Bridging Amplifiers

This is probably one of the most controversial topics in car stereo. Most are mystified by both the specifications and the way in which amplifiers are bridged. The term “Bridging” is really not a correct description of what we are trying to achieve when connecting amplifiers in this mode. The old professional term was “Strapping”. Anyhow we shall stick with “Bridging” since we are all used to it.

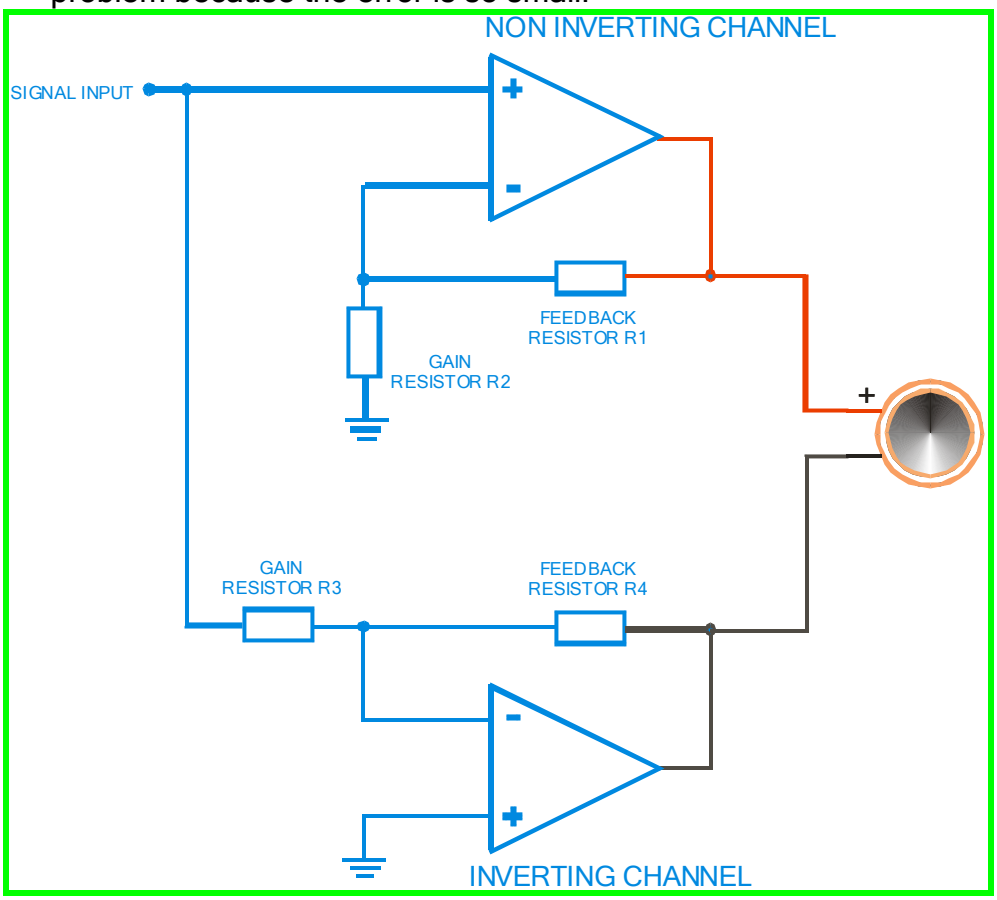
When we bridge an amplifier we actually stack the two channels one on top of each other. Not physically but electronically. What we do is to ask one channel to handle the positive side of a waveform and then the other channel to handle the negative side. This sounds rather confusing so let’s show an example. We have a 100w/ch amplifier at 4 ohms which doubles power into 2 ohms. The power supply rails are +/-33v (33 peak x 0.7071 = 23.33 volts RMS). We require that we deliver 20 volts into our 4 or 2 ohm load. So the 23.33 is fine as we have some losses in the output stages due to output device saturation volt drops. The specification of this amplifier in **bridge mode** would read as follows: 200 watt mono into 8 ohms and 400 watt mono into 4 ohms. Look at these numbers carefully and they are not magic. The 200 watt 8 ohm is derived from the 100+100 at 4 ohm and the 400 watt 4 ohm from the 200+200 at 2 ohm specifications.

What has happened is that the load impedance “seen” by **each** of the two channels in bridged mode is 50% of the total load impedance. So an 8 ohm load in bridge equals a 4 ohm load per channel in two channel mode and a 4 ohm load in bridge equals a 2 ohms load per channel in two channel mode. Since our amplifier is only rated down to 2 ohms per channel, it **CAN ONLY** drive a 4 ohm load in bridge mode.

Let’s return to those supply rails. Assume we wanted to build a single channel amplifier which is equal in power rating to out stereo amplifier when bridged our mono block specification would be: 200 watts at 8 ohm and 400 watts at 4 ohm. So as a designer I must choose the power supply rails which will allow me to deliver this power. The exercise is simple. Here goes. 200w/8 ohm or 400w/4 ohm means I must deliver 40 volts RMS into my load. (40x40/8 = 200 and 40x40/4 = 400) Take 40v RMS and we add in some extra for output stage losses (say 3 volts). Now we have 43 volts RMS, multiply it by 1.414 (To arrive at the peak for the supply rails) and we get 60.8v. This is very close, but not equal to our stereo 100w/ch amp which used 33 volt rails for a total of 66v – when in bridge mode. Here we only have 60.8v rails in the mono block. Why the difference?
The bridged amplifier has the output stages of each channel in SERIES, and because of this there are DOUBLE the volt drop losses in the output stage. In the mono block however we just have a single push-pull output stage with ONLY ONE volt drop loss.

How do we bridge channels of amplifiers? This is done by simply driving one of the channels with a 180 degree phase inverted copy of the signal OR making the second channel of the bridged pair an INVERTING amplifier. We use the latter method at Zed Audio. It is important that each channel has the same gain structure so that the final signal from the bridged pair has equal positive and negative halves of the waveform. Typically in practice this is never the case and the result is that the channel with the lower gain,

technically clips its portion of the wave a little early. We have not found this to be a serious problem because the error is so small.



Referring to the above diagram I have depicted the channels using the op-amp symbol of a triangle with a + and – inputs and an output. Power supply rails are left off for clarity. The signal is fed to both channels (The Y-Adaptor which you use to feed the mono signal to both RCA inputs) and the signal is phase inverted on the bottom channel. The gain structure of the NON-INVERT channel is R1+R2/R2 and the gain of the INVERT channel is R4/R3. This diagram shows one way of inverting the signal. As I said above one may use two NON-INVERTING amplifiers and simply have a phase inverter in front of one of the channels.

Let us examine how the amplifier delivers the power. Let us consider the top NON INVERTING section. It runs of +/-33v rails. It can therefore develop 20v RMS from its output with reference to ground. (Do not forget that this is our same 100w/ch 4 ohm amplifier example) Let us say a positive waveform is injected at the input at an amplitude of 1 volt RMS. Let us also assume that each pair of the bridge has gain structure of 20x (It will amplify an input signal twenty times). The output from the top amplifier is 20v RMS in a positive direction. Meanwhile the bottom INVERTING channel has not been sleeping! It has taken the 1v input and inverted its phase and therefore will develop a 20v RMS signal BUT in the negative direction. Since the load (speaker) is connected between the two “hot” outputs and the top channel swings the signal 20v positive and the bottom 20 volts negative, a total of 40 volts is impressed across the load. This is how the 40 volts is developed. Remember 40 volts into 8 ohm equals 200w and into 4 ohm equals 400w.

The two channels being bridged do not have to be a pair in a single chassis. Zed's mono blocks are bridgeable by simply feeding the second mono block from the first with a phase inverted signal.

An amplifier pair which is in bridge mode CANNOT be re-bridged with another amplifier which itself is in bridge mode or another non bridged amplifier. This is because of the grounding system we at Zed Audio use. This would only be possible to bridge two bridged amplifiers if their grounding systems are 100% isolated and the centre tap of the transformer secondary swings with the signal. I know of no mobile amplifier which does this and there are very few professional amplifiers which have their transformers configured to accommodate this.

Note: When bridging any amplifier, please keep in mind the minimum load impedance which the manufacturer states. If it is 2 ohm per channel then minimum bridge impedance is 4 ohms. So minimum bridged impedance is twice the minimum per channel.