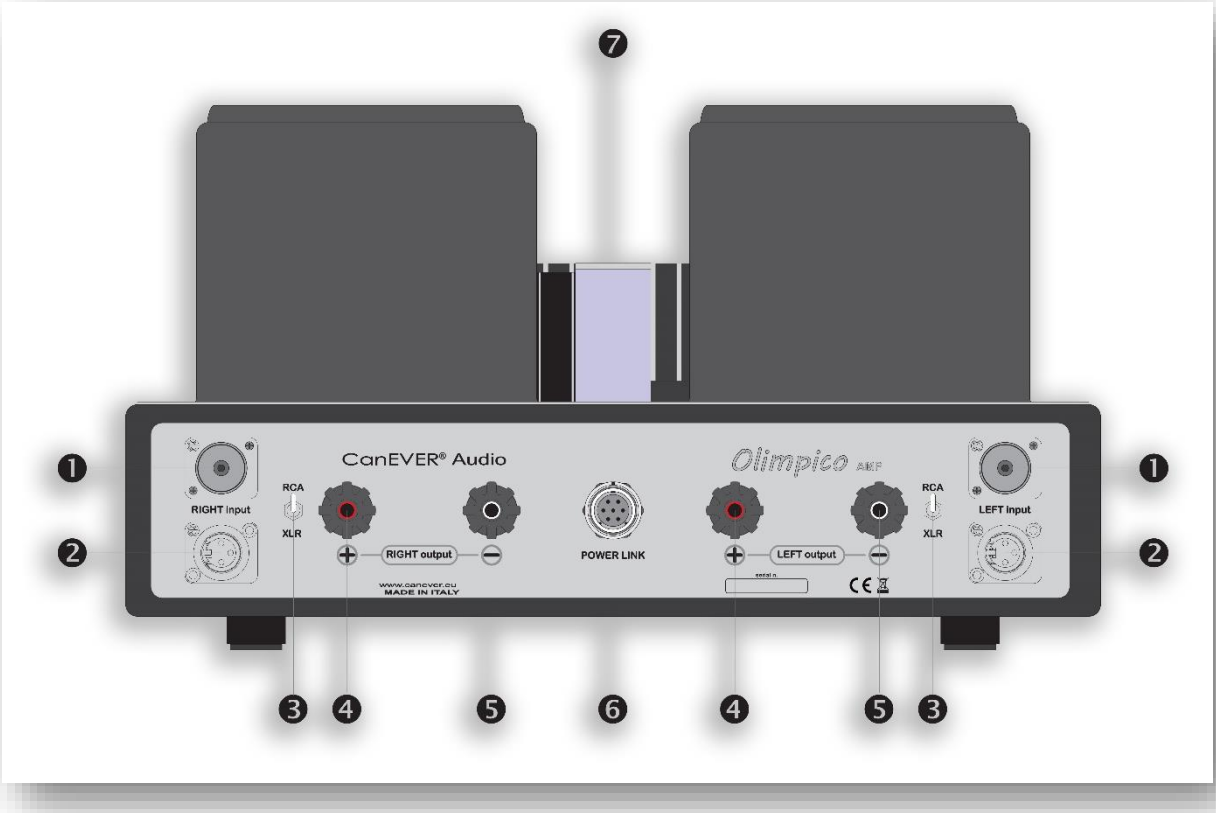
Inputs: balanced XLR and unbalanced RCA selectable at the back.
Outputs: WBT Cu NextGen 3-way binding posts.

Warranty: 3 years, limited, transferable.

12. Settings at the Amplifier Unit

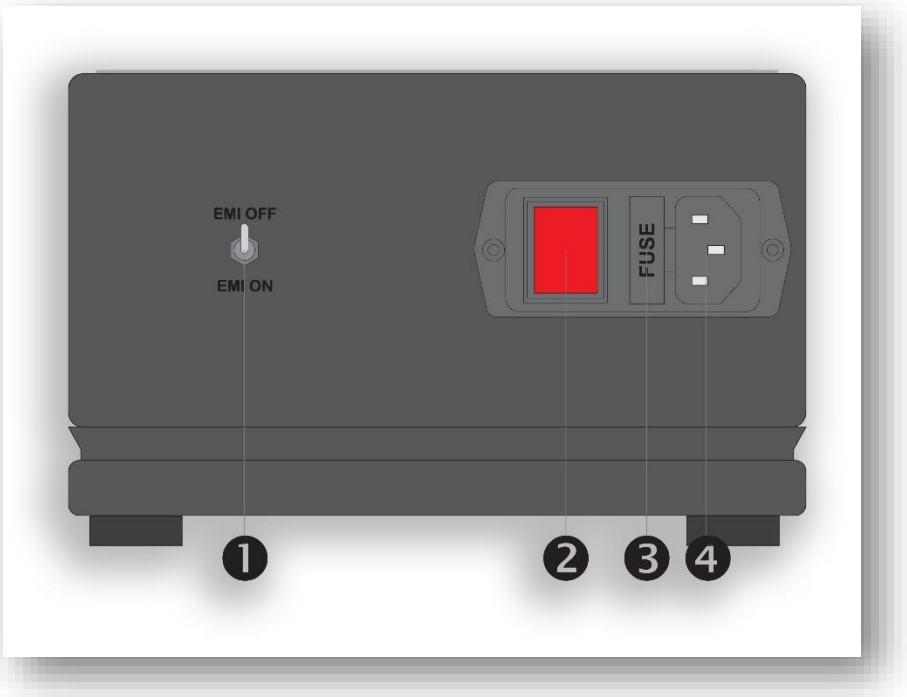


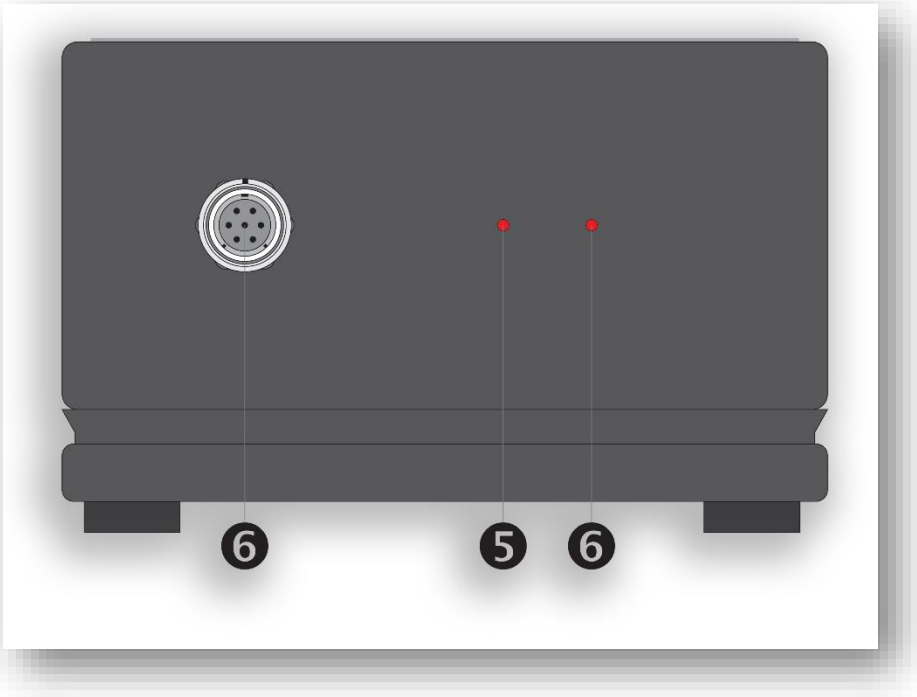
① ON/OFF Switch ② Monitor LED ③ Driver Tube / 6N6P
④ Shunt Regulator Tube/6N30P ⑤ Driver Tube / 6N6P



① RCA Unbalanced Input ② XLR Balanced Input ③ Input Selector Switch (RCA/XLR)
④ (+) Speaker Binding Post ⑤ (**-**) Speaker Binding Post ⑥ Connection to Power Supply
⑦ Shunt Regulator Tube/6N30P

13. Settings at the Power Supply Unit





① EMI Filter Switch

② Main Power Switch

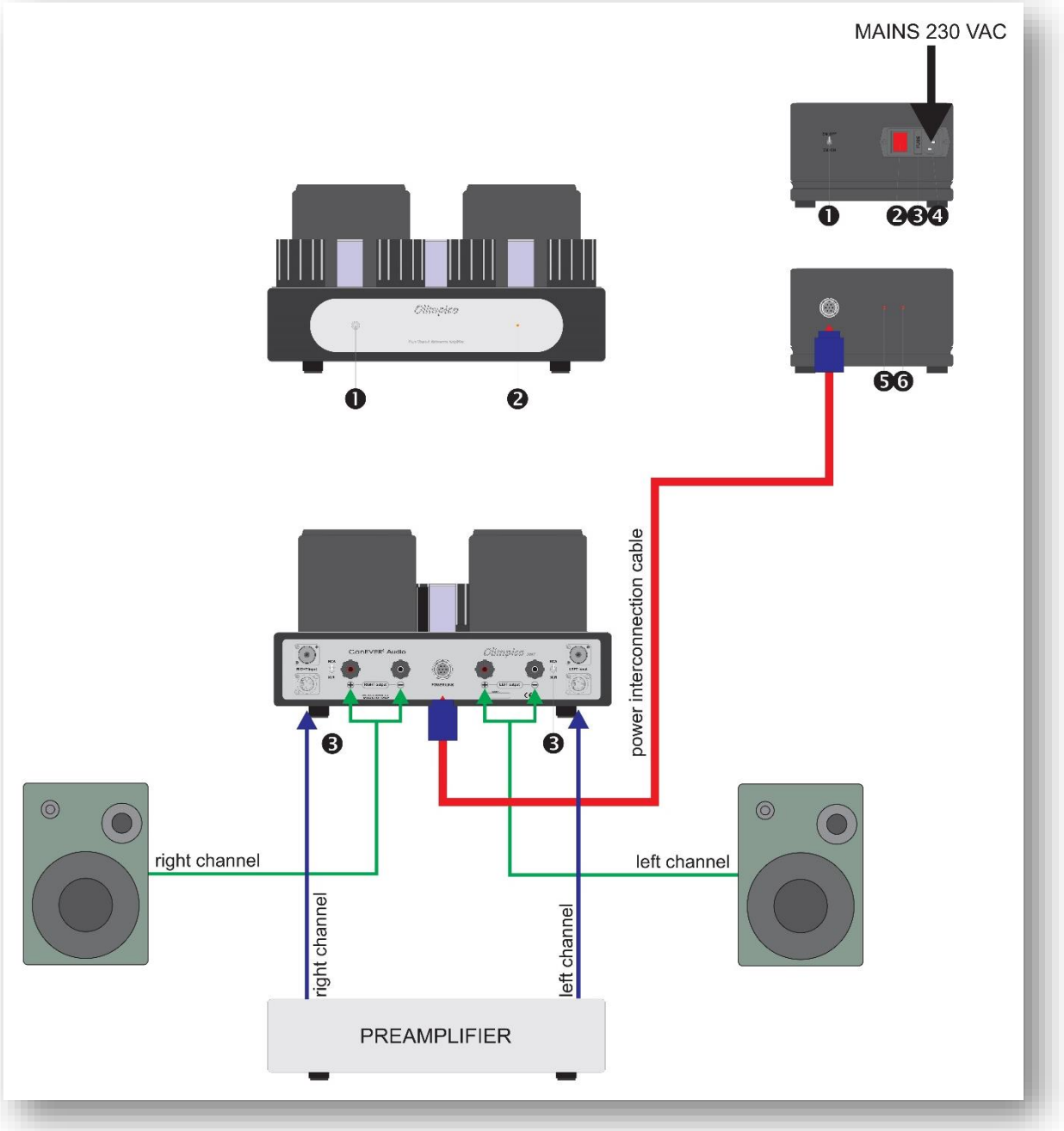
③ Main Fuse – 10A 230Vac

④ IEC Socket– 230V/AC

⑤ Standby LED

⑥ Power ON LED

14. Set-Up Instructions



1) Connect the amplifier unit to the power supply unit by the **RED cable** coming with the units.
2) Connect the speaker cables to the WBT Cu NextGen 3-way binding posts.
3) Connect the PREAMPLIFIER by the unbalanced RCA INPUTS or by the balanced XLR INPUTS.
   Flip the switches ③ at the *Olimpico PowerAmp*, **up** if the connection is unbalanced, or **down** if balanced. If the switches are not properly set a hum is present at the loudspeakers.
4) Press the MAINS SWITCH ② positioned at the rear side of the power supply.
   The backlight light inside the power switch lights up and the power supply no is in STANDBY.
   The LED ⑤ at the power supply lights up as well.
5) To POWER ON the amplifier unit press the knob ① at its front panel.
   The *Olimpico PowerAmp* powers-on only if the power supply is already in STANDBY.
   When the amplifier unit is ON. the second LED ⑥ at the Power Supply lights up as well.
6) Inside the power supply is an extra EMI FILTER.
   This filter is in use, when the related switch ① at the back of the power supply is flipped DOWN.
   If problems are experienced with the RCD switches installed in the mains of the building, please read pages 8 and 9 in the chapter “The Power Supply” of the technical description.

15. Picture Gallery

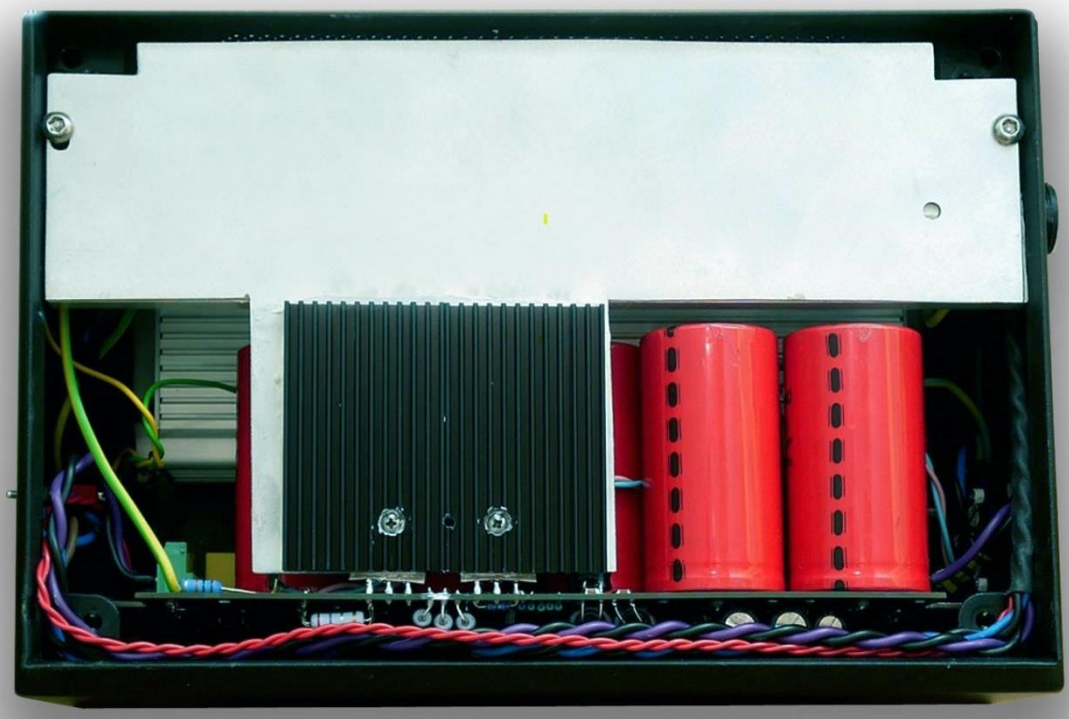
Amplifier Unit – Front View

Amplifier Unit – Rear View

Power Supply Unit – Main View

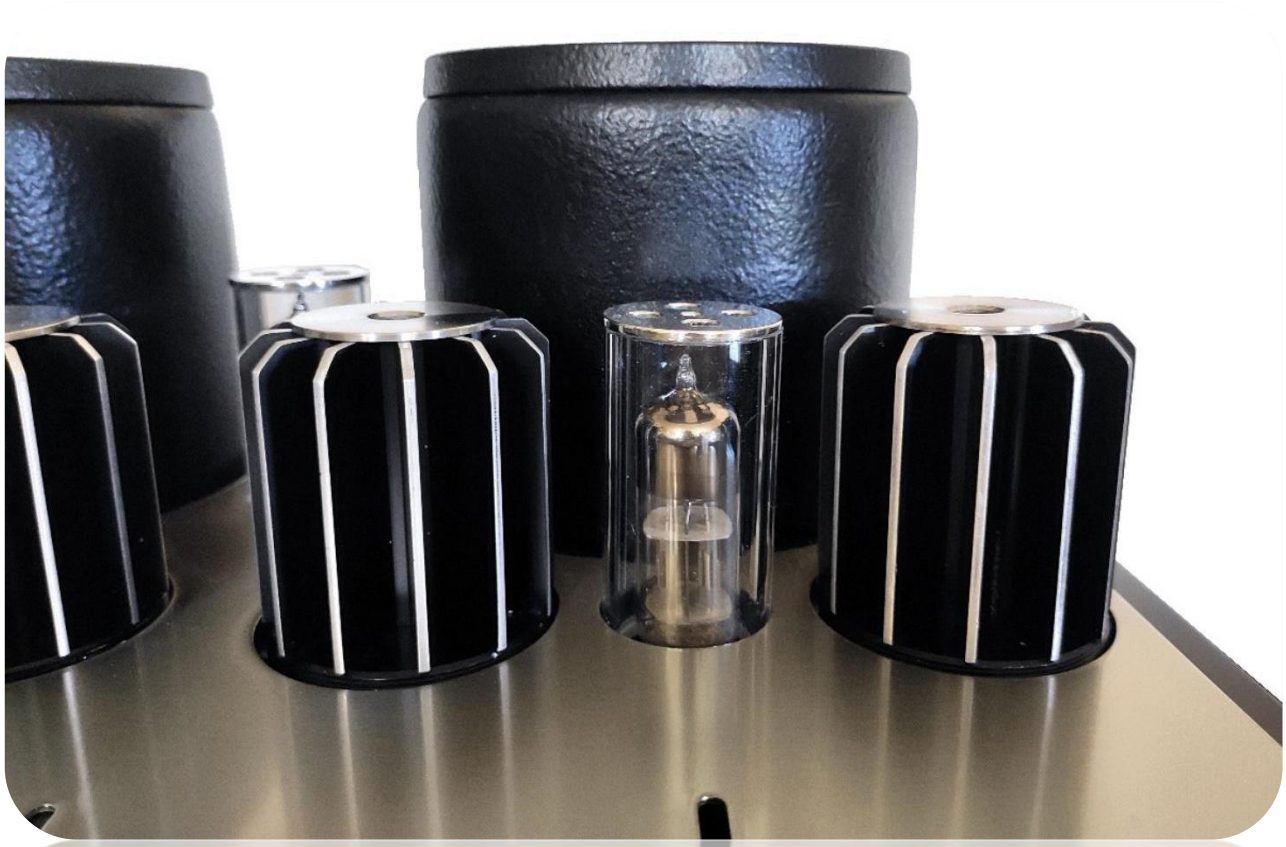
Power Supply Unit – Side View

Power Supply Unit – Rear View



Power Supply Unit – Internal View

Cable to connect Power Supply and Amplifier



The triode driver stage (one channel) in between the heatsinks

The driver stages in between the heatsinks
The shunt regulator for the high voltage power supply in between the output transformers

The *Olimpico* Power Amp – System View