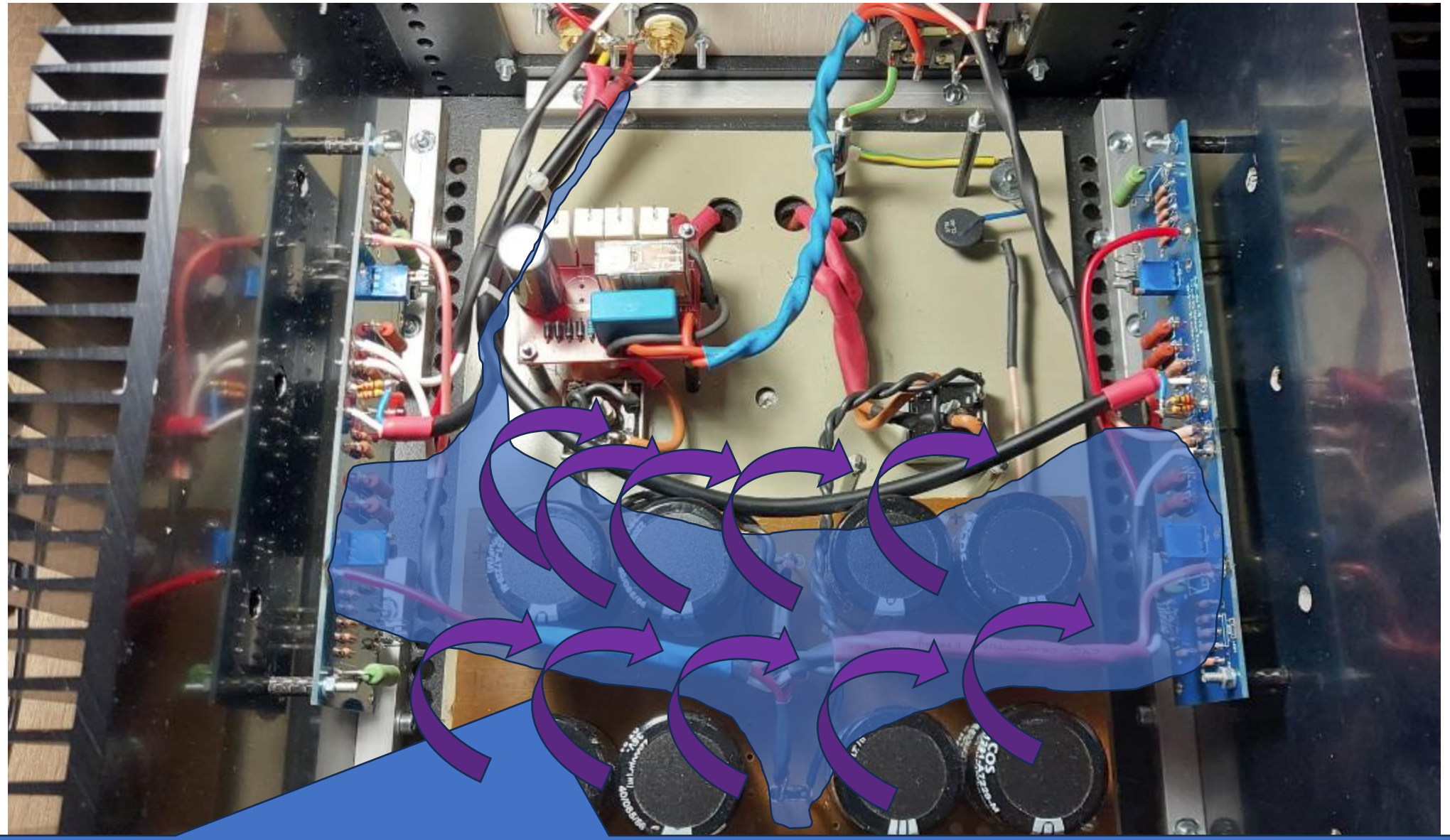
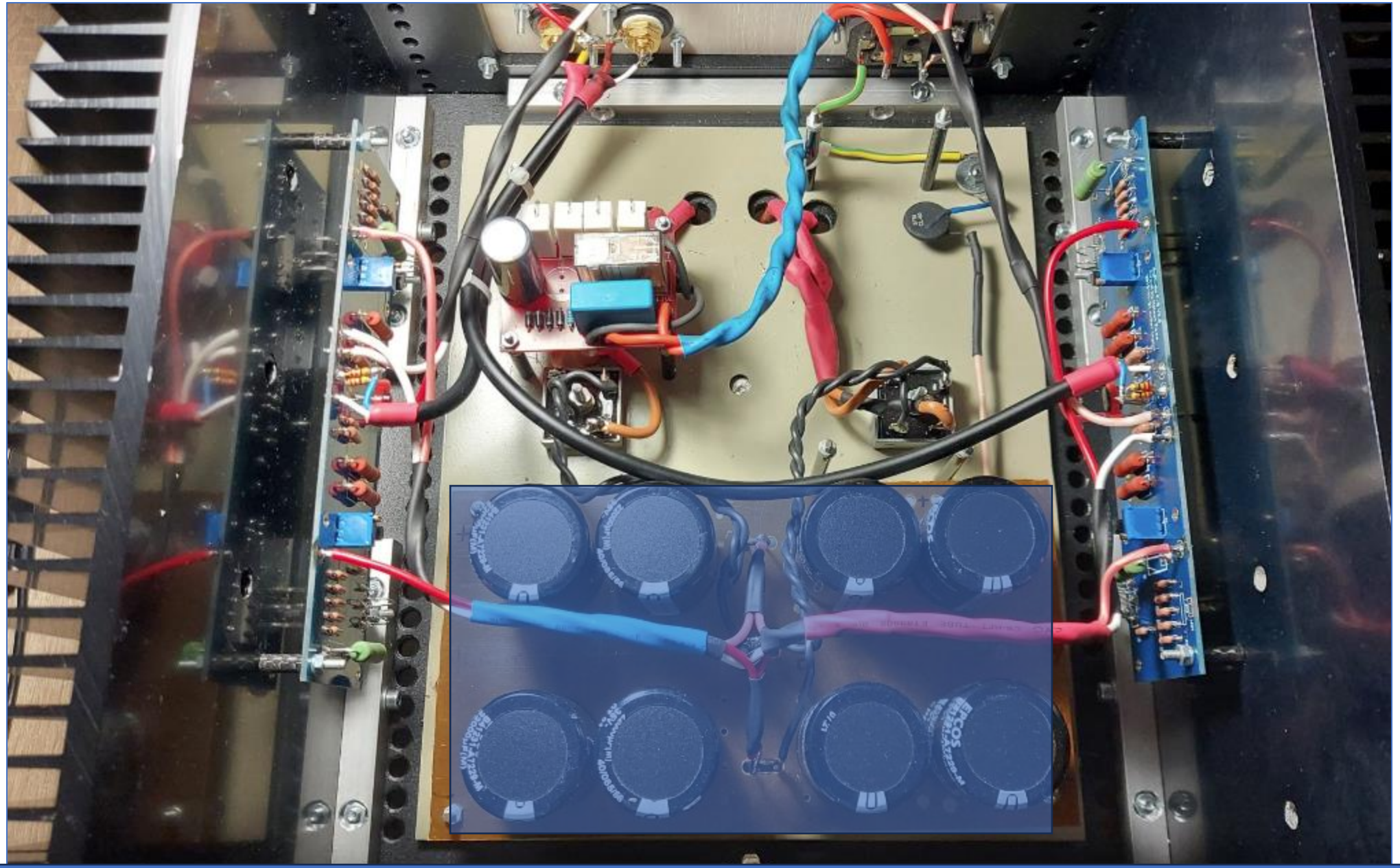
Notes

- The following slides will help to isolate the noise problems and implement wiring changes to reduce or remove radiated and/or common impedance noise arising in the amplifier.
- Note carefully, the cures on the following slides *will not fix* amplifier power supply rejection ratio issues – that is a separate problem and must be addressed through a cap multiplier or CRC PSU (but see important comments later on)
- The recommended cures are limited to the internal wiring and layout since I am not familiar with the PCB layout and circuit details



The blue shaded area is your cross-channel loop area. There are very high charging currents flowing in the CRC PSU and the loop area of the CRC is also very large. On the underside of the photo is the transformer – although a toroid with a notionally low EM field has been used, it will still generate enough of an EM field to create a problem given the large cross channel loop area. The cross-channel loop area can also exist on the PCB, but I have not shown this since I am not familiar with the board layout.

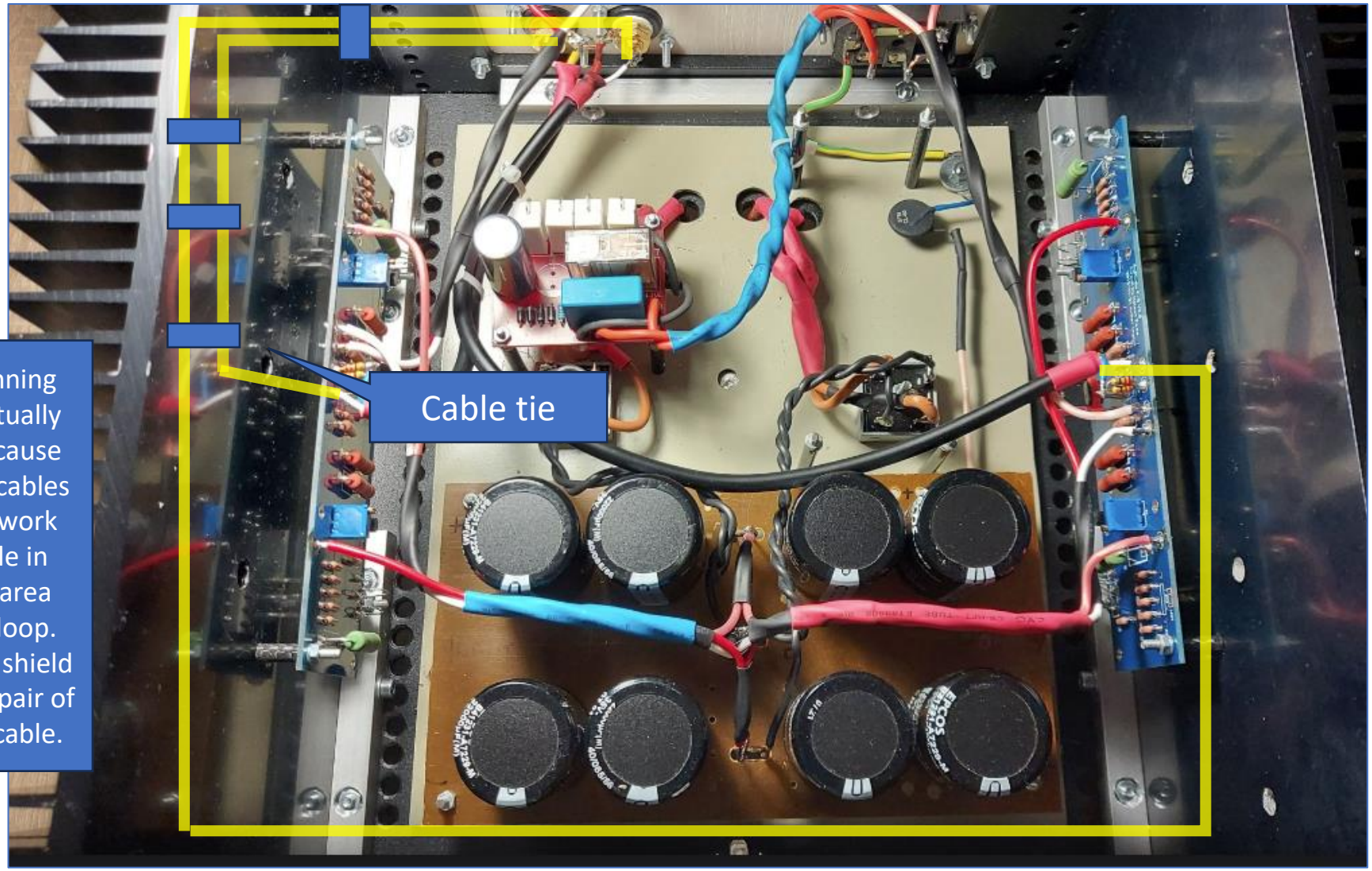


The blue shaded area is the CRC loop area which is very large. The radiated EM field will be very large since charging currents into the capacitors of 10A or more

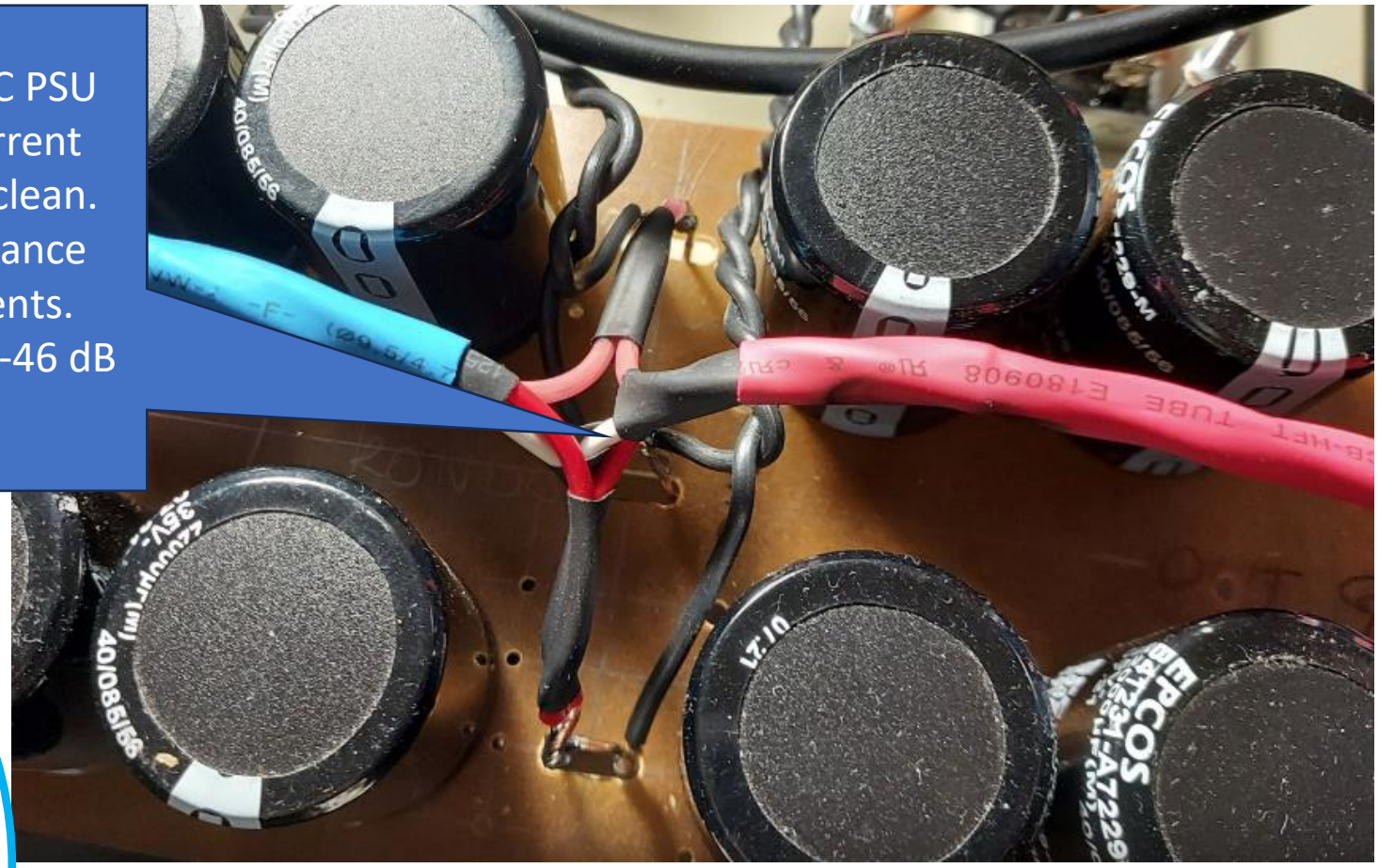
Power Supply

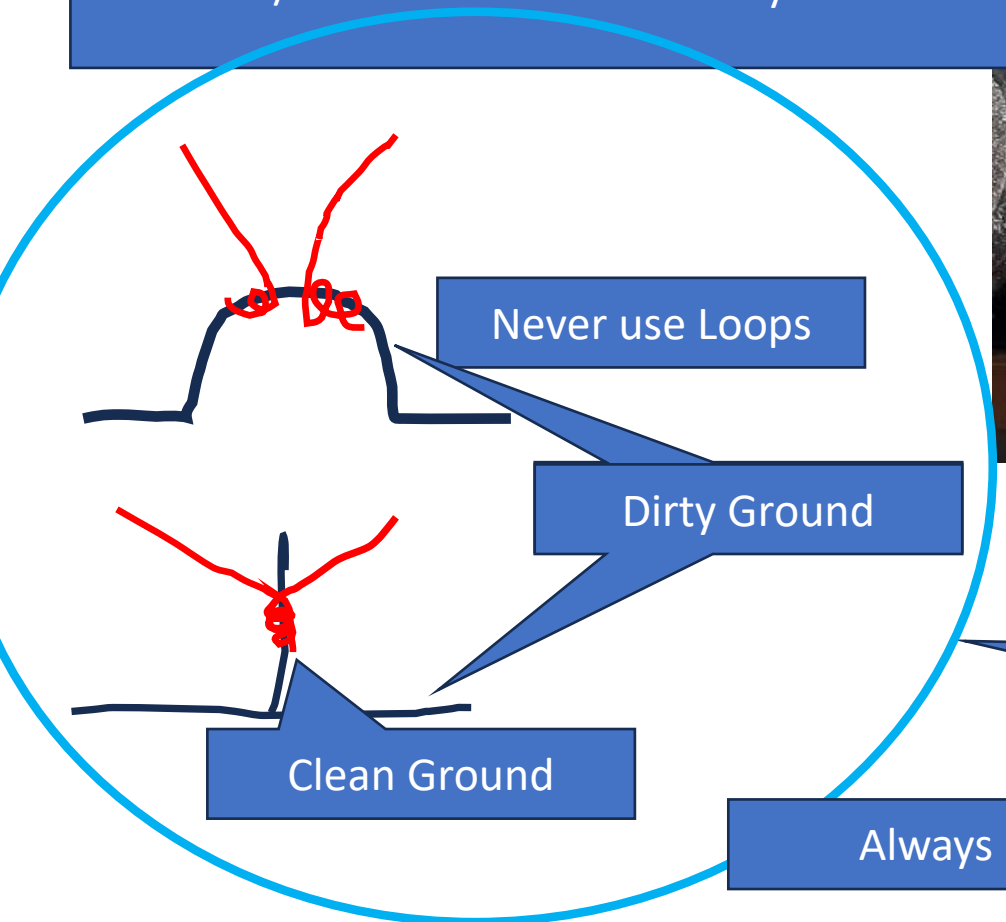
- The loop areas in the capacitor bank shown have to be dramatically reduced. Ideally, you want the +, - and 0V traces to all be laid in top of each other.
- If you are hard wiring the PSU as in your case, then keep the caps right next to each other and all connections *very short*
- Raw rectified DC must come in the one end, and at the opposite end you take the clean DC out (same comment as Ben Ma).
- If you tap off in the middle, you are mixing ‘clean ground’ with the dirty ground which has large charging currents
- Important point: There is always one and only one connection from the metal chassis to the system 0V – either directly (preferred) or through a ground lifter. With more than one ground connection to the chassis, you run the risk of a ground loop and associated noise problems

Although it seems counterintuitive, running the input leads the long way around actually reduces cross channel ground loops because the loop area is now much smaller. The cables must be run close to the chassis metal work (use Gorilla tape to hold the input cable in place) so there is no or very little loop area where PSU EM fields can intersect the loop. The loop area is now between the cable shield and the metal chassis. A tightly twisted pair of wires will work just as well as shielded cable.



You have tapped off in the middle of the CRC PSU which runs the risk of injecting charging current noise into your amplifier 0V which must be clean. Just 500 micro-Ohms of inter-channel resistance gives 5mV of noise with 10A charging currents. With a 1V input signal, that gives a best case -46 dB S/N ratio which is definitely audible.





Never use Loops

Dirty Ground

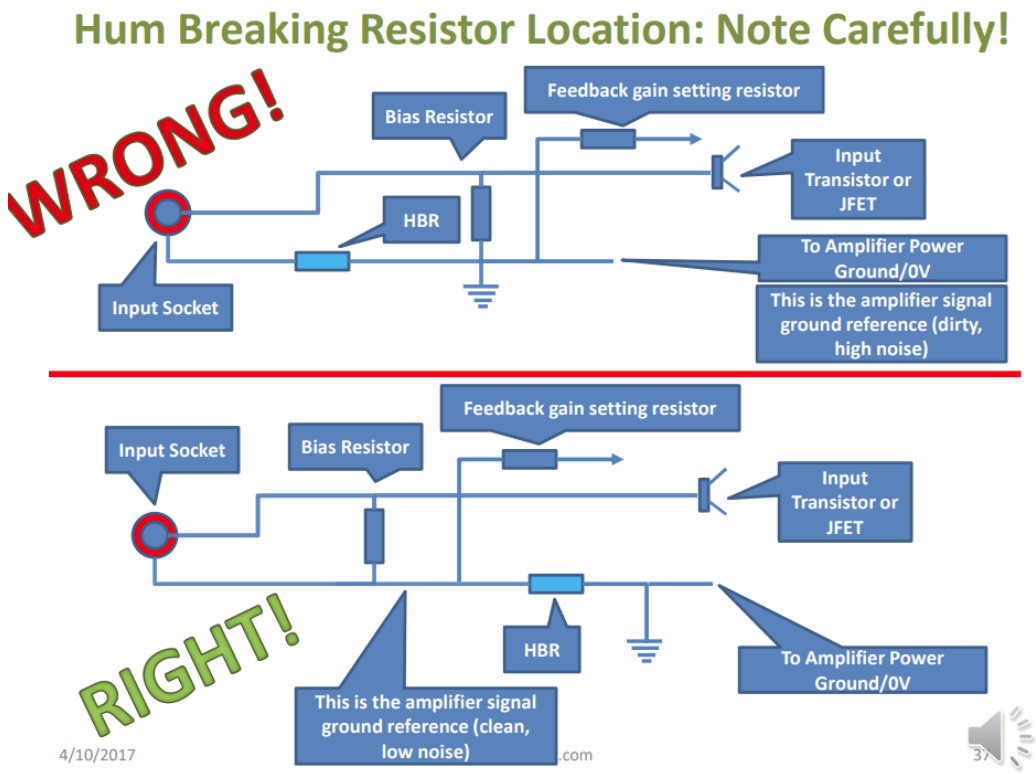
Clean Ground

Potential additional common impedance problem

Always ‘T’ Off

Hum Breaking Resistor

- Although the Hifisonix presentation says ~15 Ohms, I think this is too high (I have not changed the presentation yet!). The HBR resistor should be 2.2 to 4.7 Ohms.
- High values like 15 or 22 Ohms can give rise to other problems
- Note carefully how it is wired. If you wire it in as shown in the top part of the graphic below, it will worsen the noise problem



Rotate the transformer

- Once you have gotten the noise down to acceptable levels (means inaudible 1 metre from the speaker), try rotating the transformer by +-60 degrees. You will find a null point which can be up to 10 dB quieter.

‘Headphone Scope’ Trick – Quick and Easy Hum/Noise Debugging (1)

A pair of 90 dB at 1mW headphones is about 1000 times more sensitive than a loudspeaker – a typical spec being 1 Watt for 90 dB SPL at 1 meter. Relatively speaking, that’s of the same order as a good high gain, low noise measurement preamplifier.

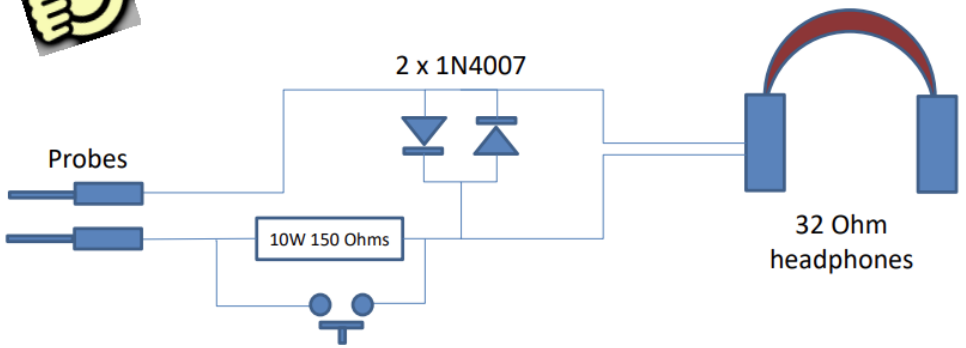
Connect a pair of headphones directly to the output of your amplifier **(do this AFTER it has been switched on and the outputs have settled)** and without any input source connected. Make sure your amp does not have any DC offsets

You can then experiment with cable dressing, transformer orientation etc to get the lowest noise on the ‘phones.

On a *really good* layout and execution, you should struggle to hear any hum/buzz on the headphones. **Disconnect the headphones before powering down your amp.**

Once you are at this level, you can then use a sound card to do further debugging. A good, practical result will be -90 to -100 dBV as measured on a sound card.

Headphone Trick – Protecting your headphone from overload (2)



Connect the headphone probe across the amplifier output terminals.

Here is a simple way to protect your headphones when using the headphone to probe cable dressing and layout in your amplifier and it will also protect your ears of you happen to probe in the wrong place. You can fit a pushbutton switch across the 150 Ohm resistor – if you hear nothing or little noise, depress the switch to momentarily improve the sensitivity.

Do not connect the headphone probe across DC!

Once you get your amplifier noise down so its quiet (inaudible or barely audible at 1 metre from speaker), use the headphone trick to further optimise your wire routing and layout.

Final target results

- With inputs open and ear against the speaker cone, you may hear a *slight* hum. This is normal.
- With inputs shorted and a young ear against the speaker cone, you should struggle to hear any noise – ideally it will be absolutely silent. This means you have no internal ground loops or common impedance coupling problems
- With a cable connecting the left to the right channel, you should hear no noise with ear against the speaker cone. This means you have no cross-channel ground loop arising in the amplifier.
- If you hear noise with the source connected, you have an external noise problem – either a classic AC ground loop, or cross channel ground loop in the source gear.
- If you have a classic AC ground loop, a ground lifter may help to break the loop and keep the system quiet. Be aware of the safety implications – the chassis must ALWAYS be directly connected to safety ground and it is the amplifier 0V that is ‘lifted’