

# Build a 2-Stage Power Attenuator for Your High Powered Tube Amp

When someone tells you to turn down your tube amp, they might as well tell you to stop having your amp sound its best. What makes a tube amp sound great can be found only when it is turned up to its sweet spot. Take away that and you might as well use a transistor amp. But yet most of the time, the amp's sweetest spot is far too loud for the occasion.

A master volume control will never get outstanding tone because it starves the output tubes for signal. The "good" distortion comes from the output tubes working hard. The only distortion you get from a master volume is the sound of a preamp tube with half the wave clipped off. This will only sound buzzy and over-compressed with homogenized dynamics. If you listen to it very long, you will develop listener fatigue.

What is needed is an attenuation device that could be placed in the signal path *between* the amplifier and the speakers so that one could turn the amp up until it sounds its best and then attenuate the signal going to the speakers so that the speakers can be turned down to the appropriate loudness for the particular room and particular situation. In a nutshell, turn the amp up and the speakers down. Not only does this allow for a great overdriven tone at the appropriate volume level, but when used in recording situations, a power attenuator will remove most, if not all, of the hiss and hum generally associated with a tube amp. When you attenuate a few db, the first thing to go is the noise!

Here are the plans for making a power attenuator that allows you to turn down your speaker by up to -12db without turning down your amp. The parts to build this attenuator will cost about \$85. Besides the true-bypass configuration, it features two toggle switches that will each attenuate -6db when switched (-12db total attenuation with both switches on) and go back to dead-nut stock when un-switched. Your tone will not be affected in the least – but the power driving the speaker will be noticeably less. And since the load impedance is kept constant regardless of which switches are "on", your amp will "think" it is just operating normally!

## Theory of operation

The idea is to use a resistor matrix to cut the both voltage and current and in doing so, we cut the power. Remember, power = voltage x current. We select the correct values of resistors so that we can attenuate both current and voltage at the correct proportion — thus keeping the impedance constant. This allows the amplifier to "see" the correct load. The device has two stages that operate exactly the same. For now, I will describe how one stage works because the second stage works exactly the same way. For the example, let's assume we are working with an 8 ohm speaker load. If you placed an 8 ohm resistor in parallel with an 8 ohm speaker, half of the current would go through the speaker and half would go through the resistor because there are now two paths for the current to go — namely through the speaker or through the resistor.

Adding this 8 ohm resistor in parallel with the speaker would change the total load impedance that the amp "sees" from 8 ohms to 4 ohms. We need for the load impedance to be 8 ohms, so to correct the 4 ohm load and to get it back up to 8 ohms; — we simply add a 4 ohm resistor in series with the existing parallel connected speaker/8ohm resistor. By adding this 4 ohm series resistor, we are also cutting the voltage going to the speaker in half. So to summarize — the 8 ohm resistor in parallel with the speaker cuts the current in half and the 4 ohm resistor in series with the existing speaker/8ohm resistor cuts the voltage in half. By using both resistors simultaneously, we are keeping the total load impedance at 8 ohms.

When we cut the current in half and the voltage in half, we end up with a -6db attenuation while maintaining the proper load impedance of 8 ohms.

If you were doing this with a 16 ohm load, you would use a 16 ohm resistor in parallel (R2) and an 8 ohm resistor in series (R1). With a 4 ohm load, you would use a 4 ohm resistor in parallel (R2) and a 2 ohm resistor in series (R1).

I have explained how one stage works. The other stage works exactly the same way. Look at **Diagram 2**. R3 and R4 are the same values and function respectively as R1 and R2. Each stage has a toggle switch and each toggle switch attenuates the power by -6db. It makes no difference which switch is flipped on first. You can use either one or both to go from true bypass to -6db to -12db. I would not recommend making a third stage because when you attenuate more than -15db, attenuation will begin to affect the tone. Attenuation with this device, however, does not degrade tone and will be unnoticeable except for the loudness from the speaker.

## Parts List for 2-Stage Power Attenuator:

**SW1 and SW2** – DPDT Toggle switch. Mouser part # 691-2BL62-73

**J1** - Input jack. Mouser part# 502-11

**J2** - Output jack. Mouser part# 502-12A

**Chassis** – metal enclosure. Mouser part# 537-138-P

**Heat sink compound** – Mouser part #5878-CT40-5

**Hook-up wire** – about 2 feet or less. Use 18 gauge.

Mouser can be reached at 1 – 800 – 34 MOUSE (1- 800 - 346 – 6873)

### For 4 ohm version:

**R1 and R3** – 2 ohm 100 watt wirewound resistor Mouser part# 284-HS100-2.0F

**R2 and R4** – 4 ohm 50 watt wirewound resistor Mouser part# 284-HS50-4.0F

### For 8 ohm version:

**R1 and R3** – 4 ohm 100 watt wirewound resistor Mouser part# 284-HS100-4.0F  
**R2 and R4** – 8 ohm 50 watt wirewound resistor Mouser part# 284-HS50-8.0F

**For 16 ohm version:**

**R1 and R3** – 8 ohm 100 watt wirewound resistor Mouser part# 284-HS100-8.0F  
**R2 and R4** – 16 ohm 50 watt wirewound resistor Mouser part# 71-RH50-16

### Let's Get Started Building

Look at all the parts and decide where they can go in the chassis. Refer the **Diagram 1** to look at a suggested layout. Look over the schematic. Refer to **Diagram 2**. Look at the parts and invest a few minutes planning – *before* you drill any holes. You've heard of the carpenter's rule: measure twice and cut once. The amp-builder's rule is to plan it twice and drill the chassis holes once.

Although it is possible to build the attenuator inside the amp, I advise not to drill any holes in a vintage tube amp. Use a separate chassis and maintain the integrity of the vintage amp.

Notice that the wirewound resistors are heatsink-able. We will mount them inside the chassis, leaving enough room for the jacks and switches. The heat sink compound is applied between the resistor and the chassis. It allows for superior heat transfer from the resistor to the chassis. You must have adequate heatsinking for the resistors to actually perform at the specified wattage rating! The component values shown will work for amps up to 100 watts and still have a margin of safety. If you would like to use the power attenuator only with a 50 watt amp, you may safely cut the wattage values of all the components to half the listed values. This would save you a little money and the device could be made smaller.

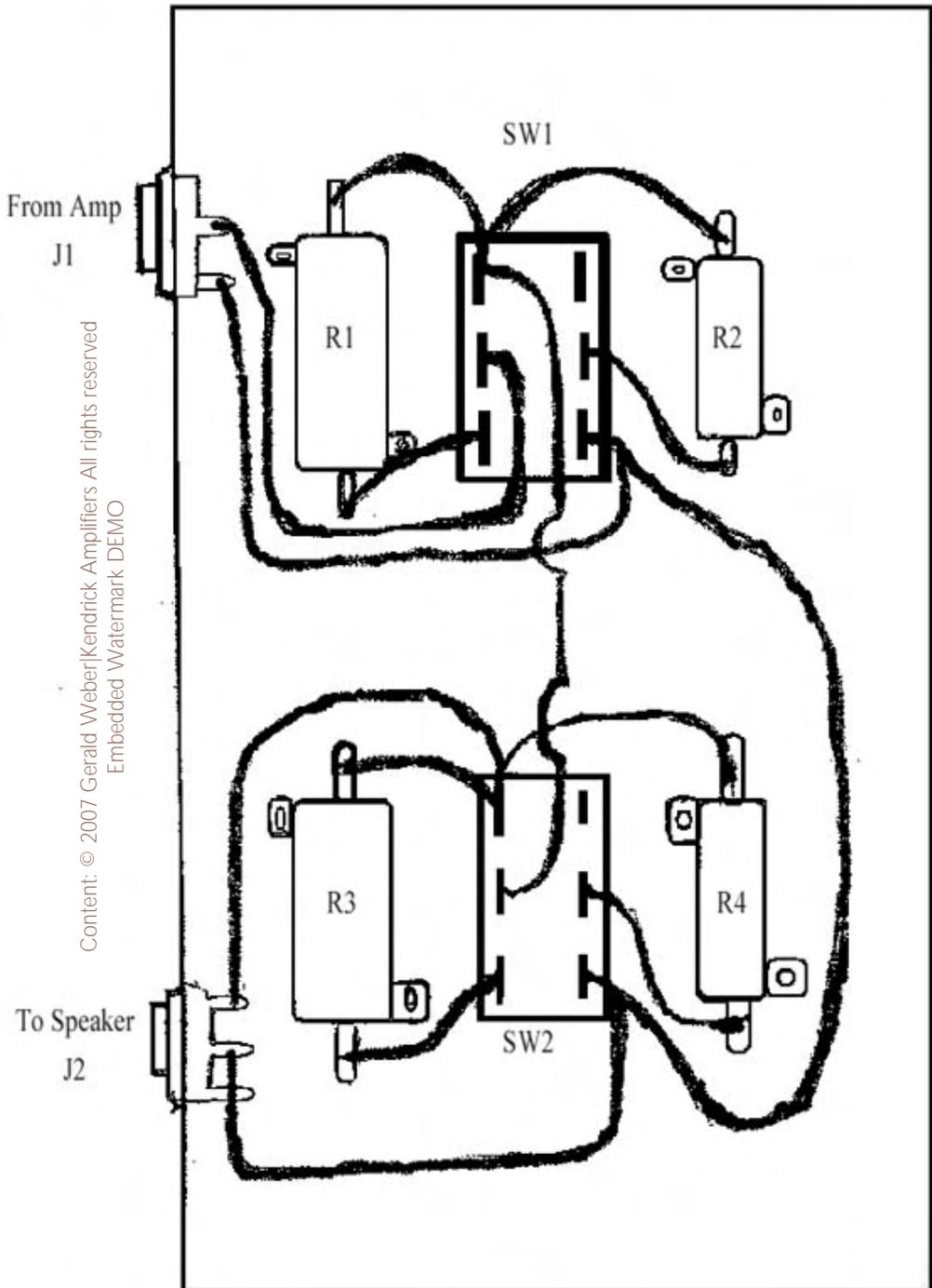
Also, notice that the output jack has a shorting switch and the input jack does not. The switch is a safety device in the event you happen to turn on the amp without a speaker plugged in to the attenuator. The switch lead on the jack simply connects to the ground lead on the same jack.

### Let's Hook It Up and Play

When the toggle switches are switched in the position shown on **Diagram 2**, then maximum attenuation occurs. But when both toggle switches are switched to the bypass position, the circuit returns to stock.

You can place the attenuator in the back of your amp and leave it there. Or you could also mount the chassis box on the wall of your amp or the inside back panel for easy access to the toggle switches. If you needed to change the attenuation level for different songs, one could use DPDT footswitches instead of toggle switches and it would be possible to change attenuation level while playing. Another usage would be for changing attenuation which channel switching. For example: turn up the volume on the overdrive channel and use the attenuation for best lead tone, but turn off the attenuation when you switch to the clean channel whose volume is already turned down for maximum loud clean headroom.

# Power Attenuator Layout and Wiring



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Diagram 1

# Two-Stage Power Attenuator Circuit

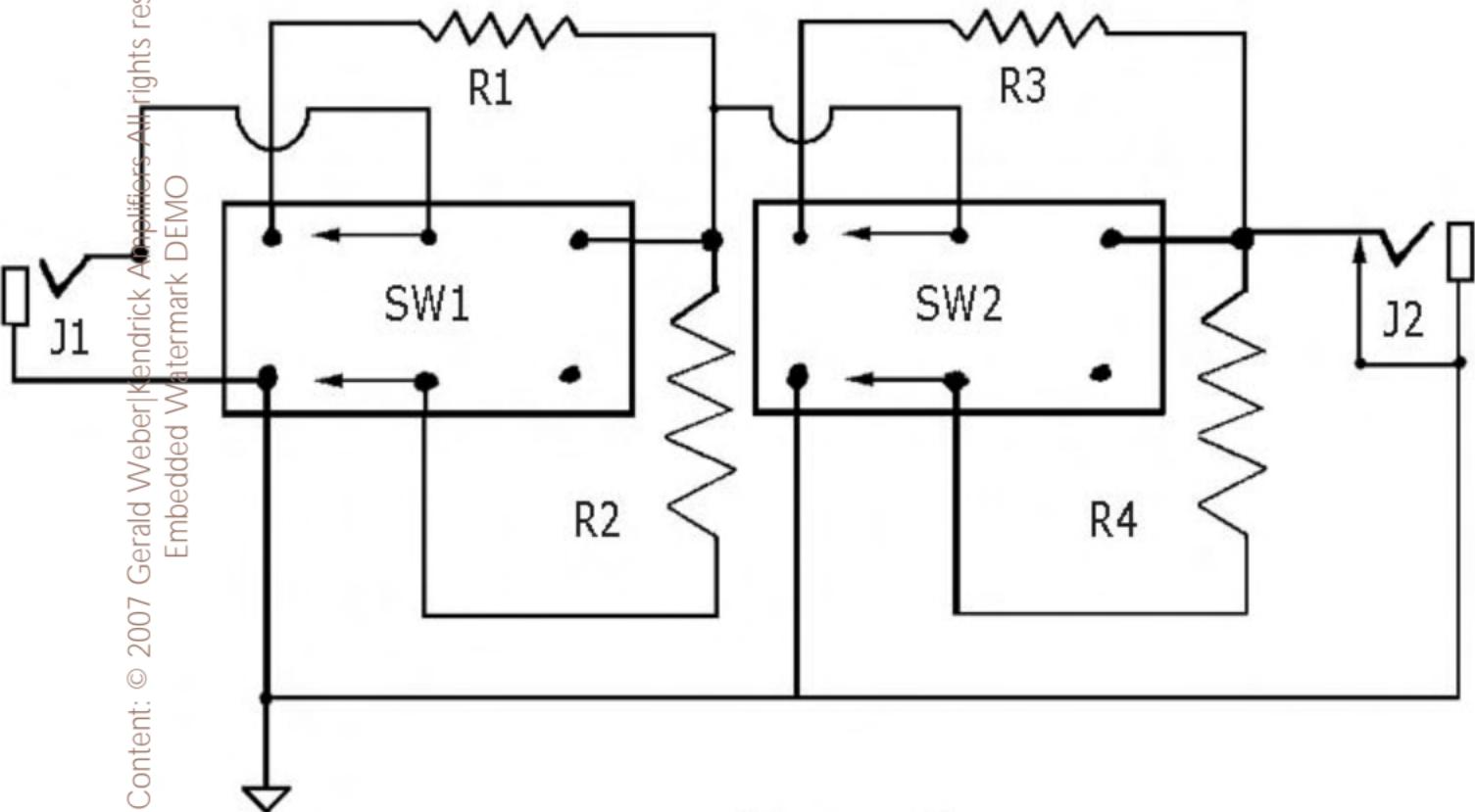


Diagram 2