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# Amplifier Output Attenuator

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Most guitarists feel that the best sounding distortion comes from a tube amp turned up almost full volume. Unfortunately, this is often not practical because it can be painfully loud, may disturb others, and be too loud for the place you are playing at.

One solution is to put a passive load between the amplifier and the speaker to absorb some of this excessive volume. There are many ways to do this. Probably the easiest, cheapest, and still pretty effective way to do this is with power resistors between the amplifier and the speaker. I understand this is the technique used by the old Scholz Power Soak, THD Hot Plate, Dr. Z Air Brake, and many other commercially available units.

Again, there are many ways to do this passive resistor load. A lot of these techniques, including the ones used by many commercially available load boxes, don't maintain a constant impedance load to your amp as you change the attenuation. People debate whether this is important. You can search the net for these discussions. I decided I wanted to keep a constant impedance load to my amps.

The L-pad is one attenuator technique that maintains a constant impedance load to the source, a guitar amp in my case. But it still provides a variable impedance to the load, the speaker in this case. Again, many debate whether this is important.

The bridged T attenuator technique does present a fairly constant impedance to both the source and the load. Figure 1 is a schematic of a bridged T attenuator. Varying R1 and R2 changes the attenuation. If your source and load impedances are the same, then R3=R4=load or source impedance. The values shown are for an 8 ohms source and load impedances and a 3 db attenuation.

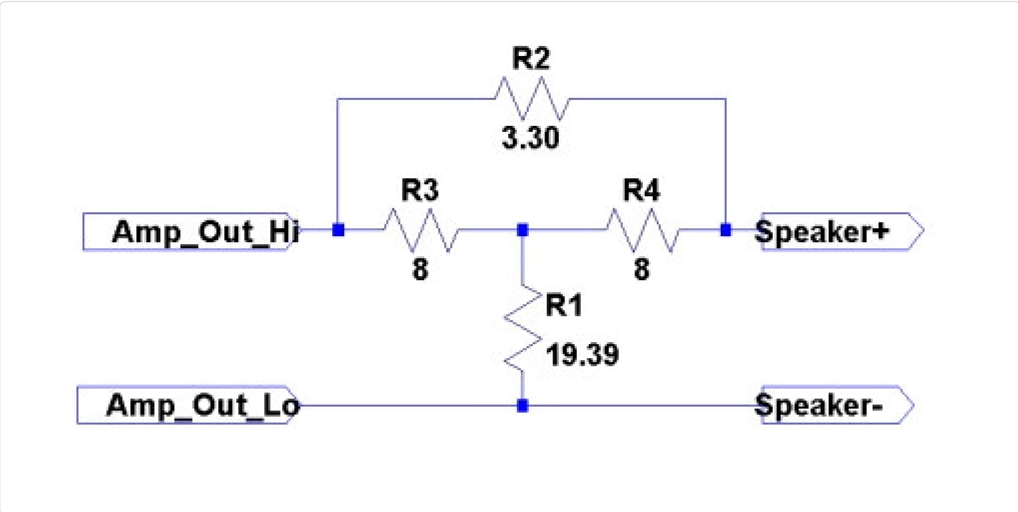


Figure 1 - Typical bridged T attenuator

**http://amps.zugster.net/articles/attenuation** [http://amps.zugster.net/articles/attenuation] has more information on the bridged T and L-pad attenuators. It also has a table for the component values for different attenuation levels. Table 1 below shows the values I would ideally need for the attenuation levels I wanted for a box for 8 ohm amplifier and speaker impedances.

Table 1 - Ideal resistor values for passive attenuator

| Attenuation (db) | R1 (ohms) | R2 (ohms) |
|---|---|---|
| 0 | open | 0 (short) |
| - 3 | 19.39 | 3.30 |
| -6 | 8.04 | 7.96 |
| -9 | 4.40 | 14.55 |
| -12 | 2.68 | 23.85 |

Figure 2 is the schematic of my resulting attenuator box. I tend to build my stuff out of parts I salvage from other stuff people are throwing away, such as old TV sets, organs, computer CRTs and power supplies, etc. It is called "recycling" by some. I dug through my parts boxes and put power resistors in series and parallel combinations until I got the approximate values and combined power levels I desired. I don’t show all these different resistors but only the resulting values of the combinations. Since buried with all these resistors were already an 8 ohm and 4 ohm passive load, I added two more switch positions for 8 ohm and 4 ohm passive loads, which are useful for testing amplifiers without speakers attached.

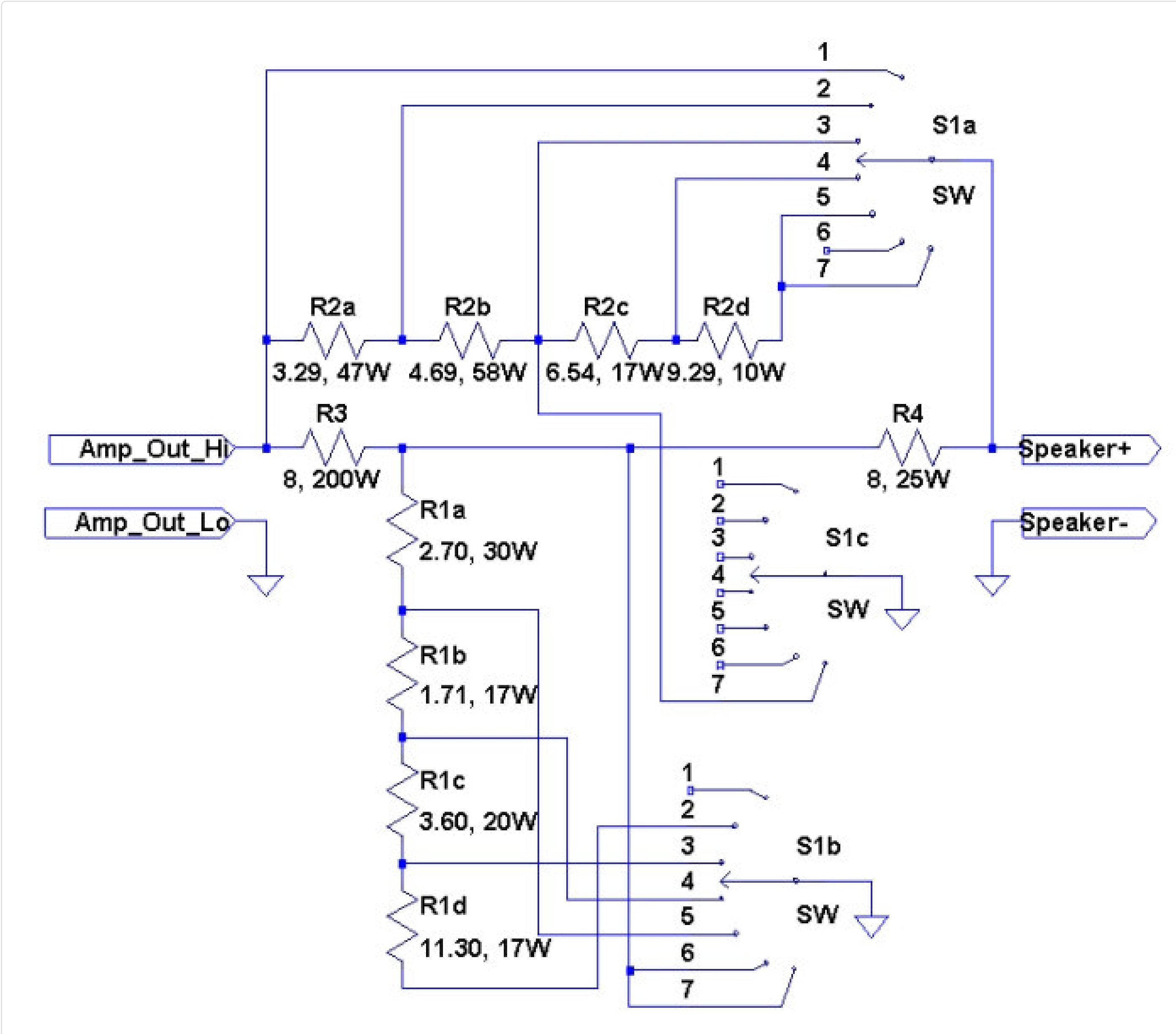


Figure 2 - Schematic of my attenuator box

I achieved my desired resistor values by putting resistors from the various switch positions in series. For example, to get - 6 db attenuation, I would switch to switch position 3. At this switch position, R1 in Table 1 is approximated by R1d and R1c in the schematic in series and R2 in Table 1 is approximated by R2a and R2b in the schematic in series. Table 2 shows what the ideal values for these resistors in the schematic should be and what I was able to achieve with my series/parallel combinations.

Table 2 - Resistor values for my passive attenuator

| Resistor | Ideal value (ohms) | Min power (W) | Actual value (ohms) | Actual power (W) |
|---|---|---|---|---|
| R3 | 8 | 100 | 8 | 200 |
| R4 | 8 | 25 | 7.96 | 25 |
| R1a | 2.68 | 18.8 | 2.70 | 30 |
| R1b | 1.72 | 9.0 | 1.71 | 17.3 |
| R1c | 3.64 | 11.4 | 3.60 | 20 |
| R1d | 11.35 | 12.1 | 11.30 | 17.1 |
| R2a | 3.30 | 20.7 | 3.29 | 47 |
| R2b | 4.66 | 29.3 | 4.69 | 58 |
| R2c | 6.59 | 10.4 | 6.54 | 17.4 |
| R2d | 9.30 | 7.4 | 9.29 | 10.7 |

Note these are calculated values, not measured. I don't have equipment that can measure resistances that accurately. I don't think it matters, either. Plus or minus 10 % is probably good enough.

Also, the minimum power shown in Table 2 is for a 100 W minimum power rating at all settings. I calculate that, with the components I used, I achieved a minimum of 140 W for all the attenuation settings and 200 W for the passive 4 and 8 ohm load settings. If you want a different power rating for your load box, just adjust these minimum powers proportionately. For example, for a 200 W attenuator box, double all the minimum powers in column 3 of Table 2. Just to be safe, I would avoid using this box or any other attenuator box on any amplifier that is anything close to the rated power level of the box.

In theory, R4 doesn't have any current flowing through it under steady state conditions.

One might think you could just delete this part or use a very low power resistor for R4. In fact, I understand that the Dr. Z Airbrake, designed by Ken Fischer of Trainwreck fame, does omit this part. But I suspect it does have an effect during transients, so I left it in, especially since I had the parts lying around and it cost me only some time to include it.

Table 3 shows the attenuation for each of the switch settings. I used a pushbutton switch assembly I salvaged from the rhythm section of an old organ (I removed the "Foxtrot" "Waltz," etc., labels off the pushbuttons.) You will probably have a next to impossible time trying to find an equivalent switch assembly. An alternative is to use a double pole, six position rotary switch. Just don’t wire up switch position "7." If you still want to be able to switch to a 4 ohm passive load, replace S1c in the schematic with a SPST toggle switch. This toggle switch would be left open for all settings of S1 except position 6, where open on the toggle switch would select the 8 ohm passive load and closed would select the 4 ohm load. But be sure to return the toggle switch to open before using any other settings on S1.

Table 3 - S1 Switch positions

| S1 Switch position | Attenuation (db) |
|---|---|
| 1 | 0 |
| 2 | - 3 |
| 3 | - 6 |
| 4 | - 9 |
| 5 | - 12 |
| 6 | 8 ohm passive load |
| 7 | 4 ohm passive load |

Be sure that whatever switches you end up using have adequate current capability. For example, a 100 W, 8 ohm impedance load box can have over 5 amps peaks running through the switches, a 200 W, 8 ohm box twice that (10 amps), a 200W, 4 ohm box 3 times that (15 amps), etc.

Figure 3 shows a top-front view of my attenuator box. The case is from a old AM-FM tuner I got for $1 at a garage sale. The organ pushbutton switches are the only controls. I obviously forgot about the one switch assembly mounting screw which intrudes on my labeling.


Figure 3 - My amplifier output attentuator box

Figure 4 shows the inside of my box. It is definitely not an artistic masterpiece, but it works and cost next to nothing. You could use series/parallel combinations of whatever resistors you have or can find to get the values in Table 2 like I did. Or you can do something like Dr. Z did with the Air Brake and replace R1 and R2 each with a big multitapped power resistor and adjust the taps to get the values you want. The Ohmite 210 series parts, either 100 W or 225 W, are good examples of these tapped resistors, which Mouser Electronics carries. These would be much easier and neater to use, though probably more expensive than individual resistors. Just remember that each tap can only handle a fraction of the total resistor rated power. For example, a 5 ohm tap on a 25 ohm, 100 W resistor can only handle:

(5 ohms/25 ohms) x 100 W = 20 W.

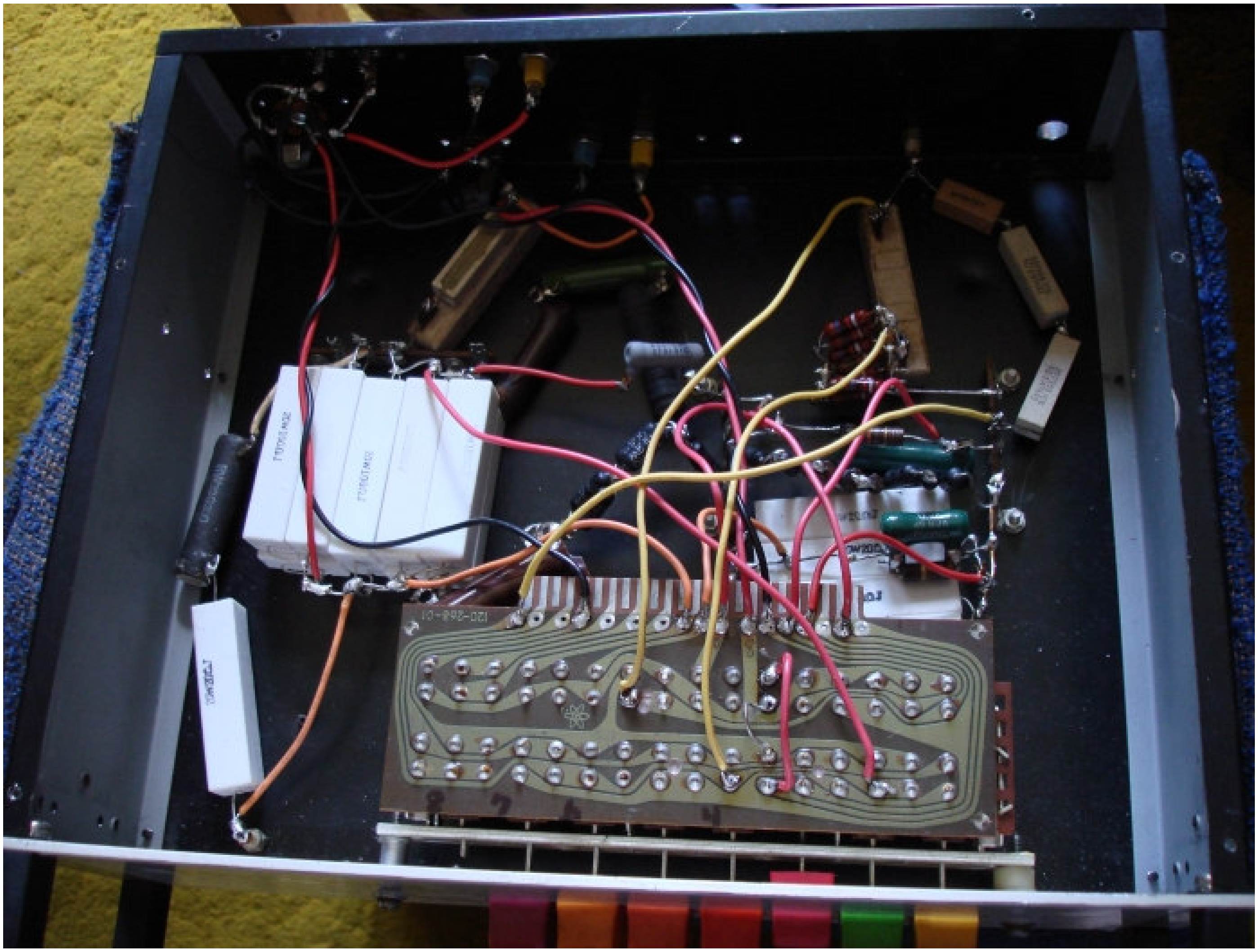

Figure 4 - Inside my amplifier output attentuator box

To use as a passive load, you still plug the input of this box into the speaker output of the amplifier. Just don't plug a speaker into the output of the attenuator box.

Does this load box sound just like an amp running at full volume, only quieter? Not quite. This is partly because the speaker is not being driven as hard, so we are missing any distortion due to the speaker. But mostly because we don't hear the same at lower volumes as at higher volumes, thanks to the famous Fletcher-Munson curves and probably other physiological and psychological effects. But I can get good sounds out of my amps at reasonable volume levels with this box, which is all that is important.

Note that using a device like this can be hard on your amplifiers. The problem is not that the attenuator box does anything harmful to your amps. The problem is that running your amplifiers turn up to their maximum volume levels is hard on the amps and their tubes, whether or not you use a box like this to attenuate their actual volume levels. So use with care.

A hint: The 4 and 8 ohm passive load positions can be useful for other stuff beside dummy loads when testing amplifiers. For example, you could use the passive load to replace one of the speakers in a twin speaker cabinet. Or, if you usually use two speaker cabinets, you could replace one of them with this box switched to the appropriate passive load position. In both of these situations, there would be a noticable drop in volume and the sound would probably be less focused and more dispersed.

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