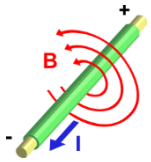
ELTIM high-end POWER AMPLIFIER modules

NEW PRELIMINARY October 31th, 2021

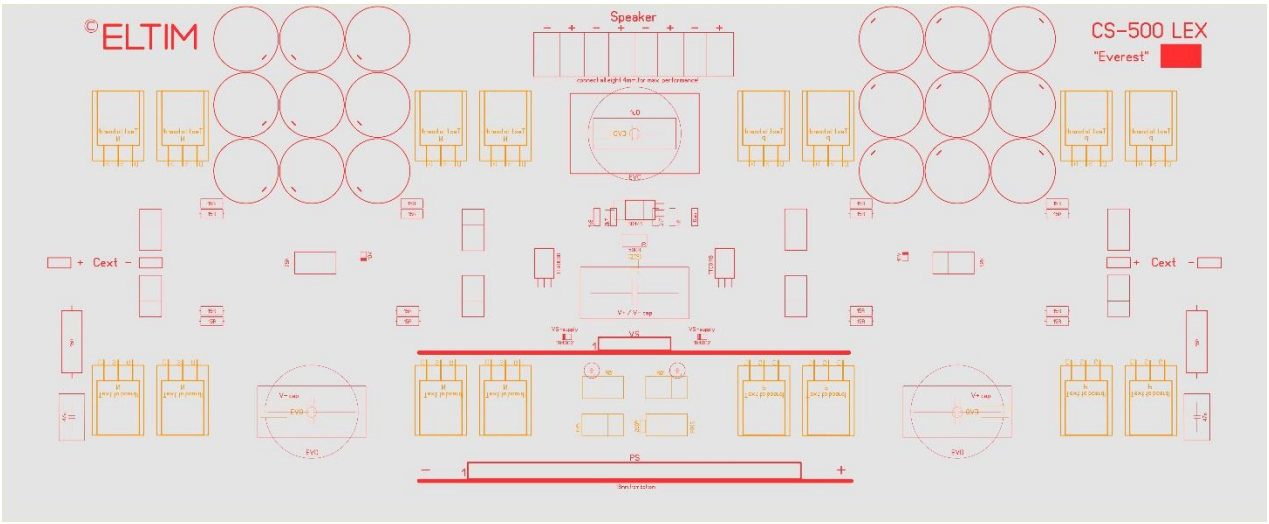
CS-500 Current Stage module

Due to our completely different way of thinking when it comes to PCB design and layout, mechanical and thermal stress, magnetic interference, EMI, etc., an ELTIM High-End amplifier built with these modules looks and acts a bit different compared to other amplifier designs, which is confirmed by customers. According to them they make *MUSIC*, not just power **! And that for a (very) long period of time due to the stress-free setup and high-quality components. All are oversized quality parts and PCB tracks and stays below 40ºC most of the time. Instead of trying to obtain the lowest possible price we set our goal for best musicality instead.**

To make a true difference, we split our power amplifier schematics in a voltage- and a current stage board to obtain the maximum possible sound quality. Now both parts of the power amplifier can be designed in an optimal way: the VS-board with small tracks, leading low energy signals and containing heat sensitive parts, and the CS-board leading large high currents and high temperature parts where this board has large tracks which also act a bit as thermal vents for several parts. The VS- and CS-tracks are in a 90º angle, preventing magnetic interference between VS- and CS-tracks and parts. This means that a working ELTIM power amplifier is always based on these two (VS + CS) modules. This cooperation works very well indeed as many indicated as a “tube like” sound, yet with extras like an unbeaten speaker control as noted in f.e. a very “tight” bass.



The size of the huge PCB only fits MODU Dissipante cabinets 210mm high, 500mm deep……
While using a large PCB’s all tracks could be made well oversized, so the limiting factor of this setup will be the thermal dissipation factor, still slightly lower than 4 pairs of 16A EXICON Mosfets could produce.
While using four pairs of large TO-247 or even TO-263 sized power Fets, this CS-500 is very stable and can deliver way enough power for any purpose and more important, together with our totally different PCB setup, they have way better control over your speaker system compared to most other amplifier designs as noticed immediately after powering them up. We only use very high quality materials lasting for 20 years and heat conducting/resistant, double sided FR4+ European made PCB’s, double sided (*2x70um*, where 1x 18um is usual !), gold plated solder isles, text on both sides, etc.



CS-500 layout with eight pairs of EXICON Mosfets at the back side, positioned in a way that there is a maximum heat transfer to the immense heatsinks of a MODU Dissipante 435x500x210mm cabinet where it actually just fits.

With this amp you could take the full 16A from the power grid.

This amplifier only exists on paper so far!

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The most massive PCB structure shows the supply-, ground- and speaker tracks in an unbeaten width.
About 92% of all (dual layer) copper surface is used for ground-, supply-, and speaker tracks.
Combining this most powerful output stage with our cost effective and compact PS-2 or PS-3 module will do for pure home-based listening. For really high-power purposes we strongly recommend having them assisted with extra chassis mounted capacitors, which can be connected directly to this CS-500.
We like to refer to our special document where we explain all the details we implemented in our designs.

This **CS-500** power (current) stage PCB highlights:

- Extremely large sized version with high power capabilities.
- 50-1100Wrms with eight pairs of 8A Mosfets, 100-1800Wrms with 16A types.
- Matches 2x MODU 250 x 210mm heatsinks.
- Only fits in MODU 5U (210mm) Dissipante cabinets with depth 500mm……. (or equivalent).
- Positions for eight pairs of GSD (mostly Mosfets) types, TO-247 (8A) or TO-263 (16A). We use EXICON.
- Power Mosfets located in the heart of the heat sink for optimal dissipation rate.
- Large, extremely high quality MKP capacitors in the idle current network and over the supply rails.
- Current driven feedback resistors in the centre of PCB (VISHAY WSHP2818, Bourns PWR163 or CADDOCK MP725).
- Current sensing series resistors, thick film types (VISHAY WSHP2818, Bourns PWR163 or CADDOCK MP725).
- All these (relatively very expensive) resistors are cooled by the PCB surface with venting holes.
- Current sensing lines lead to the bottom and side connectors for protection purposes.
- 2x9 locations for Ø25mm electrolytic capacitors (f.e. MUNDORF MLGO 1500uF/100V) for more “punch”.
- MUNDORF Speaker output screw connectors at centre top. Connect all 8 wires to relief these connectors!
- The absence of a coil in the output line results in way better impulse behaviour. Not needed here!
- Separate Current stage (CS) and Voltage stage (VS) voltage rails.
- Separate tracks for Power-, speaker-, feedback-, VS-stage and input ground.
- All grounds are separately leading to the centre area of the bottom connector.
- Very wide and thick (70um) speaker-, ground- and power rails tracks.
- Milled, gold plated beryllium copper headers, with multiple pin (26x 3A for supply) connections. Way higher quality than the regular (mostly 1A) headers.

- Speaker signal for signalling/protection purposes at all connectors.
- VS-xx input signal also leads to bottom connector for protection purposes.
- PCB position to mount an NTC/PTC at centre, connected to both horizontal connectors. Will be connected to a Protection module if mounted. It measures heatsink temperature.
- Frequency range limited by us to 4 (or DC) to >450.000Hz
- Unbeaten high Slew Rate >60V/us. (Note: extreme high-quality op-amps are 20V/us)
- Microphonic free mounted to a heat sink, which is electrically separated from the PCB.
- Dimensions: 490x200x12mm. Height depending on the assisting electrolytic capacitor types.

P i c t u r e some day -)

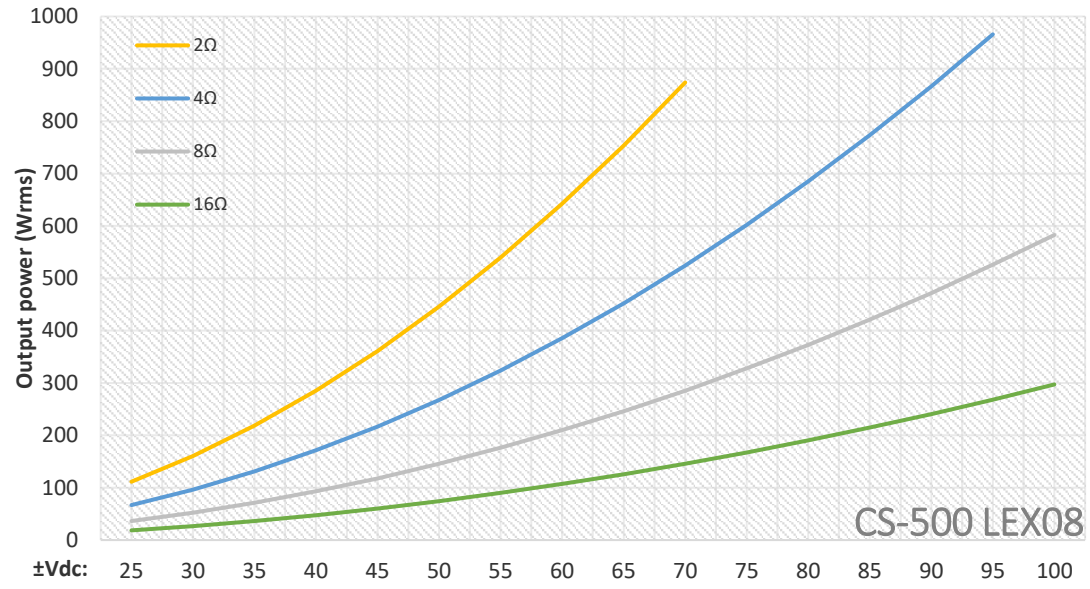
We also developed several similar types of Current Stage modules:

- CS-75, with one pair of Mosfets, fitting a standard 200x75mm heatsink and about all MODU 80mm high cabinets.
- CS-100, with two pairs of Mosfets, fitting a standard 200x100mm heatsink and about all MODU 120mm high cabinets.
- CS-150, with three pairs of Mosfets, fitting a standard 200x150mm heatsink and about all MODU 165mm high cabinets.
- CS-200, with four pairs of Mosfets, fitting a standard 200x200mm heatsink and MODU Dissipante 210mm high cabinets.
- CS-250, with four pairs of Mosfets, fitting a (MODU) 250x200mm heatsink and MODU Dissipante 210mm high cabinets.
- CS-300, with four pairs of Mosfets, fitting a (MODU) 300x20mm heatsink and MODU Dissipante 435x300x210mm cabinets.
- CS-400, with four pairs of Mosfets, fitting a (MODU) 2x 200x200mm heatsink and MODU Dissipante 435x400x210mm cabinets.

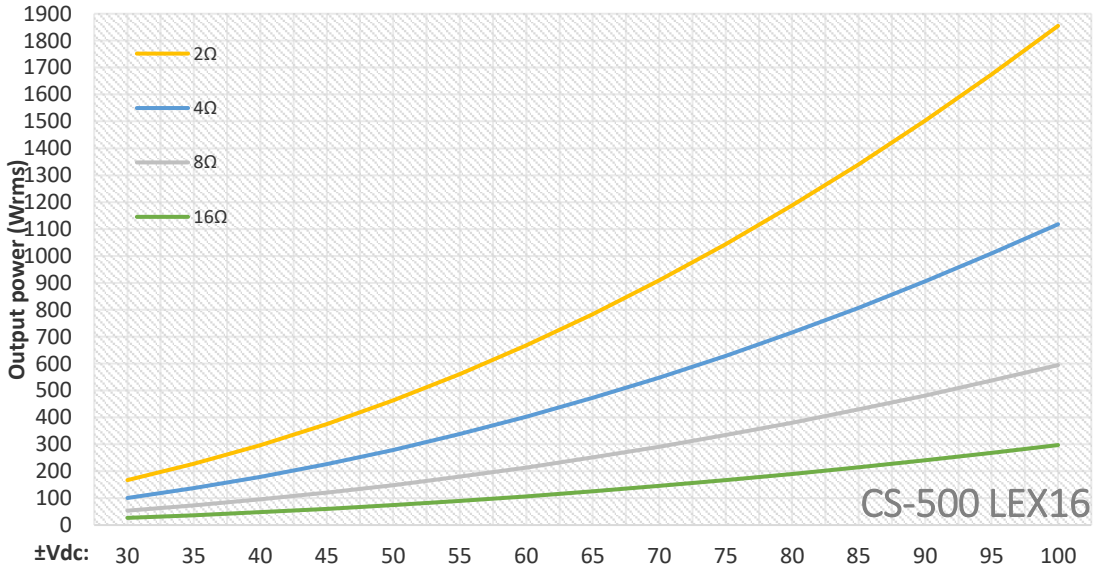
Check our info bulletin page for more details.

NOTE : Only while using a MODU (Mini) Dissipante cabinet our CS-modules can come to their full power potential due to a better heat exchange.

Calculated output power for ELTIM CS-500 models with audiophile EXICON lateral Mosfets:



CS-500 LEX08, *with EXICON 8A/200V/125W, TO-247 lateral Mosfets* (ECX10N20 / ECX10P20)



CS-500 LEX16, *with EXICON 16A/200V/250W, TO-263 lateral Mosfets* (ECW20N20 / ECW20P20)

Technical specifications:

Frequency range:	DC - >2MHz within 2dB (limited and defined by VS-module used, 270kHz / >450kHz)
Distortion figure (THD):	< 0,0005% (1W/1kHz/8ohm) < 0,001% (80W/1kHz/8ohm)
Slew rate:	> 65V/uS (@ +/- 30V). Limited by AC-input filter on VS-module used.
Harmonics:	< -60dB, Nonspecific, see graph right below.
Damping factor:	> 1000 (strongly depending on power Mosfets and supply used)
Input sensitivity:	1 Volt
Input impedance:	47kOhm
Output load:	depending on the model and supply voltages, see graphs
Supply voltage:	depending on the model, see graphs
Output power:	depending on the model and supplied voltages, see graphs.
Dimensions:	490x200x15mm. *Only a MODU Dissipante 435x500x210mm fits actually….. NICE -)*

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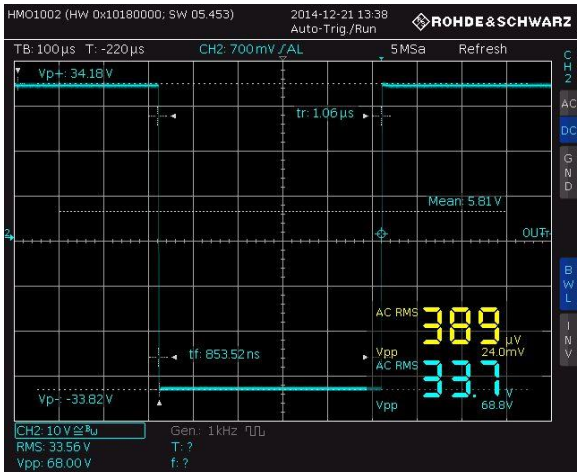
Bridged mode

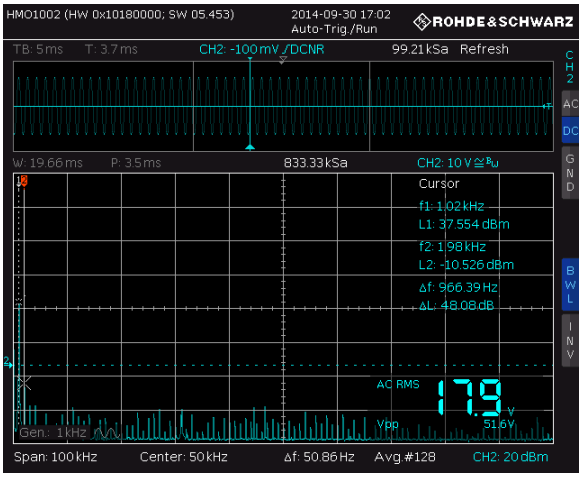
This CS-500 module is very suitable to make a bridged mode Monoblock amplifier. Theoretically, with two CS-500 LEX16's in bridged mode you could make around 3000-5000Wrms in High End quality actually. The only restriction is that the constant (!) speaker current does not exceed 128A (8x16A). Since most power grids can't deliver that nor there are transformers in that size, this is just a theoretical possibility indeed.
Into 4 ohms, the theoretical limit would be the max output voltage, where the power in a bridged amp is calculated as ***Prms = (2*Urms)² / Z = (2 * 65)² / 4 = 4250W*** based on ±100V supply voltage.
In practice there will be significant losses in the amplifier and most grids cannot deliver more than 3.6kW = 2.4kWrms output. Calculating this for 8 ohm loads you also end up in around 2500Wrms, which is also the limit for a 16A grid fuse. The power Mosfets can even take current peaks of a few hundred amps total. Mostly the limits of the power grid will be the limit, funny. Pmax = U * I = 230 * 16 = 3680W available. 1/3th of that (67% efficiency in class A/B) gets lost in heat, so "only" around 2400W for the speakers, sorry. A 32 amp grid supply could take it to the max actually. NOTE: this is all theoretically, not built yet.

If you don't need this amount of power, you could use the CS-400, schematically being the same as this CS-500, yet 100mm smaller in width, and with four pairs of Mosfets and due to the size forcing us to use smaller speaker- and power tracks.
To let the 8 pairs of 16A Mosfets in CS-500 perform at their max, the track widths are significantly wider, and the power header connector has way more pins compared to our smaller versions, limiting all to the 8x 16 = 128A of the Mosfets.
Even with a huge PCB layout and heat spreading like this, 8 pairs of EXICON Mosfets not even show what they really can do and so, the grid supply, heat exchange and your speakers are the limiting factor in this design……
Of course, this amplifier design is not meant to do this continuously though, it is meant to make sure that every power burst in any signal will come out without any distortion for sure.

Some measurement data:



Square wave signal without ANY irregularities
It also shows a slew rate is > 60V/uS.



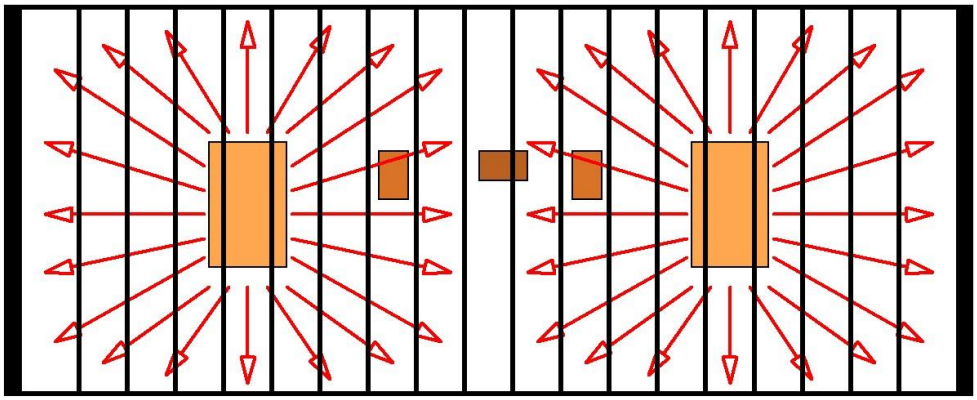
Frequency domain (100kHz wide)
without any significant harmonics.

NOTE: outdated data, measured with Hexfets. EXICON Mosfets show even way better figures. Will be updated later.

Please note that we run on 40W/8ohms here, not 1W as others do, giving better figures than on 40W!

Heatsink data

Unlike most amplifier modules available today, in this design heat is spread symmetrical over the heat sink by spreading the transistors over the heat sink symmetrically. Doing so increases effective thermal load of the power transistors. In practise, with us the amps will become only hand warm.

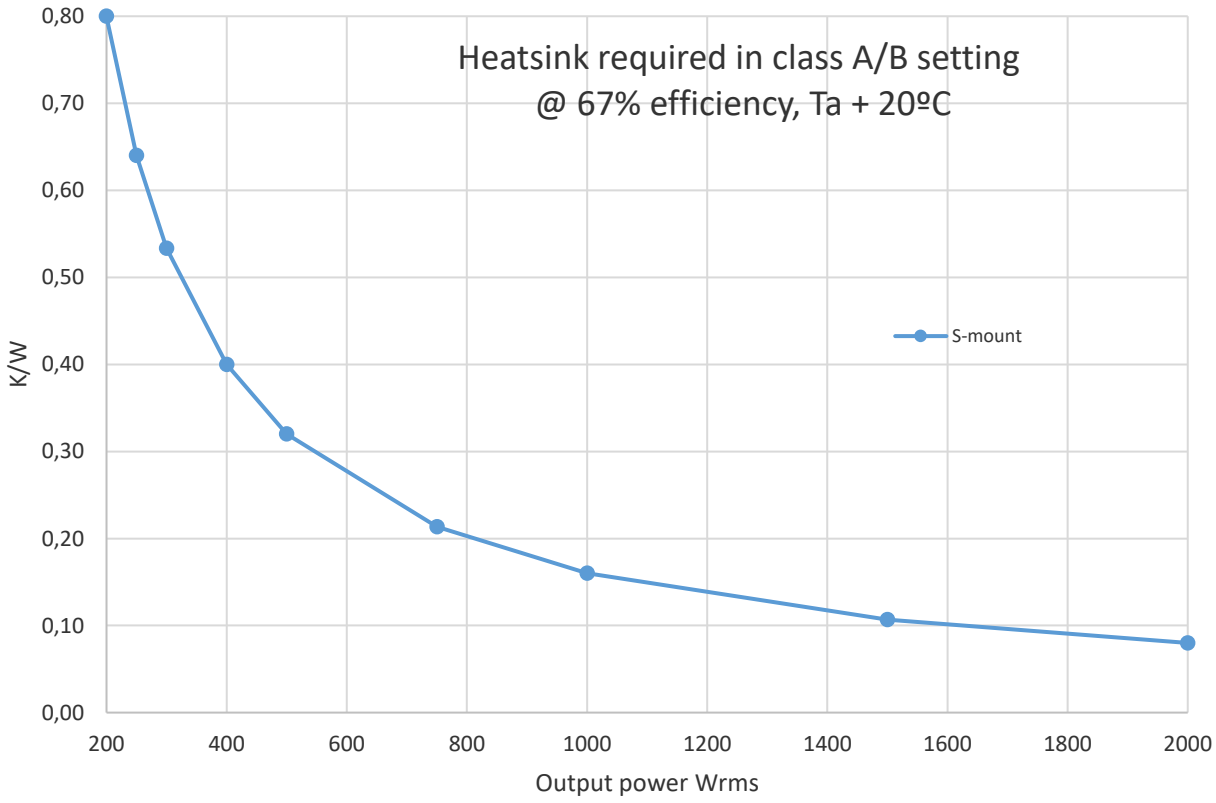


This CS-500 exactly fits a standard 2x 250x200mm heatsinks, available with several fin lengths.

While used in f.e. a MODU Dissipante 5U (435x500x210mm) cabinet, the full potential of a CS-500 module can be shown. It uses 4x 3PD05250 heatsinks, and the cabinet itself is also cooling a bit.
The module exactly fits between the construction L-bars.

In all cases the CS-500 module is mounted extremely rigid by twenty M3 bolts to a rock solid panel, so forget about microphonic effects.

Heat sink data:



Note that the max. output power strongly depends on the supply voltages, type of Mosfets used and the dissipation rate (K/W) of the heatsinks mounted.

CONNECTOR FUNCTIONS

The bottom connector of our CS-modules is meant to connect a symmetrical power supply to it.
Like f.e. CS-165, this CS-500 also fit some supply capacitors, but a rock-solid power supply with significant capacitor value and rectification must be connected at the bottom connector.
Our PS-2 or PS-3 f.e. will do fine in most High-End listening environments. For high power purposes also mount some extra chassis mounded electrolytic supply capacitors. There are connectors for that on CS-500.
Of course, you also could connect a hardwired or universal power supply here.
Do us and yourself a favour and don't use a cheap Chinese supply. It won't match this CS-500 capabilities.

The centre connector is where one of our VS-5/10/20 Voltage Stage modules is connected, L-mounted or sandwiched. This last option sets the total height at a minimum of around 30mm.

Please note that only a set of a CS- and a VS-module is a working amplifier!

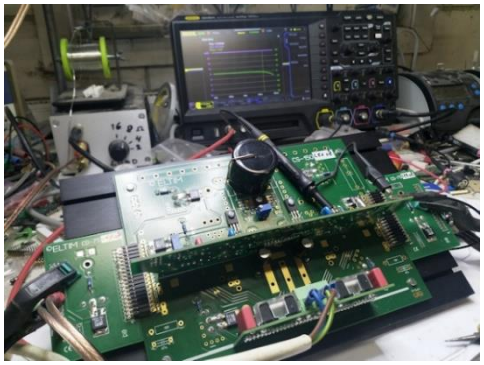
NOTE: There are two diodes left and right of the VS-header connector. These diodes connect the V+ and V- directly to the VS-module. If a Voltage Regulator module is mounted, this is regulating V+ and V- to a lower voltage which is then lead to the VS- module. Only if a VR-module is mounted: remove both diodes!
Besides the needed connections for basic amplifier function, there are also connections for a PTC and the centre contact leads to the idle current potmeter. With later VS-modules you could adjust idle current, f.e. to switch to class A mode automatically when only low power is used or to class B when NO power is used.
The PTC leads via the header connectors to our Protection module which can be mounted optionally.

At the top screw connectors the speaker leads are to be connected. Due to their limits (20A each), we use 4x 4mm², both for speaker + and -. Please connect all eight wires to prevent overload of these connectors.
The polarity switches every next connector, so make it a nice bundle of wires red/black/red/black, etc.

Protection

If you want to protect your speaker, you need one of our Protection modules. This module detects differences between in- and output signals and acts if this event occurs, f.e. overloading it or if the amp has a fault/distorting. It also measures the current in 4 pairs (so all 8) of Mosfets and the interior and heatsink temperatures. Indications by three different LED's or one where all three are combined.
The protection module separates the power supply from the electronics and/or discharges it very fast, instead of a relay with unsuitable nickel/wolfram contacts causing distortion, especially with small signals.
This protection module must be mounted on one of our Power Supply boards.
Unlike most transistors and older Mosfet types, the Mosfets we use show NO irregularities (easy breakdown, thermal runaway and oscillations at high power, etc.) tend to show.
So far we nor any of our customers experienced breakdown of power Fets in our designs.

You Tube video



With our RIGOL 5000 series oscilloscope we have a 7 in 1 measuring instrument. It also (even) can make so called Bode plots, meaning that we can measure the frequency range and at the same time the phase shift between the in- and output of the amplifier, defining the 3D staging.
We made a video of VS-20 / CS-150 / CD-75 combination while testing both the scope and CS-150 module for the first time this way. With 4 pairs of Mosfets as this CS-500 single handed has, it appears to run over 450kHz, with a phase shift over the full audio band with a constant -3º shift. In practice this very nice figure will result in a stunning 3D performance.

While using different schematics our amps can be way more simple and symmetrical, also solving some other issues, resulting in an amazing open and "airy" sound as noticed by many, even competing professionals. After six years of operation, it's now called "the ELTIM sound". Nice -)
Our amps show a tube-like sound, but with way more and rock solid bass, finest detailed highs, fantastic 3D, a super wide frequency range and an amazing speaker control.

We make *MUSIC* again, not just power under the slogan "***LESS IS MORE***!"

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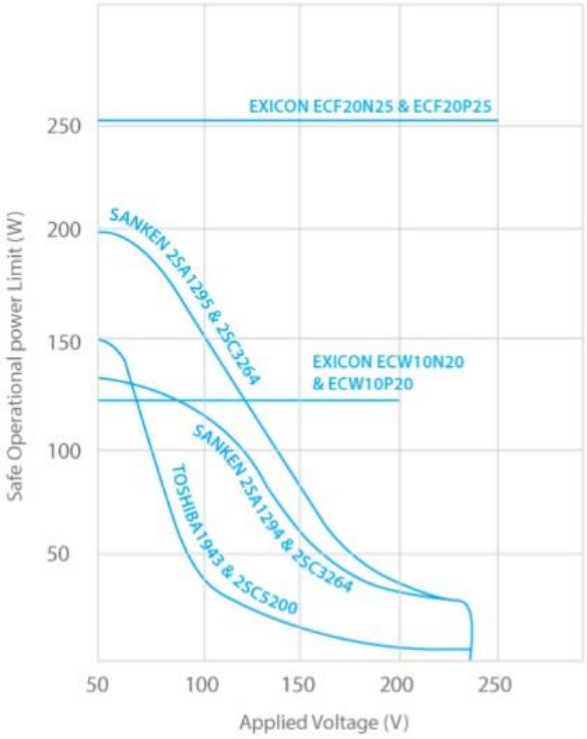
THE MISSING PARTS, or less is more….

While using the Mosfets we do, the schematics can be kept very simple. We don't need to feed the power transistors with a lot of current. Mosfets only require a lowest possible impedance voltage signal.
Also, they show a negative temperature characteristic. Due to this effect, we also don't need to take precautions avoiding a so called "thermal runaway" effect as regular transistor-based amps tend to show. In other words: if they become hot, they tend to take less current. Regular transistors will take more, and….
We also don't need rows of Mosfets as seen everywhere and required to keep the Mosfets inside their Safe Operating Area (SOA).

Due to our thermal design construction and the fact that the Mosfets we use simply don't have a SOA, you need only one pair for 150-250Wrms.



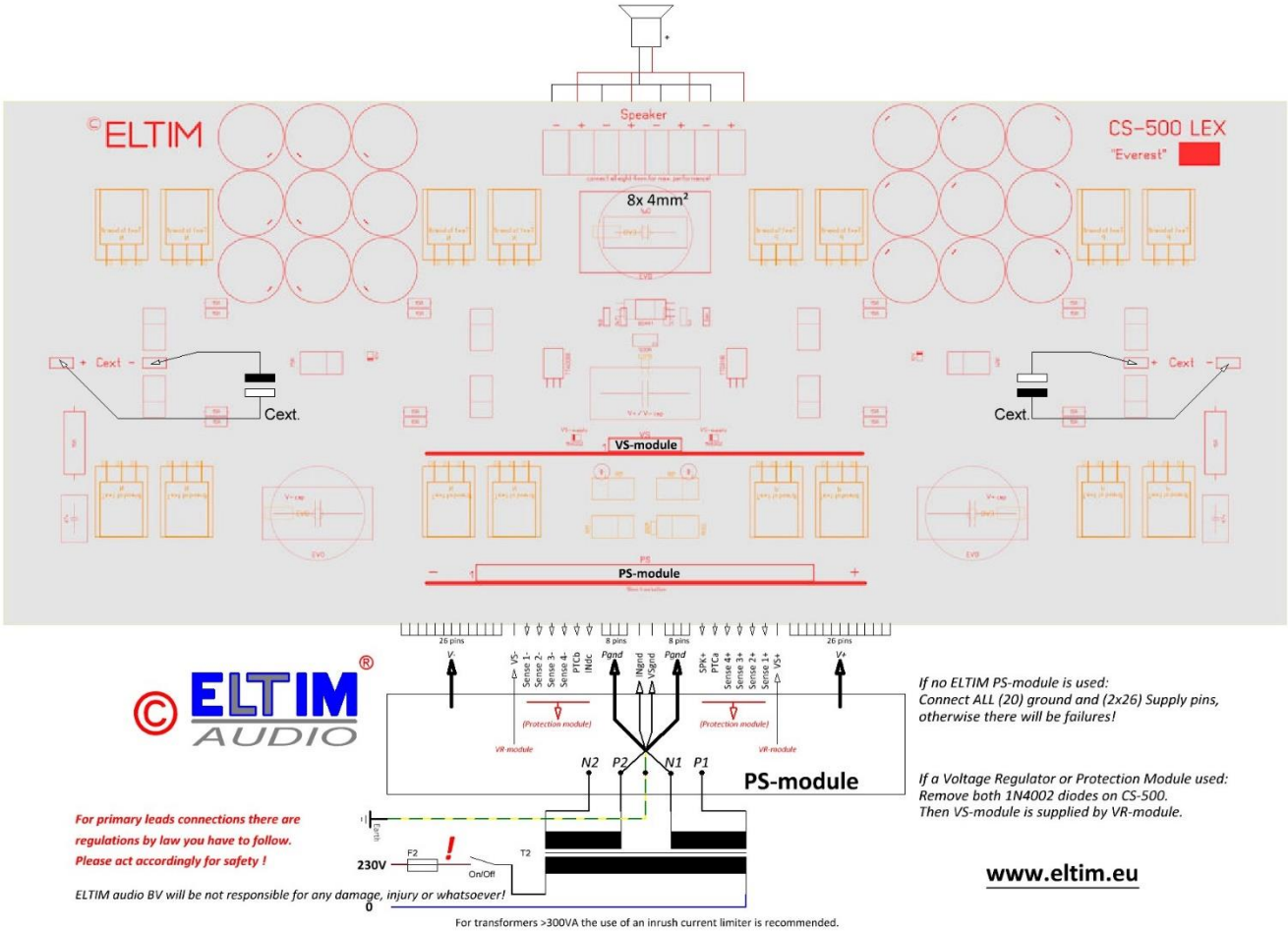
By using a fully symmetrical design, electrical AND mechanical, there are no DC-irregularities in the output while switching the amp on or off, there is NO speaker "anti-plop" protection needed, mostly a (distorting) relay in the speaker line. With this amp module there is just a tiny "tick", without any woofer DC shifts when power comes on and about 1,5 secs. some minor distortion when power goes down (@ around 15Vdc) before signal stops, also without slow and far moving around of the woofer cone.
If this short period of distortion disturbs you, take away the input signal with power off or use our protection module, which prevents this event by discharging the power supply fast, instead of a relay in the speaker line.

There is also no output coil in the output line, meant to prevent current peaks. As a matter of fact, especially short impulse peaks make the music more real and this network is killing it…….
The Mosfets we use can easily handle these peaks, don't worry. We did about all possible, 24 hours of clipping them, short circuit (unintentionally of course….), square wave signals @ 2ohms loads, etc.
This coil comes from ancient times where the power transistors (f.e. famous mother of all 2N3055) just barely could handle the power even without serious peak currents…… And still they blew out even while rows of them were mounted. The same counts for older Mosfet based amplifiers giving power Mosfets a bad name.

Finally: In technical terms we use a class A/B setting, meaning that the power Mosfets are set just in their linear range. BUT and unlike about all other transistors/mosfets, from that point on they are working extreme linear.
So, even though you can, there is about NO advantage in aligning them in class-A operation.

Read more……

The input signal is fed into a VS-module,which has to be mounted at the centre connector. See the specific info of the module in question.
For extra power / improved specs you could add a pair of chassis mounted supply capacitors left and right. They are fed by the V+ resp. V- lines.
The voltage drop over the current sensing resistors is available at the Sense 1+/2+/3+/4+ resp. Sense 1-/2-/3-/4- lines at the power connector.
The 2x50 pin horizontal connector leads to one of our Power Supply modules. Our PR-module fits there and measures these sense lines and take action if required.



The input signal is fed into the VS-module, which must be mounted on the centre connector.

Only at least a combination of a VS- and a CS- module makes a working ELTIM amplifier.

Note that this module only fits in the largest MODU Dissipante cabinet
in size of 435x500x210mm, so a real impressive one!