

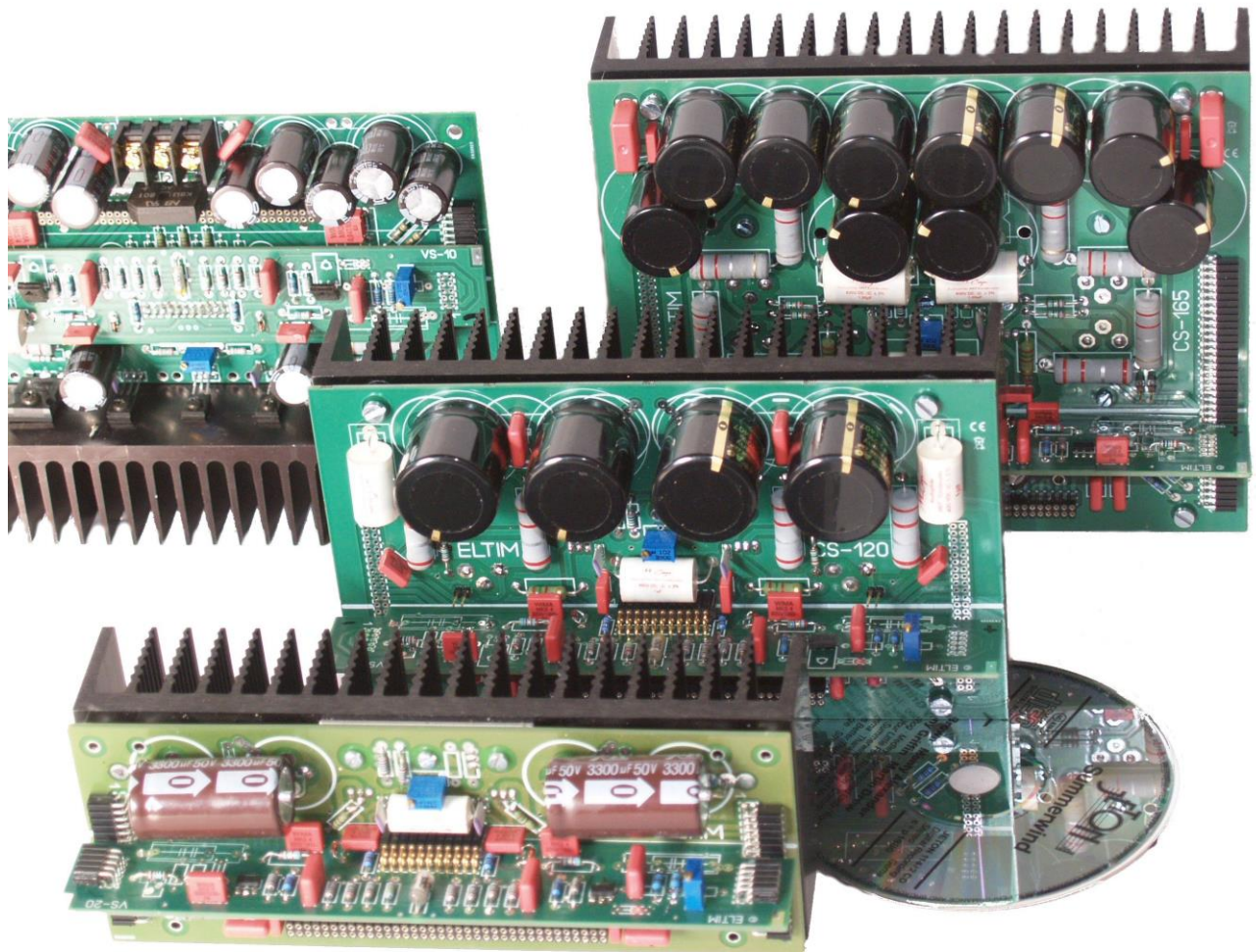
ELTIM[®] High-end / reference quality POWER AMPLIFIER modules

updated March 29th, 2019

We started this amplifier project as a study in order to find out if symmetrical and RF-decoupled PCB's could result in a better amp design as we have seen and listened to in all these years. A wide range of combinations should be possible with only a few different modules, where a minimum of wiring would be needed.

All the design errors (mechanical, electrical, RF-interference, magnetic Influences, PCB layout, etc.) we had experienced in the years of repairing electronics should be taken away as well, expecting a better sound due to all this. And it does, as [is recognised by several audiophiles](#) by now....

So, with our designs it appears that you can build your own true High-End or even Reference Quality amplifier. In this document we explain about all we did to make it a real and at least a high-end amp. If you just are interested in the products themselves, you perhaps better read the [short version](#).



The whole idea was to develop a reliable and easy to assemble amplifier module range making it possible to fit in any amplifier system for every need from reference quality to rugged PA-applications. To fill this working field, the design must be as rigid and temperature stable as possible as well as being capable of driving the most difficult loads.

Introduction

Despite it's fantastic tube-like sound, fast Hexfet/Mosfet designs mostly are compromised due to a poor PCB layout, based on the strange idea that electronics has to be as small as possible, all based on a copycat idea of the smaller the better. Why, if there is plenty space in a cabinet? Also they copycat each other with shortest, tiniest tracks, because 'this "IS" better', ignoring all the (un)written design rules and use auto routing software. Then are these designs measure fantastic, but don't make **MUSIC** anymore and sound tiresome boring?!?!?!? More complicated electronics brought lower distortion and intermodulation figures to levels nobody notices. We believe this started in the end of the 80's already with a result that lots of people lost their interest in audio equipment since it didn't make music any more. Just clean and "undistorted" sound. Also the tiny "midi-sets" with carnival like lightings in the fronts didn't increase the feel for music at all. About all DIY modules available today are built that way too and mostly are built as asymmetrical as you can get (Computer auto route designed) and also show several mechanical and thermal flaws. We made the PCB's symmetrical by using human common sense by "old school" human brain work and checked it with modern equipment of course. Our PCB tacks are at least 20% over calculated for the currents they have to withstand. Then, they are several mm's wide, not just around 1mm. Thermal, mechanical, parasitic and EMI issues are taken care of as well. You can put a calling GSM on any PCB without hearing the dut, du, dutt sound. We believed we could improve the sound even more by using better components than used elsewhere. Of course this takes his toll in pricing of our modules. Our goal was best quality, not lowest pricing.

In this document we try to explain what we believe has to be done different and how we did it, no secrets. We also make no secret of the fact that our designs are based on schematics known for years presenting very good figures as it was with asymmetrical PCB and TO220 Hexfets. We made a lot of improvements, resulting in an amplifier design able to compete 5 figure amplifiers as [confirmed by DIY'ers and audiophiles](#). One of them spent over € 3500,- in a handmade ELTIM amplifier, according to this group beating lots of high quality amps costing 4-10 times more. Our own reference amplifier Accuphase P-450 (€ 10k) we don't use any more....



We did write this document in order to share our thoughts with you. So, please read this document without prejudgement and find out that we improved a lot and used way better components, resulting in a super stable, microphonic free, rigid and very high performing amplifier module range. Without wiring.

Before we start to explain: our input (and other) modules can easily be exchanged with the most modern input stages available, without dumping a complete amplifier. So, use your imagination and share it with us.

Mostly we have a demo amplifier A2300 HRQ available we can send out. So, you can [test it yourself at home](#) !

We believed that while making a symmetrical, wide oriented setup, musicality would come back. By developing it as a fully symmetrical design (electronically, PCB-layout AND mechanically) we found out that there are even more combinations possible than we could imagine in the first place. With the choice of different power Fets and Power Supply capacitors, the range becomes quite large actually, so there must be one of your choice as well.

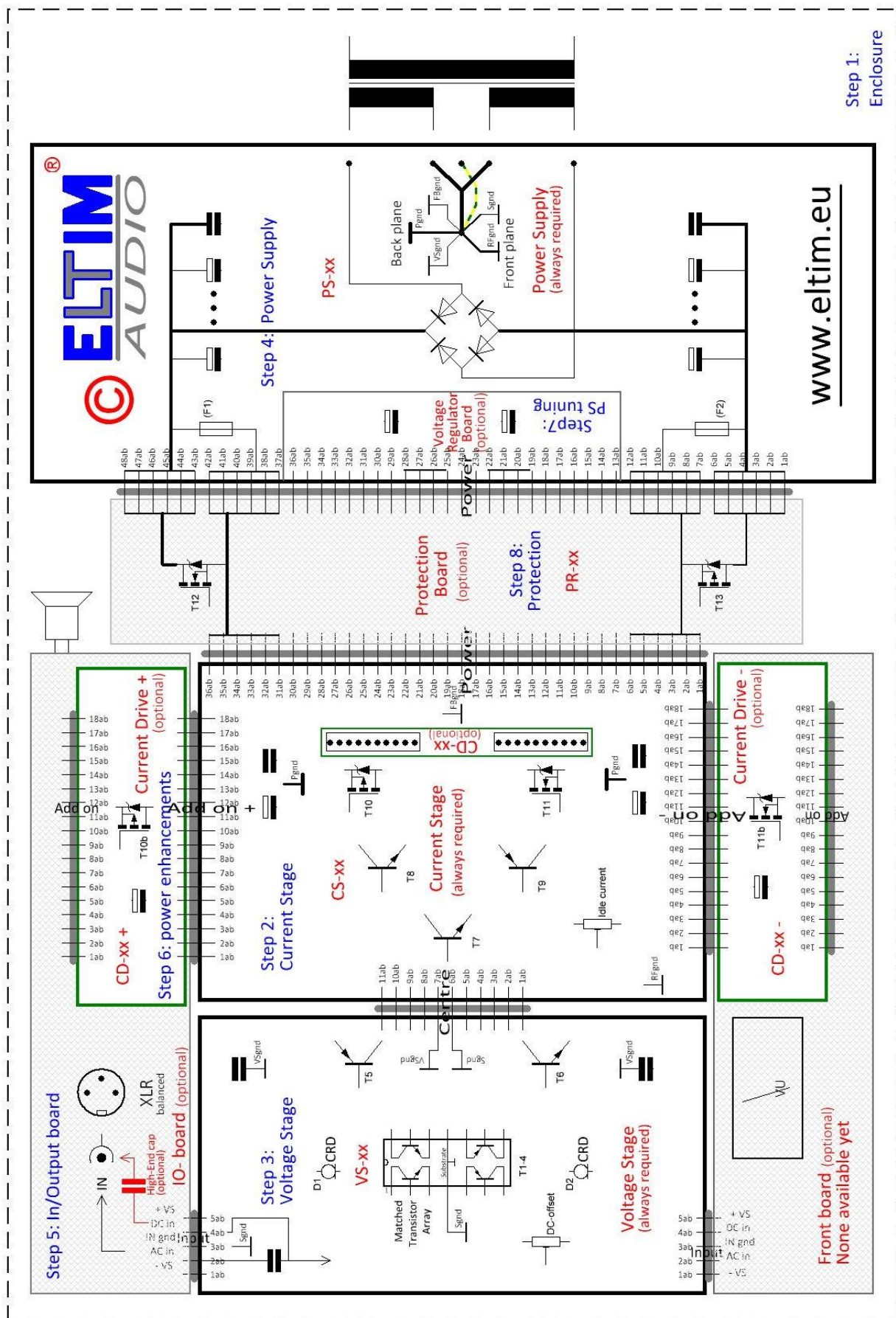
With 5 basic models, one can build a number of different [amplifiers as kit](#) or with [ready built modules](#). We also make bespoke, ready amplifiers. Examples are to be found at www.eltimaudio.com.

Some general details of this refreshing design:

- Fully symmetrical left/right electronics, mechanical and PCB design.
- Easy to (dis)assemble pack.
- Slim and compact design, easy to fit in your system.
- NO wiring (causing EMI) needed, except for transformer and in/out connectors.
- Modular setup, easy to assemble and /or change.
- NO precautions (relay) needed while power on/off.
- High quality, gold plated beryllium copper (3 Amps) connectors > >
- Hexfet (N/P-ch) or Mosfet (N/P-ch) power transistors.
- Up to **four** parallel TO-247 or even TO-264 power transistor pairs, GDS or GSD oriented.
- Even without a casing no EMI influences noticeable.
- Frequency range on AC-input limited to 2- >250kHz (prototype DC - >2MHz on DC-input).
- Slew rate better than 60V/uS (limit of our measuring equipment).
- Natural and very low harmonics distortion (<<-60dB, no specific peaks).
- Separated Current (CS) and Voltage (VS) stage PCBs improves quality and eases upgrade.
- Special care is taken about heat distribution.
- Power Supply modules can be stacked on without wiring required.
- IN/Output modules can be stacked on without wiring needed.
- Protection/control modules can be stacked without wiring needed.
- Voltage regulator boards for the input module can be stacked without wiring needed.
- Only highest quality components used, f.e EXICON, BOURNS, VISHAY, MURATA, THAT, etc.
- We only use long life, high grade components, lasting for 20 years, not just 2...
- You could even implement your own ideas.



Full option assembled system, using CS-80, VS-20, PS-80, VR-3 and IO-80bal modules, working perfectly together without any wiring except for connector- and transformer leads.



The base of a working ELTIM amplifier module is a VS-xx AND a CS-xx module. All other is extra.

At the following pages we give a lot of information about our modular setup and how/why we did it.

VOLTAGE STAGE MODULES (VS-modules)

As mentioned, our ELTIM designed power amplifiers are split in two parts in order to obtain the max. possible sound quality and to give you freedom of choice. There is an input (VS) and an output (CS) module required.

Our Voltage Stage modules convert the (small) input signal into signals for driving the high current leading CS- modules. Due to the easy to drive Hex/Mosfets, there is no need for a very complex input stage. We just used about a most basic one with double mirror circuits, already competing lots of highly regarded and high priced High-End brands. Maybe it is the mirror circuit IC as well. We used the latest stuff here. Obviously our design ideas work, no matter what the critics say. And then again, do they make something?

These separate (upgradeable) most basic fully symmetrical Voltage Stage highlights:

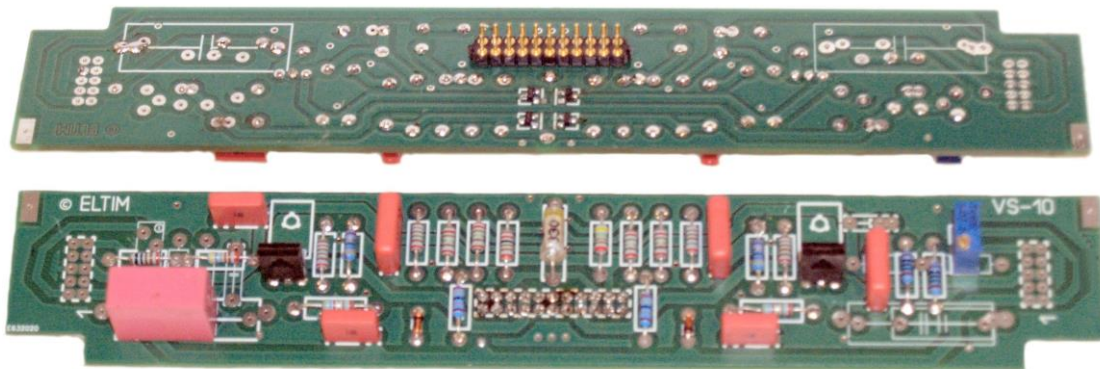
- [Symmetrical and matched transistor array](#) (instead of T1-T4) used for mirrored input stage (VS-20).
- Transistor array substrate (VS-20) grounded to input ground, avoiding any noise and EMI. Actually, you can put a calling GSM on top of it, no disturbance at all....
- Extremely stable, wide range (10-100V) Current regulator diodes ([CRD's](#)) in the mirror circuits. This results in a very wide power supply range of the total pack and regulating the current into the mirror circuit most effectively and stable.
- AC-input, where a MKP Mundorf Mcap250 (VS-20) or a regular MKS cap (VS-10) is used.
- DC input on left and right side. **High end capacitor between this input and RCA-inlet possible!**
- Output DC-offset can be regulated to 0V with 10 turns trimmer.
- DC-servo control possible via the DC-input as well.
- AC- (>2Hz, other on request) and DC-input on left or right side.
- Upper frequency limiting network can be mounted on left or right side.
- MKP capacitors in frequency limiting feedback circuit, Mica types in VS-20.
- RF-interference blocking capacitors in strategic positions.
- Styroflex RF-capacitor in feedback circuit.
- Separate Voltage Stage power ground and input ground tracks, ending at centre tap of our Power Supplies while using our boards.

At this moment we have two models in our program. One with SMD transistors (VS-10) and one with a very high quality SMD transistor array (VS-20).

We are also not using transistor pairs coupled mechanically in order to keep them at the same temperature. We use a group of SMD transistors positioned within 1 cm², or in more expensive versions even a fully symmetrical 4-transistor array made for purposes like this in very expensive equipment.

All transistors in this array are matched within 500uV and even the substrate of the chip is grounded in order to keep noise, etc. at the lowest possible level.

VS-10 Voltage Stage module

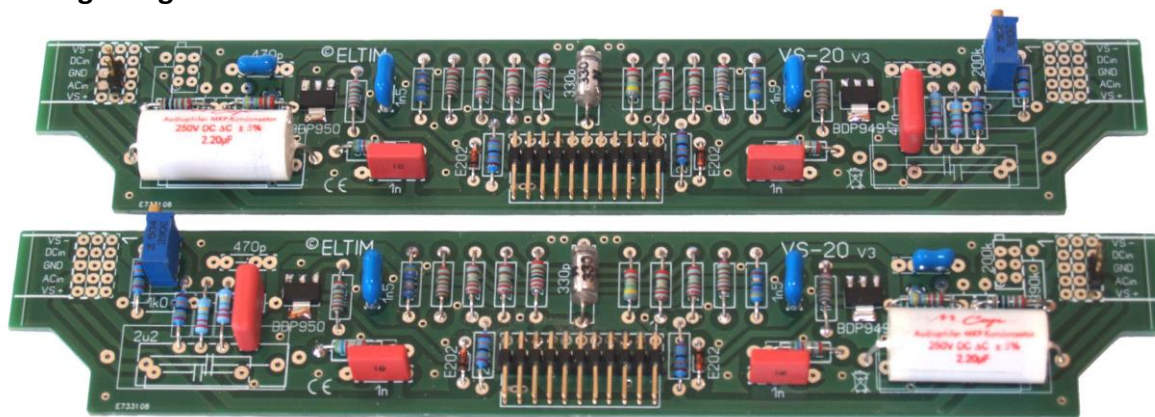


VS-10 For lower costs and/or high power purposes we made the VS-10 version, based on regular (SMD) transistors for T1-4, visible exactly in the middle and back side of the PCB. (Still V1 shown) The driving transistors are high voltage TO-126 models.

It has the same connections and size as the VS-20 module. It can handle +/- 100V though, but it will run from +/- 25V up. This wide voltage range is due to the CRD's we used. V2 is selectable 63/100V.

This example uses a straight connector mounted at the back, for stack mounting to a CS-module. Here the input is at the left side, and DC-level adjustment at the right side. This can be exchanged.

VS-20 Voltage Stage module



VS-20 version is using special input transistor mirror array, matched within 500uV. T1-T4 couple in this case is a very small SMD component also mounted at the centre back side. This rare, [exactly symmetrical 4-transistor array](#) made by THAT Corp., has a grounded substrate and 100% symmetrical layout, matching the symmetrical layout if this small 3,5cm wide board. Transistors are matched within 500uV.

The input filter and local feedback circuits use highest grade (blue) mica capacitors instead of MKP. This board can be connected to the centre connector of all our CS Current driving stages, stack or L-mounted. In this picture a connector is mounted for an L-mounted setup. Here we show inputs at the left and right side, DC-level adjustment at the other side.

Since we can't do it all in one time, we will later develop more modern and sophisticated VS-modules. That is, if people still believe this is necessary, what we doubt while reading first customer comments. Highly regarded brands don't sound as natural as ours though, but any suggestions are most welcome.

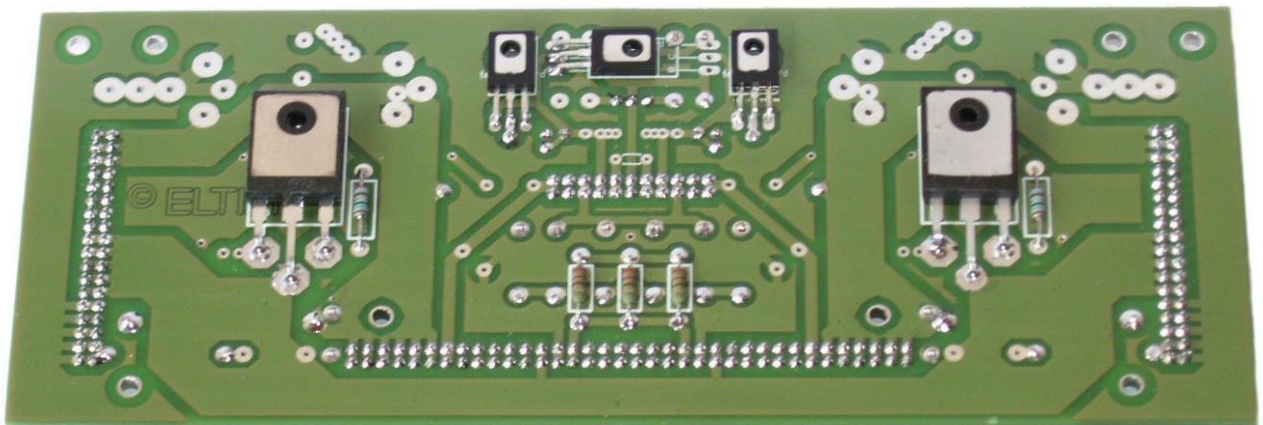
Please also think "out of the box"... You can build yours for 1/5th of the price.

The CS-modules are as in ANY Mosfet power stage, so there is nothing to change, except for the Power Fets used. We used the best and most modern ones we could find already.

Current Stage modules (CS-modules)

The control signals coming from a VS-xx module are fed into any of our CD-xx Current Stage modules. In turn, these CS-modules convert these signals into high current speaker signals. Some details:

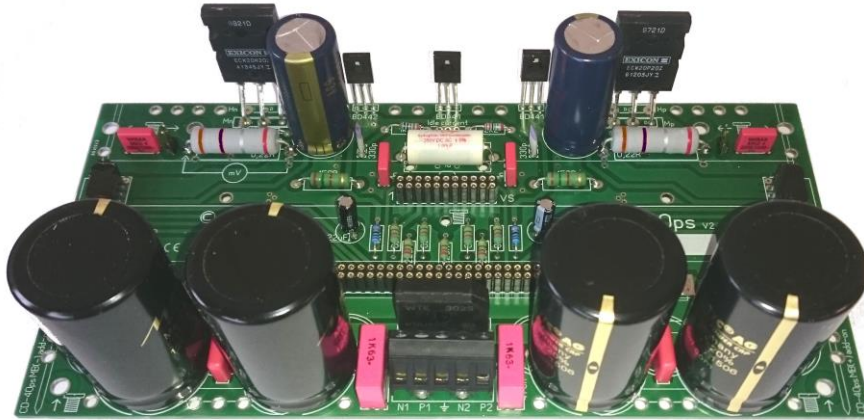
- 12A/200V, 150W, TO-247 Hexfet pair(s) for high power 8 ohms loads (becoming obsolete) OR
- 23A/100V, 150W, TO-247 Hexfet pair(s) for high-end audio purposes (becoming obsolete) OR
- 8A/200V, 125W, TO-247 [EXICON](#) reference quality Mosfets OR
- 16A/200V, 250W, TO-264 [EXICON](#) reference quality Mosfets.
- Power transistors at centre position of the heat sink for max. heat flow over cooling surface.
- Heavy duty mounting by lots of screws, also using all mounted transistors as distance holders.
- Heat sink (200mm wide, 80, 120 or 165mm high) electrically separated from PCB.
- Power grid Capacitor bank positions located close to the power transistors in several sizes.
- RF-interference blocking capacitors in strategic positions and grounded separately as in RF-equipment.
- All resistors are long life 1% components or better.
- Current driven high power feedback in the centre of PCB with multiple paralleled resistors, reducing noise.
- MUNDORF MCap MKP in zener diode (Idle current) circuit. Normally this is a very cheap one.
- Voltage Stage connector with separate power supply leads to amp bottom power connector.
- Speaker output and extra Hexfet/Mosfet connector both left and right.
- No output coil provided nor needed.
- Symmetrical, multi connected pins power connector layout with extra leads for other purposes.
- Separate Voltage Stage and Current Stage voltage rails, incl. ground.
- Separate tracks for RF-ground (front plane), Power/speaker ground (back plane), feedback, VS-stage and input ground.
- CS-, VS- and input ground separately ending at the centre earth point of our Power Supplies.
- Tracks are as short and wide as possible.
- Crossing tracks (bottom/top side) are crossing in an angle to avoid interference and parasitic capacitances.
- High current tracks return signal at the other side of the PCB, avoiding electro-magnetic interference.
- Speaker and input signal for signalling/protection purposes at the horizontal connectors.
- PCB position to mount an NTC/PTC at centre, connected to both horizontal connectors.
- Idle current can be controlled externally by a DC-signal to centre connector for A/A-B/B mode setting external. NOTE: With EXICON lateral Mosfets a class A setting makes no sense, see later.
- CS-80/120/165 flat mounted to the back of a cooling device. Doing so, the module becomes very rigid and at the same time it has maximum cooling due to a symmetrical spread of heat. All transistors act as extra PCB distance holders too. The PCB below is then mounted with 9 screws, instead of mostly just 4.



CS-80 (V1) model, backside

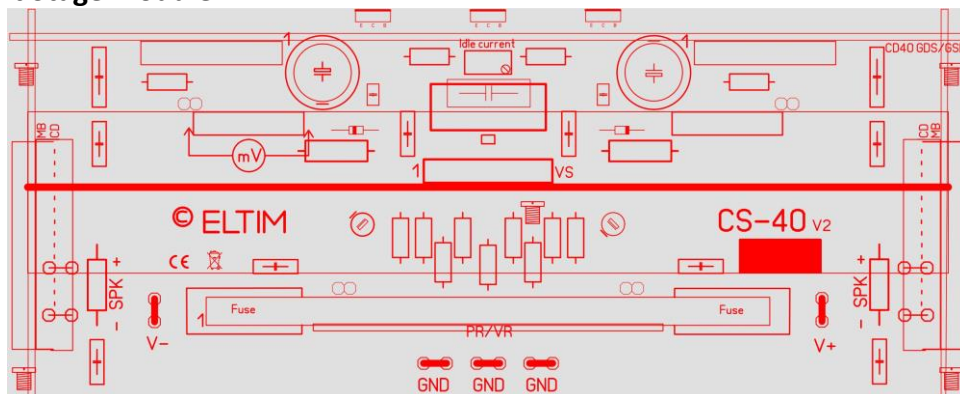
With 9 bolts mounted to a rigid surface there are no microphonic effects whatsoever. Also you can see here that we use very wide tracks and multiple header pin (3A each) connections.

CS-40ps Current Stage module with integrated power supply

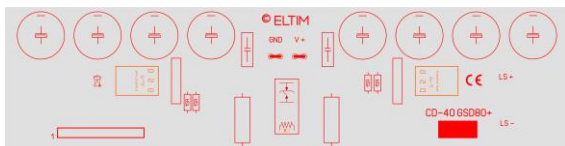


CS-40ps (HRQ model, NEW V2 PCB version) with integrated Power Supply, for L-mounting to any cooling surface as commonly used. It fits in all MODU Pesante (Dissipante) and Slimline models, leaving enough room for a suitable toroidal transformer(s). You even could build a (very) small power mono/stereo/bridged (one upside down) amplifier in any MODU Galaxy (Maggiorato) cabinet, 230/280mm deep, where also one or two 50/80VA transformers just fit. With 2x5 1000uF caps (CS-40ps LP) and VS20 mounted horizontal it even fits in a Galaxy 1GX148, 230x124x42mm (transformer mounted externally). With the V2 version now launched, you could make a very nice MONOBLOCK with this one also. In that case, there are no capacitors on this module but on two side flank mounted extra PCB, fitting exactly a 230mm wide Galaxy cabinet.

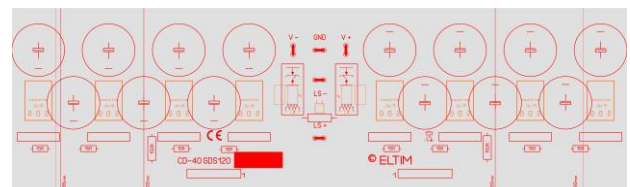
CS-40 Current Stage module



CS-40, (V2 shown) with the same layout as CS-40ps but lacking an integrated power supply, fits in any cabinet and is mounted as about ALL amplifier PCB's, L-mounted to any cooling surface as commonly used. It now is our most flexible layout and you can make about any possible amplifier setup with it. Instead of feeding a single pair of power Fets as mounted on the other PCB's, we have several add-on modules with 2 - 4 Fet pairs. They are connected via the side or top mounted connectors in order to be capable of producing up to 5kW of power..... An amp like this looks and works impressive.



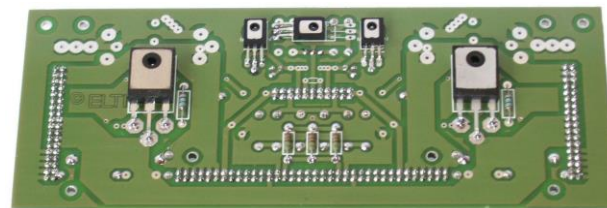
Just one of the two modules required for a monoblock setup.



Here a FOUR pairs configuration.

Above just some examples, we have [several models in our program](#), yet still working on them. Of course, the power lines are hardwired from these Mosfet power bank(s) to the power supply directly. As in CS-40ps, a Voltage Regulator board or Protection Module would fit there instead while hardwiring the power supply. With the last, you have to take away the SMD mounted fuse holders first.

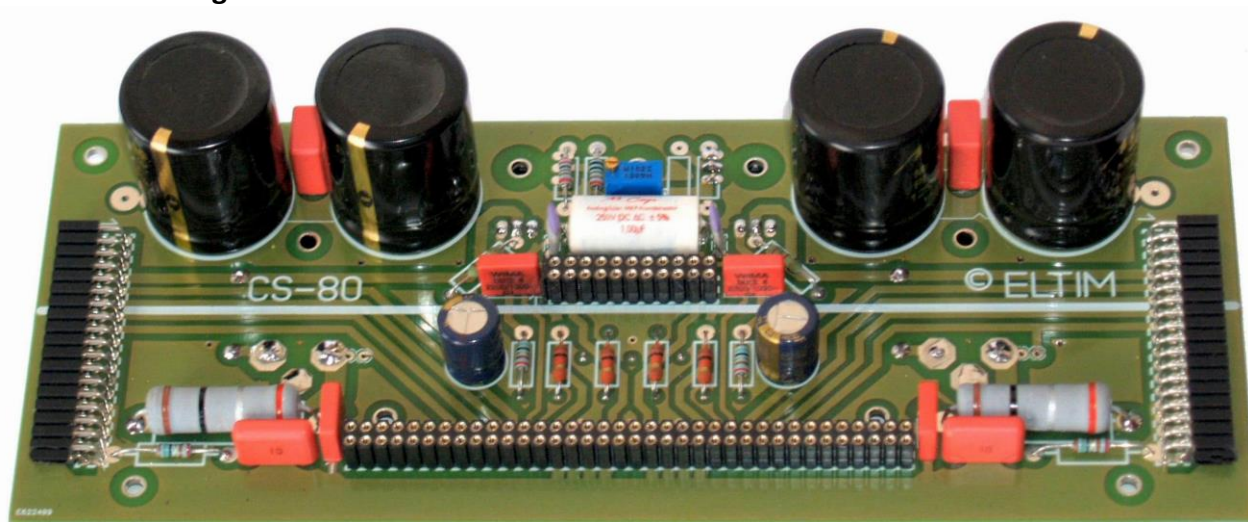
Quite unusual are following boards, fitting flat on the backside of a heat sink. Probably this isn't done by others due to the heat exchange between the heat sink, PCB and components. However, our CS-80 (picture) f.e. becomes only hand warm while producing quite some power. We also use highest quality FR4+ boards which are double sided, through hole with soldering masks and printing on both sides and tinned for easy and reliable soldering. Transistors are mounted at the back, so these boards are mounted to a heat sink in full as shown at first page.



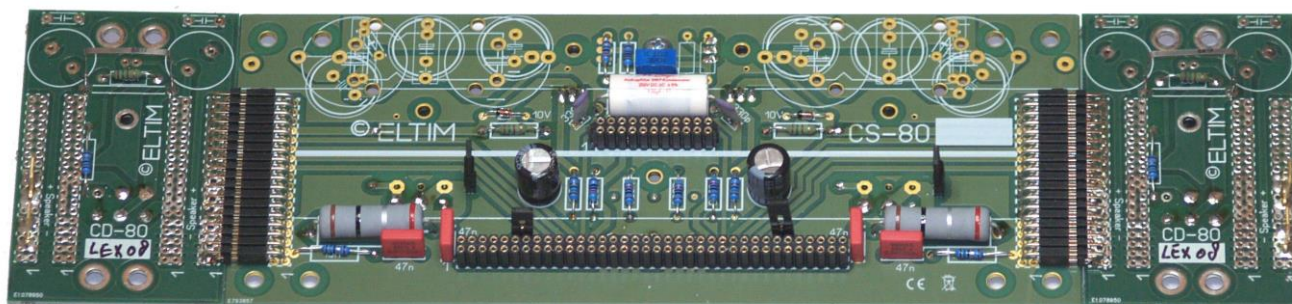
CS-80 back side view.

Mounting directly to a heat conducting element/surface

CS-80 Current Stage module



CS-80 (LEX08 version shown), fits flat on a 200x80mm heat sink like MODU 3PD02200 or use 3PD02300 with extra **CD-80** transistor pair mounted to the sides of the CS-80 module:



All transistors are located on the backside, around the trimmer and where CS-80 and ELTIM is printed.

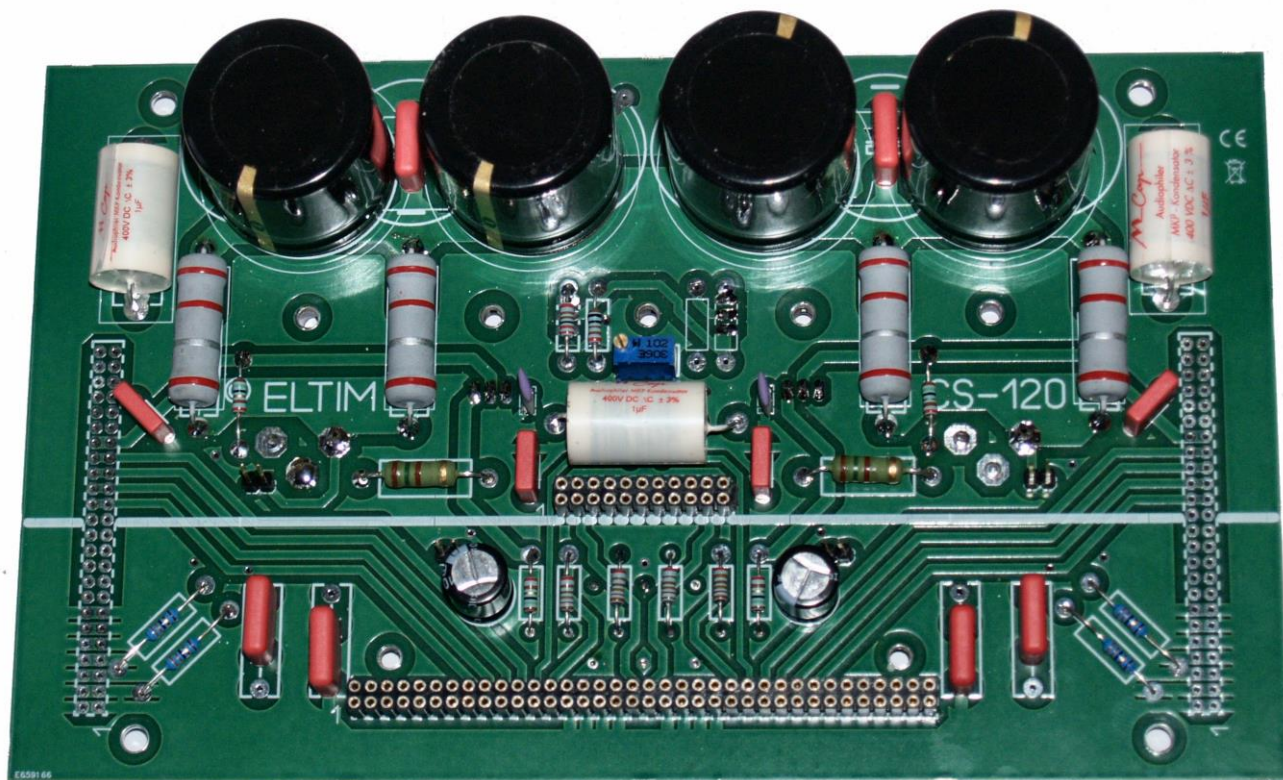
This CS-80 unit can also be mounted in MODU Pesante Dissipante 3U/300 or 400mm cabinets. Supply caps are standard not included anymore!

Power supply PS-80 is stacked or some other L-mounted to the bottom connector.

Available as:

- CS-80 HEX23 with 23A/100V IR Hexfets (kits only)
- CS-80 HEX12 with 12A/200V IR Hexfets (kits only)
- CS-80 LEX08 with 8A/200V EXICON lateral Mosfets
- CS-80 LEX16 with 16A/200V EXICON lateral Mosfets

CS-120 Current Stage module



[CS-120](#), (HEX12 version) fits flat on a 200x120mm heat sink like MODU 3PD03200 or 3PD03300 with extra transistor pair. Supply caps are standard not included anymore!

This unit can also be mounted in MODU Pesante Dissipante 4U/300 or 400mm cabinets.

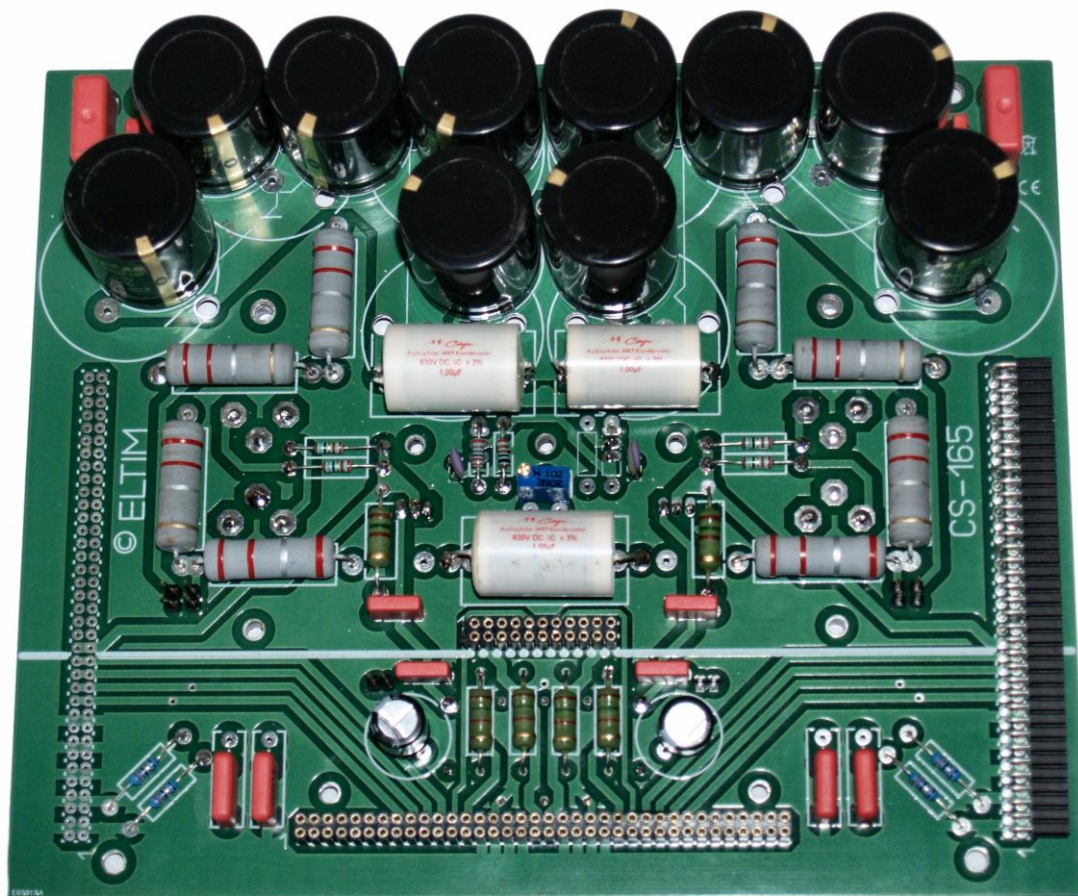
You could add a pair of CD-120 Current Drive PCB's left and right for increased specs.

Power supply PS-80 or PS-120 is stacked or any other L-mounted to the bottom connector.

Available as:

- CS-120 HEX23 with 23A/100V IR Hexfets (kits only)
- CS-120 HEX12 with 12A/200V IR Hexfets (kits only)
- CS-120 LEX08 with 8A/200V EXICON lateral Mosfets
- CS-120 LEX16 with 16A/200V EXICON lateral Mosfets

CS-165 Current Stage module



CS-165, (HEX12 version) top of our range model fits flat on a 200x165mm heat sink like MODU 3PD04200 or 3PD04300 with extra transistor pair. This board already fits TWO pairs of power transistors with total 46 Amps (160A peak) drive capability in the HEX23 version! 24 Amps/200Volt in the HEX12 version where extra CD modules are recommended for high power 8 ohm load demands. Also available with EXICON Mosfets.

You could add a pair of CD-165 Current Drive PCB's left and right for increased specs. Total size: 300x165mm. For max. specs a second pair of CD-165 Current Drive PCB's is required. Max. 92A drive current.....
Total size with two pairs of CD-165 mounted: 400x165mm. Supply caps are standard not included anymore!

This unit can also be mounted in MODU Pesante Dissipante 5U/300, 400 (one extra pair CD-165) or even in the huge MODU Pesante Dissipante 1NPD05500 (450x500x210mm) (two extra pairs CD-165) cabinet..... -)

Power supply PS-165 is stacked or any other L-mounted to the bottom connector.
Theoretically, with two extra CD module pairs this one could drain about 16A from your 230V net....

Available as:

- CS-165 HEX23 with two pairs of 23A/100V IR Hexfets (kits only)
- CS-165 HEX12 with two pairs of 12A/200V IR Hexfets (kits only)
- CS-165 LEX08 with two pairs of 8A/200V EXICON lateral Mosfets
- CS-165 LEX16 with two pairs of 16A/200V EXICON lateral Mosfets

DC-output level control

Normally the DC-output can be set to 0Vdc with a 10-tuns, high quality trimmer at the VS-board. You can also connect a DC-Servo circuit to the DC-input. This circuit keeps the average DC-level of the speaker line at 0Vdc regardless temperature caused shifts, altering of components, etc. Under development.

In/Output modules

In order to make connections required most easy, we also developed special I/O modules for these CS-80 modules. We have boards with a line input and with XLR balanced input, using the unique [InGenius](#) technology by

THAT Corporation

While using these balanced modules there are **NO capacitors in the full audio path**, from XLR input to speaker terminals!

You just need to bring some straight, short wires from this board to the connectors of the back of the amplifier.

The [circuit used](#) act as an audio transformer and absolutely does NOT sound as a regular used Opamp circuit at all !!



MONOBLOCK based on CS-40ps MB + VS-20L + VR-3/30 + CD-40ps MB pair + 160VA trafo.

Add-on Hexfet modules.

Left and right of the CS- PCB's you see a connector where on both sides an extra HEXFET PCB of 5cm wide can be mounted in order to fill a 400mm (or even with a double pair a 500mm) cabinet. With this extra module even more power is available and/or heat is spread more. Mounted to any of these CS-modules will about double the damping factor as well as the driving current capability. With this add-on the length of the modules will be 300mm, height and depth stays the same. Left and right there is still 5cm space left then.

An example is shown at the CS-80 page above.

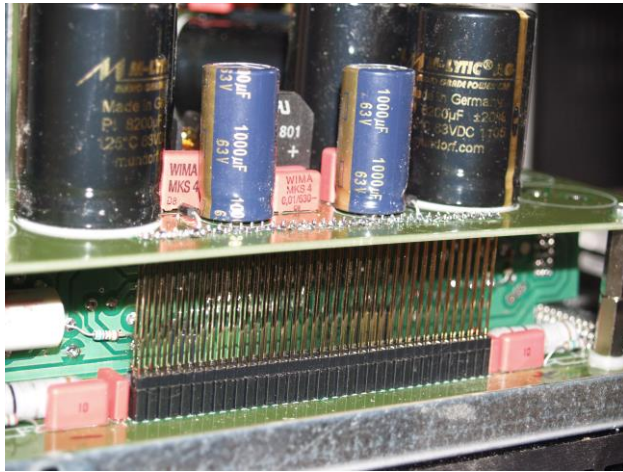
CS-165 can even connect 2 pairs > boards 400x165mm. This specific setup could drive 96A continuously, 320A peak..... In this case your 16A net fuse is the power limiting factor -)

NEW: our MB type CS-40ps modules are equipped with vertical mounted side connectors. There you can connect very compact CD-40 MB modules with Power Transistors and extra Power Supply capacitors. With a combination as shown above you can build a very nice performing and compact MONOBLOCK.

Power Supplies

We believe that a power amplifier is as good as its power supply. Simply because it is part of the AC-signal path of the speaker signal.....

For every CS-module except CS-40(ps) we have an exactly fitting [Power Supply modules](#). They are NOT connected by wires, but with 2x36 pin, 38mm long, gold plated copper headers, without ANY wiring needed:



At the former page is an example of an amplifier where a CS-80 Current Stage module is combined with a VS-20L Voltage Stage module and a IO80-BAL(anced) Input/Output module.

A PS-xx Power Supply is connected in the way as shown to the left. Can't be done better.

We also have Supply modules which are connected L-mounted directly to the CS-xx Supply header connector.

Basically we recommend to use horizontal ones only if a few heavy Power Supply capacitors are used.

We developed separate Power Supply modules for these amplifiers:

- CS-40PS already has a small Power Supply, incl. rectifier on board, just add a transformer.
- CS-40/CS-80/CS120/CS-165 could use a compact, stacked Power Supply board, exactly matching size and demands.
- All CS-modules (except CS-40PS) could work with one of our L-mounted Power Supply boards.
- For most compact solutions we also provide PS-boards feeding two CS-modules. Using such a PS-module, it is necessary that one of the CS/VS modules is built with reversed polarity!
- There are also Voltage Regulator boards available feeding a regulated voltage to our VS-modules. These boards fit on most of our Power Supply modules and even on the CS-40PS module.

Voltage Regulator boards

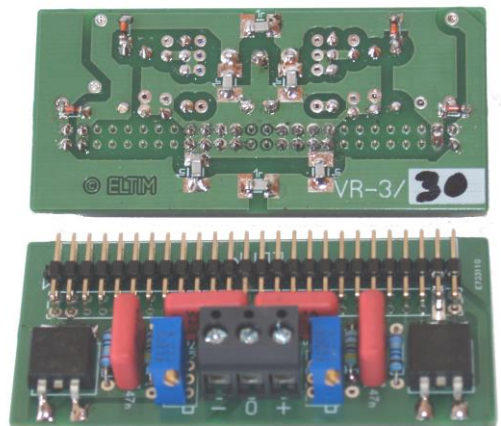
If you are using our modules at higher voltages or want even higher sound quality and figures, a [Voltage regulator board](#) is an option. These boards provide a regulated +/- voltage to a connected VS-module. These VR boards can be connected directly on the CS40(ps) modules and on our Power Supply modules, also without any wiring needed. You can use these regulated voltages also via the screw terminal in the middle.

Power / Error measurement

Notice the front side of the CS-modules again. There you see two "4-bit" paths leading to the centre- and left/right connectors. Normally you can use these paths for anything you like.

If one of our [protection modules](#) is used, some jumpers have to be placed and the "cold" side of the Source series resistors are connected to one of these paths. Our protection modules can monitor four pairs of power transistors max.

The voltage on these rails is compared to the referring voltage rail by our protection modules. If the voltage drop exceeds about 0.5-0.8V (so measuring overcurrent) the electronics comes in action and shuts down the power supply, NOT an output relay, since this would decrease the sound quality of the pack. We bring down the power instead of disconnecting the speaker which seems, besides the quality loss of having a relay contact in the speaker line, quite logical since obviously the amp has a fault and has to be shut down.....



This module will also detect any other irregularities in the output signal like clipping and DC-offset and act accordingly. It also controls a fan and shuts the amp down if it becomes too hot somehow, even if this Protection module fails to work by any reason.

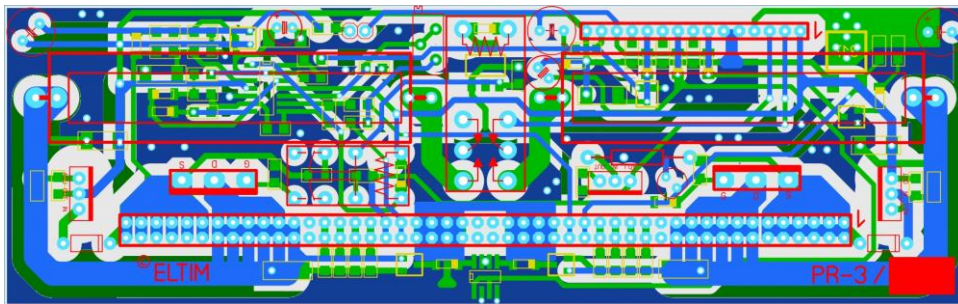
If you use one of our special, nice on/off switches or let us build your amplifier, a red lightning ring around this push switch will blink or flash in order to warn you that f.e. the amp is clipping or overloaded. If the protection really shuts down the amp, the ring will light up. Then you need to take away the power totally and try again. If it comes red again, there is really something wrong and the amp has to be checked or perhaps there is a shortcut in the speaker(line).

You could decide to mount three extra warning lights:

- Distortion measured
- Overload detected
- Overheating detected (also linear increasing DC signal available, temperature vs. voltage)

This DC voltage could also feed a fan, advised where high power demands or warm environments are the case. Actually it will respond to interior AND/OR exterior overheating.

A protection module fits on most of our power supply modules and directly on a CS-40PS module, also without ANY wiring required as with our other modules.



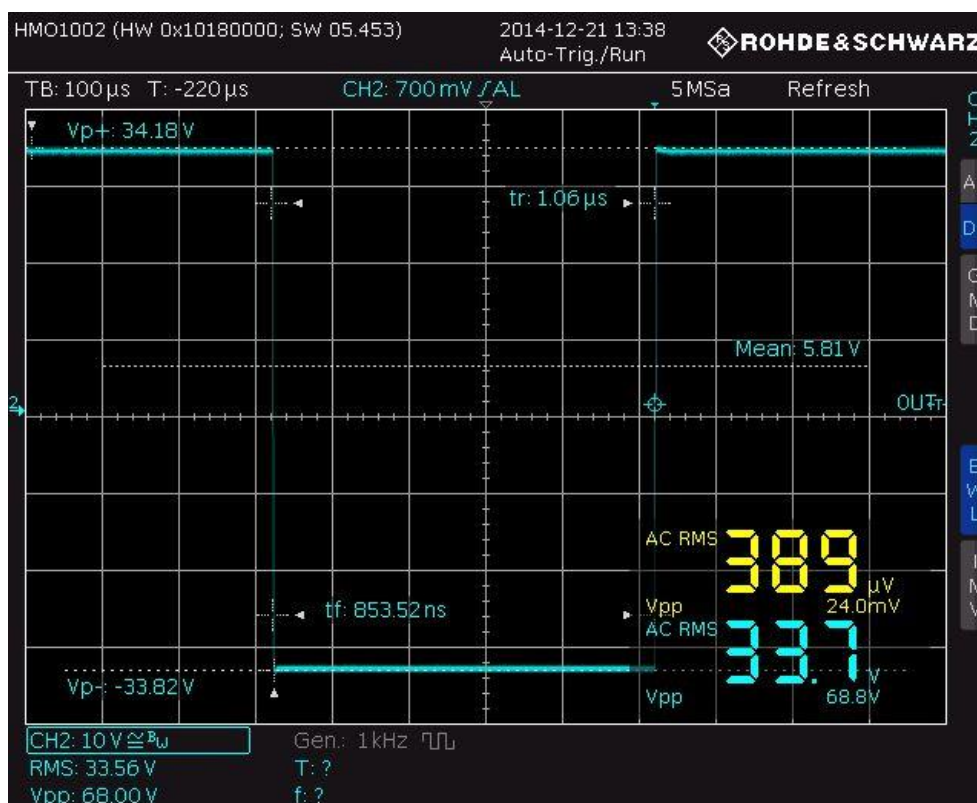
Prototype PCB, we are still working on it.

We have to make sure that they work under all circumstances and with all our boards....

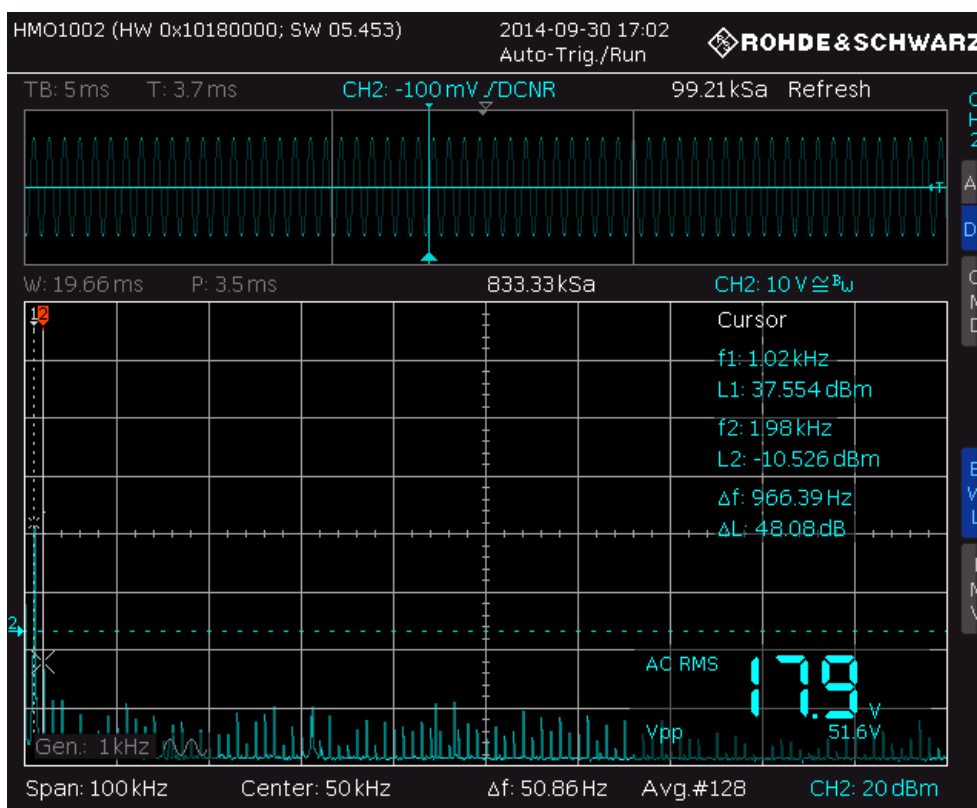
So far, due to the increasing sales of our amplifier modules, we didn't find time to finish this module.

On the other hand, we sold a lot of amps already and NOBODY ever reported it broke down.

Since a lot of people want to see figures first, let's show you some:



Rise/fall time better than 60V/us; what we actually see here is the restricted slew rate of our test generator.....
Please note that there is **NO** over/undershoot, despite the fact that it is running close to voltage rails level.



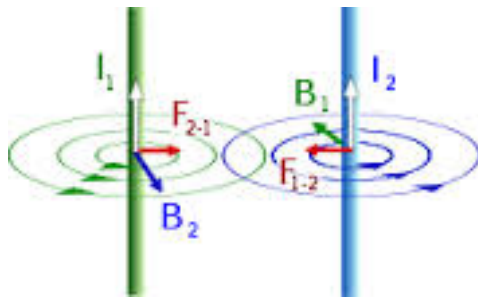
About **NO** specific harmonics measurable, all <<-60dB @ full power! Nice and clean.....

Both graphs are CS-80 LEX08/VS-20 shown @ full power/8 ohm/+30V power supply using the AC input, which is rise time limiting due to the input filter circuitry !
At 1W (or 2,83V as commonly used) and/or higher supply voltages all figures even become better.

Some extra information about our way of thinking.

Electro-magnetic interference

We started development of our prototype with the idea that about all designs are built way to compact, mostly single side boards without any special precautions made. We believed this is causing electro-magnetic interference a you f.e. also notice at your TV screen while using bad TV cables, etc.



We designed our boards not only symmetrical, but also taking care of some design rules about nobody else (and so it is wrong?) uses:

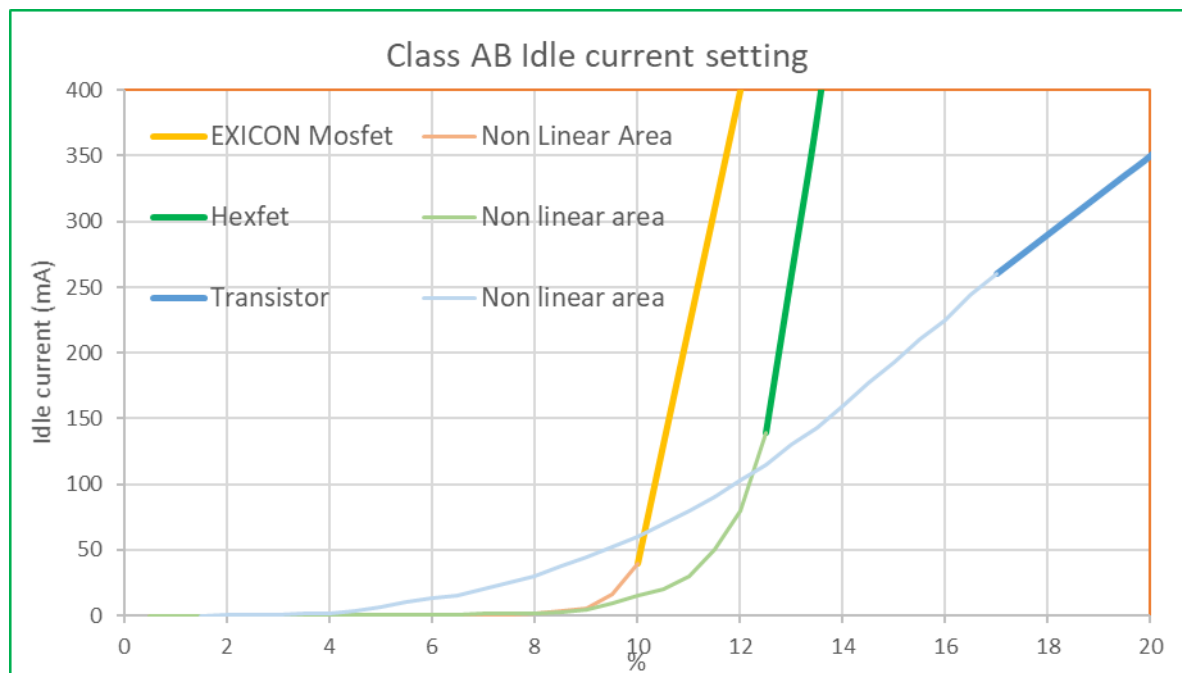
- The reversing track of current leading tracks like speaker- and power supply lines is on the opposite side, resulting in NO electro-magnetic interference.
- Small signal tracks are in an 180° angle to high power tracks, avoiding pick-up of electro-magnetic signals.
- We are using both sides (doubles copper surface) for about 100% as well.
- All unused front side copper is RF-ground and decoupled by small capacitors in strategic positions. It also shields the Voltage Stage board from [magnetic fields](#), caused by currents flowing on the back side tracks of a CS-module.
- All “unused” back side copper is always connected to Power ground. Actually all mm² of available copper is used.

ANALOGUE??? Why an analogue design instead of Class D?? And not even Class A???

This is a story for itself, so we wrote a separate story about that.

In short: with today's power Mosfets/Hexfets one can build extremely well sounding analogue amplifiers WITHOUT generating serious heat while average used on daily bases (<5W) as we all have in mind today. Actually, at normal daily use our amps only generate a few watts, so then they will be hand warm only. This is 90% of the way you are using it, right? Only in the other 10%, where you “kick some asses”, a class D generates less heat. And then, have you found a class –D design having a high-end setup, meaning using high quality, long lasting components, with an open sound as if there is no amplifier???? We didn't so far.

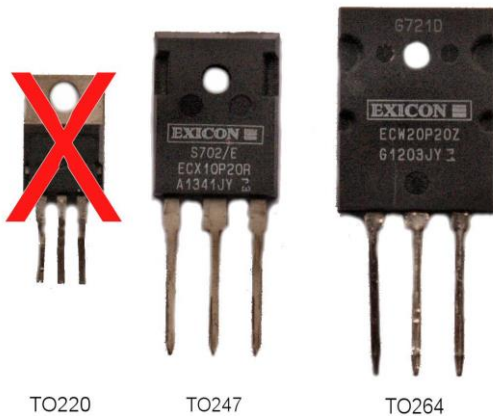
So read more about modern class A/B in our [separate document](#)



Our class A/B setting can be way lower than with regular transistors (blue), so using less power in (almost) idle state. Since Hexfets (green) and especially the EXICON Mosfets (orange) are extremely linear and lacking the so called “crossover distortion” at a very low bias setting already, a class A setting makes no sense with our designs. But if you want, you could do it just by trimming the idle potmeter on the CS-module some more.

Power transistors

With the power we (can) generate, a TO-220 type Hexfet, as often used in analogue Hexfet designs, cannot dissipate the heat produced in the high power designs as we have, so we use TO-247 Hexfet models instead.



TO220

TO247

TO264

We now are also using the unique [Exicon](#) 250W Mosfets in huge TO-264 housing and 125W TO-247 models, both specifically designed for highest grade analog power amplifier designs.

Unlike with regular transistors, paralleling Hexfets and Mosfets is most easy to do, thanks to the fact that they hardly take any current from the drive section AND even more important, having a negative temperature coefficient. In other words: if they get hot, they tend to take less current and so cooling down a bit. In practise this results in a balanced load/temperature of all Fets used in the amplifier. We just have to take care of similar heat distribution (about same temperature) for all power Fets and so balancing the power distribution that way in a most easy way.

Just drive them correctly, which is a “grey field” in audio land. You have to drive them with voltage instead of current and take the capacitive load of the gates in consideration. And that is the tricky part.....

Since this gate capacitance reduces the “speed” of the amplifier use the minimum amount of power Fets for your application. A tiny board with 4 pairs of 16A Mosfets makes no sense at all !

With this negative temp. coeff. behaviour it is possible to add the CD-modules as listed above in order to increase the performance of our designs. With our CS-165 HEX23 and two pairs of CD-165 HEX23 you could drive 96A, 320A peak..... NO speaker will survive that actually.

So far, Mosfet Power Amplifiers are remembered as having two typical behaviours:

- Fantastic, Tube like natural sound.
- Breaking down, just by looking at them.

The last gave Mosfets amplifiers a bad name and also made them looking impressive due to the fact that multiple Mosfet pairs were required in order to stay inside their Safe Operating Area.

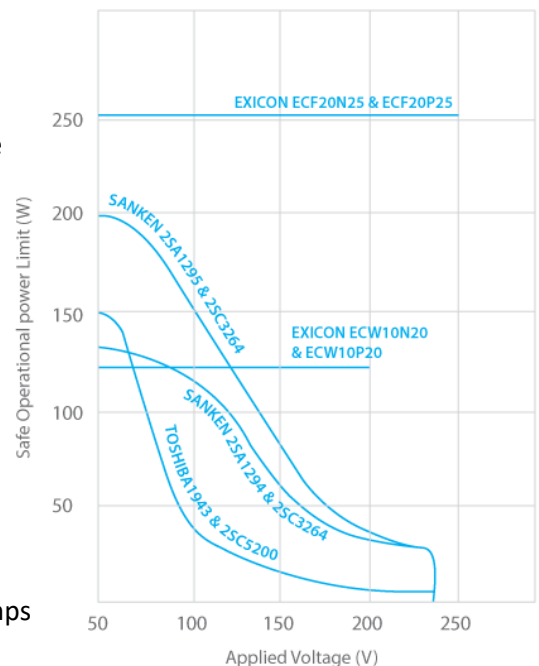
With the new generation of [EXICON lateral Mosfets](#), specifically and only developed for use in the highest quality analogue Power Amplifiers, both items are dramatically improved.

The second one, caused by a small Safe Operating Area (SOA) is left behind and now even better as Hexfets show. This made us decide to add amplifiers with these new Mosfets in our program.

Before this decision was made, we loaded a CS-80 LEX08 with 2 ohms at 60Wrms for 24 hours. NO PROBLEM while really hot and outside specs, because the heat sink was inappropriate small.....

Any other Mosfet would give way under these circumstances.

Using multiple of these transistors only makes sense while using them in very high power amplifiers. Doing so in High-End amps < 300W only decreases slew rate due to higher total gate capacitance.... Could be a habit from using the old stuff.



Input circuitry

About the input circuitry there is a lot to be found on the internet. These circuits become more and more complex in order to bring down distortion figures even more. We are able to build VS-modules this way also, but decided to keep it as simple and stable as possible. One of the advantages of our way of constructing is that at any time one can stack on another type of input circuitry at any time! BUT, we believe these circuits are degrading the JOY of listening as our listeners by now are experiencing.

We tested a long existing principle (transistor mirroring circuit), measured it and especially LISTENED how it sounded. Since the result sounded way better than our Accuphase P450 (€ 10k) amplifier (having complex

input circuitry indeed) we went for this most simple design. Beside the very musical sound, it is more easy for you to build it. However, we didn't use the simple standard transistor mirrors in the input circuit. We use high quality SMD transistors, positioned within 1 cm² in order to keep them at the same temperature, avoiding temperature "drift". What more do you want than a better sound than a top brand, € 10k amplifier?

Our VS-20 Voltage Stage module is equipped with a rare, fully symmetrical [2-NPN/2-PNP transistor array](#) with a grounded substrate for T1-4. This transistor array is specified for use in the highest quality mixers, preamps, etc. and are matched within 500uV.



This very rare chip is also available at our [web shop](#) as separate! We also have the 4 PNP and 4 NPN types.

We use hard to find temperature neutral current regulator diodes (CRD's) with a wide working area of 10-100V instead of the LED idea (having bad dynamic response and low voltage range) which is mostly used in designs like this.

Connectors

At first glance, you'll probably think: what a lot of connector pins, that can't be right!

This idea is based on the fact that about all commercial equipment uses very cheap tin plated connectors, sometimes not even meant for the purpose they are used for..... We repaired a lot in the past.

Believe it or not: even in the most expensive equipment we see PCB headers of the cheapest quality directly after expensive WBT's..... What quality chain???

We chose to use high quality, milled gold plated copper / Beryllium copper contacts 3A/250V per contact, 150°C resistant. Using these, there will be no contact problems for decades. The cheap ones you know are mostly not specified, but 1A/contact max. and mostly tinned.

With the versions we use (priced at least 10 times more), expensive RCA's and banana's in your amp makes sense as well.

With 2x6 pins used in the power leads a current of 36A can flow from any Power Supply module to any Current Stage module without any problem.

Note that every Current Stage board also has (locations for) extra Power Capacitors, so total drive current can be way more than that.

The larger the Current Stage model, the larger the capacitor bank and more pins for speaker output as well.



Mirroring

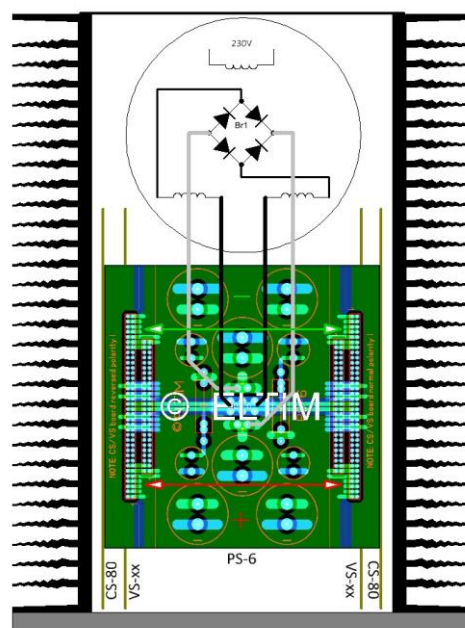
This is a tricky one, only for experts!

The voltage of about ALL our boards could be inverted, just by rotating the elco's and exchanging active components positions!!

However, basic delivery is where the + is on the right side. This mirroring option is used where a stereo or bridged amp in f.e. a [Galaxy Maggiore](#) or a new [Mini Dissipante](#) cabinet is planned.

With the minimum space available, a single (symmetrical PS-6) power supply in the middle between both amps can be used, connecting both bottom connectors to this power supply board with simple straight tracks. With one amp reversed polarity, the powerlines don't need to be crossed and we can use short and thick supply tracks.

So, then there are five PCB's (2x VS, 2xCS, 1x PS) connected with each other, without any wiring with input and output signals and +/- voltages on both sides of the PCB's..... Actually, you even could mount a pair of Voltage regulator boards or Protection Boards as well on the PS-6 board, also without wiring. Just connect a transformer and the in/out connectors.

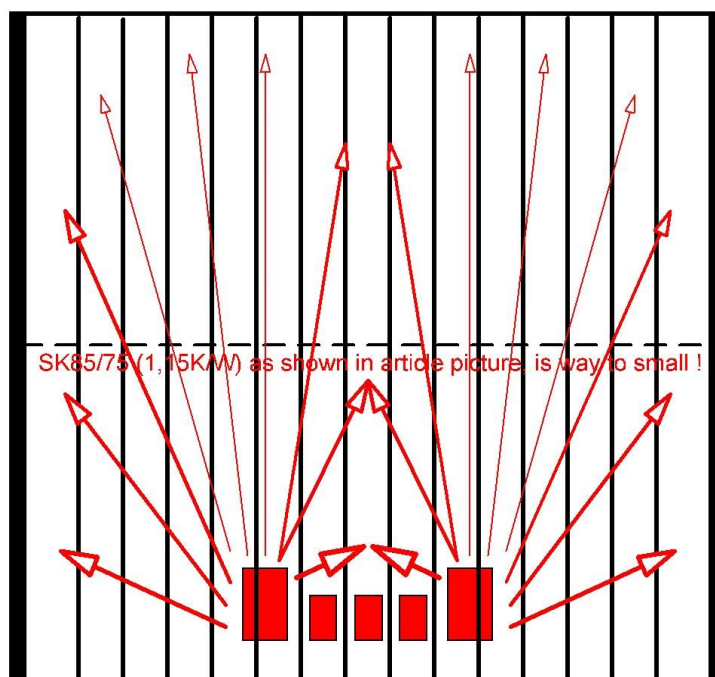


You make this compact stereo amplifier a Monoblock, just by adding a special I/O board, having THAT line- and balanced input and a THAT circuit providing a 0° and a 180° signal for both amplifier modules, resulting in a correctly bridged driven, high power Monoblock structure.

Heat distribution

One of the most common failures in equipment is caused by a poor heat distribution, especially in Power Amplifiers. Sometimes the poor PCB layout and the thermal “hotspot” on a heat sink, caused by the clustering of heat producing components, is covered up by use of an oversized heat sink or use of an unnecessary number of components, mostly extra power transistors. IN our repair life we had to resolder a lot of power transistors, because the soldering’s were permanently hot. Due to the gate capacitance of Hexfets/Mosfets, paralleling these is degrading slew rate and upper frequency figures! Former Mosfet amplifiers required multiple pairs in order to stay inside their SOA area; with the ones we use one pair is mostly sufficient. So, only add extra Mosfet pairs if you require the power by adding (some) of our CD-modules. Also, we have venting gaps in the PCB’s wherever possible. Less heat > longer lifecycle.

Let’s take f.e. a design of a similar amplifier design we read in a magazine years ago:



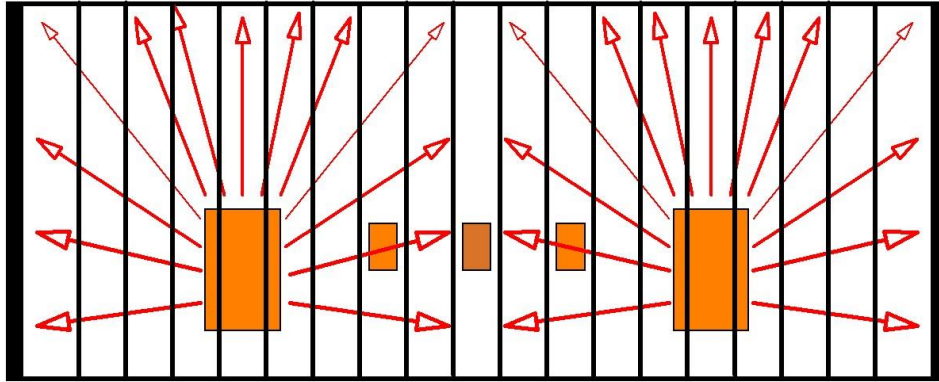
The similar designed Hexfet based amplifier module used TO-220 Hexfets they used can't even cope the heat produced due to the power demands, but are extra stressed due to the fact that all power transistors are clustered at one side of the heat sink. It could make 60Wrms at max. We can make up to 2kW actually.

Dissipation of a TO220 transistor is generally accepted at 50W max.

Given heat sink data is only valid if the thermal load is spread symmetrical over this heat sink!

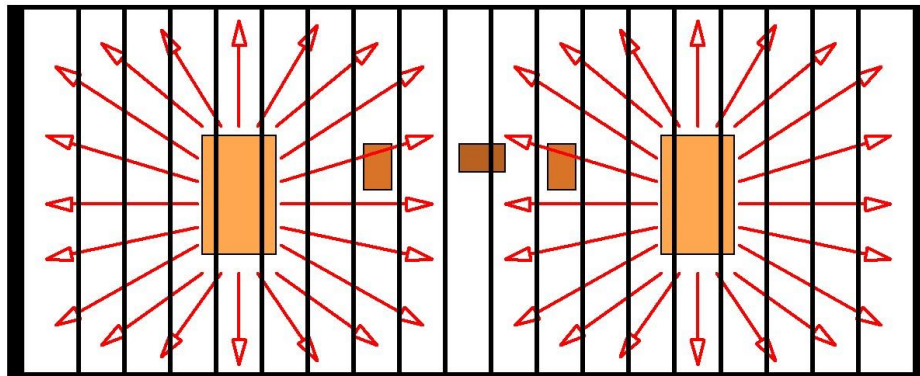
In this case, as in many others, you need a larger than expected heat sink, since it is only partial used effectively. A design like this need a 150mm high heat sink, but they showed it with a 75mm version....

With our CS-40(ps) L-mounted amps we spread the power transistors way more over the heat sink:



This results in a way better heat distribution, assisted by the better heat conductance of the TO-247's we use, set at a dissipation rate of 125W (Mosfet) or 150W (Hexfet) each. The EXICON TO-264 Mosfets can even handle 250W dissipation. Something else than 50W max of a TO-220 model...

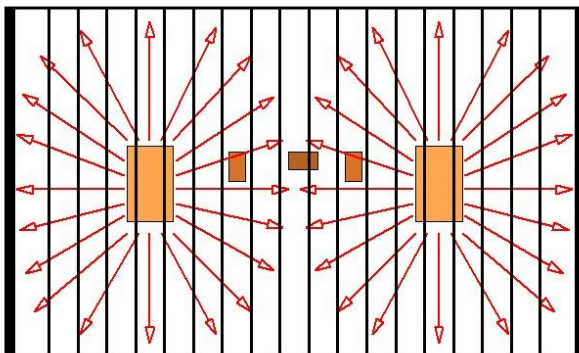
We managed to do it the way everybody should do in our CS-80/120/165 stack-mounted amplifiers:



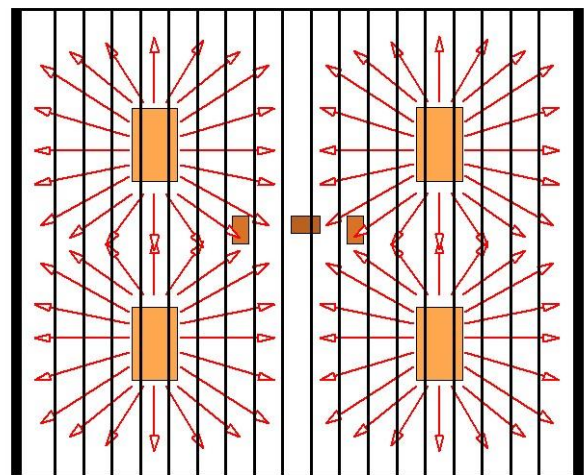
Heat distribution is completely symmetrical, resulting in the use of a smaller heat sink, or in other words: more power with the same heat sink. Playing quite loud, the heat sinks just get hand warm.....

Compared to the original design we can drive twice as much power with 20% less cooling surface -)

NOTE: All three pictures above are in the same scale.



CS-120 (off scale)



CS-165 (off scale)

Extra info

Our modules can drive that much peak current (80A peak per Hexfet pair....), that we even left out the output coil in the output, normally preventing peak currents BUT also causes lack of impulse response..... Due to this peak current capability, the fuses will blow before the Mosfet does.

The Voltage Stage PCB has similar connectors (+/- VS-Power, DC/AC in, Ground) on both sides, one side can be used for the input/output connector board. On the front side of the amp, same connectors are available where f.e. a V.U.-meter system or mode switches can be connected. A DC-servo circuit, maintaining DC-output to 0V, can also be connected here.

The CS-165 even fills the 450x210x500mm MODU Pesante Dissipante Cabinets with FOUR pairs of HEXFETS using two pairs of additional stacks. Theoretically this could deliver over 2,5kW (48A constant current, 320A peak, 60Vrms)..... We should try that ;=))). Drains full 16A/230V from the power grid.

On the other hand, a very nice built and small mono block feeding up to 300 Watts/8ohms into a nice speaker system will match lots of demands too as we believe.

On our request MODU developed a 230mm and 330mm wide [Mini Dissipante](#) 80mm and 120mm high cabinet for such mono block purposes. These cabinets fit 2x CS-80 (bridged) with a single PS-6 power supply board.

We can't wait to build one of these....



At the left the smallest Monoblock we can build in a 230x124x40mm cabinet.

Some of our Current Stage modules, marked LP (for Low Profile), are less than 40mm high, even fitting in MODU Galaxy 40/80mm high cabinets. The smallest one is a CS-40PS LP in a MODU Galaxy 124x230x40mm housing. Of course for lower power purposes, unless you use a forced cooling by a fan.

MUNDORF MLGO capacitors

Most of you seem not interested in the quality of the power supply capacitors used. If you follow the total signal current path, you'll notice that these capacitors need to form a shortcut for AC-signals in order to get a closed loop. This will never happen unfortunately, since we have to deal with series resistances, inductances, etc. In order to come close to it, most suppliers use a batch of capacitors in a bank in an effort to get the total ESR (Equivalent Series Resistance) as low as possible, also looking nice. However, this is basically done due to lack of superior power supply caps. Doing so, inductance increases though, slowing down the power "punch".



As one of the improvements we made is the use of the best available power supply capacitors in the market today. Check out the [MUNDORF Power Supply capacitors](#) ranges and find out more about these superior parts with extreme low ESR and ESL (inductivity) values. Not using bad conducting steel rods as about everybody uses, but solid Ø1,2mm copper rods. MLGO's are not "hanging" on the PCB soldering, but glued to the PCB first by a 3M double sided glue ring and then soldered **mechanically stress free** in the PCB. Repair technicians know that most common failures in electronic equipment is caused by "cold" soldering of power supply capacitors caused by stressing the soldering mechanical, resulting in bad

soldering over time. Not with these! Of course, these MLGO's are withstanding 125° and have a serious lifecycle of 16.000 hours. Read the documentation and find out even more. In fact, exchanging your (probably

worn out with mostly a life cycle of only 2000 hours) power capacitors in any electronics by some of these will improve your total sound system in a similar way as better cables, connectors, spikes, etc. do.

Power Supply capacitors are available in a number of values, voltage rates, quality levels and lifetime cycli. Did you know that in most (even high prices) equipment capacitors are used rated at a lifespan of only 1000-2000 hours????? So, exchanging the ones in your existing equipment could be a good idea.....

Production

All our modules are completely soldered by hand in house, noticeable by the shiny soldering's. A soldering like this lasts forever. On request we can use any other soldering than regular tin, for example MUNDORF Silver/gold solder.

Since we assemble them ourselves we even could use the special components you prefer.

We always produce in quite small amounts, so new ideas can and will be implemented fast.

Ready built, custom made amplifiers

We decided that we offer ready built amplifiers as well. Actually we already have built some.

They all are bespoke amplifiers, so we make them the way you want them, of course within the parameters and possibilities of the modules.

Since our modules have a wide variety, we can build lots of different models. In order to give you an idea about pricing, we have made a separate website: www.eltimaudio.com

If you decide for a hand build amp, we [will discuss](#) with you how we have to make it (which modules to use) or order one of the examples listed. You can also give us your own ideas and we will try to implement it. Delivery takes about 3-4 weeks after your payment is received.

Sound quality

Our first amplifiers run for four years now as you would use it yourself, without any problems at all.

We (and others) have listened to different bespoke amps, all sounding amazingly clean and natural.

Read f.e. the [review where our CS40ps HRQ is tested against the famous HYPEX NCore](#) module (in Dutch).

They all came to the same [astonishing conclusion](#): These amps sounds better than about all the high-end stuff they listened to so far with great pleasure. Nicer, warmer (tube like) 3D, rock solid bass, no sharp s and t sounds etc. One word came up all the time: *EMOTIONAL* That's exactly what we wanted to achieve -)

Documentation

We made a [special page](#) where all actual info bulletins, datasheets, etc. are available.

Components

We also have other very interesting, rare, audiophile chips, transistors and passive components available in [our webshop](#). We provide f.e. very nice [MODU electronics cabinets](#) (base of all our designs), [EXICON](#) Mosfets (specifically designed for the highest quality analogue amplifiers), [THAT](#) audiophile analogue (!) [IC's](#), [power supply capacitors](#), Mundorf and Intertechnik crossover components, [drive units](#), [connectors](#), [phono cartridges](#) / [replacement styli](#) and many more nice, often hard to find DIY stuff..... -)

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Our A2300 HRQ [demo](#) amplifier with

- CS-40ps HRQ Current (output) Stage modules
- VS-20L Voltage Stage (input) modules
- VR-3/30 Voltage Regulator modules
- 2x 160VA, 2x30V transformers
- RIKE-S input capacitors as extra in top back corners

We can ship this one to you, so you can listen for a week. We ask € 200,- , to be refunded or as a down payment.

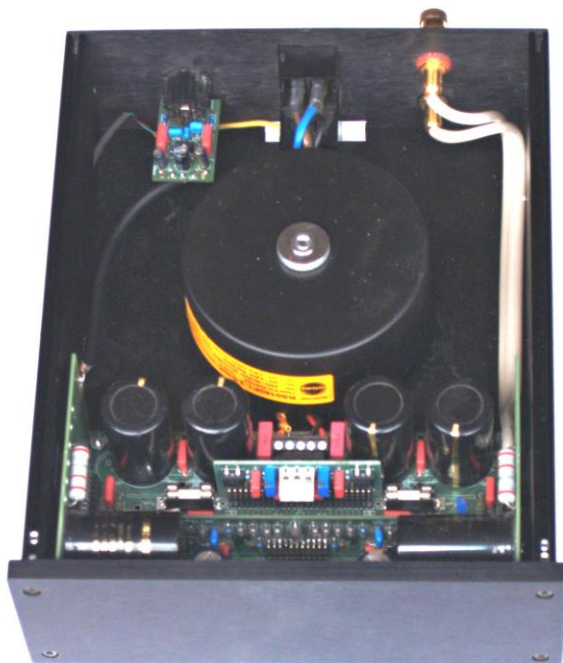


Very first custom built ELTIM A3300 HRQ model without top panel.

You can call this customer under **+31 (0)517-642020** and learn more about his experiences.
In August 2015 we modified this amp with larger transformers, V-caps over the power rails, etc.



Very first custom built ELTIM A2280 RQ model without top panel.



Our first Monoblock as we use for some time now ourselves. Makes around 130Wrms/8ohms. We also could make a 40mm higher version of this one, producing around 200Wrms. Per 2018 we also have other, way larger combinations available. With those you can make about any Monoblock amplifier you want actually.

Notice the small PCB at left top corner.
This is a balanced to line converter/buffer circuit we