

Simplify Transceiver-Amplifier Interfacing with an In-Line Attenuator
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Most high power HF amplifiers typically require less than 100 watts to drive them to full output. And all modern transceivers have the ability to have their output power reduced as necessary to properly drive an external amplifier. However besides having to remember to turn down your transceiver's output power when you put your amplifier on-line, it can also be somewhat of a hassle to re-adjust your transceiver's output power, especially if this has to be done via a menu setting. Additionally, many transceivers output a full power transmit spike when first keyed at the beginning of each new transmission even when the power has been reduced. The output power is quickly cut back to the desired output level by the radio's internal ALC circuitry, but the initial spike may cause some amplifiers to "fault" from the amplifier's internal overdrive protection circuitry. I first ran into this problem when driving my ALS-600 solid-state amplifier with my IC-706MKIIG transceiver. The ALS-600 needs about 65 watts to drive it to full output power. Turning back the power of the IC-706MKIIG to 65 watts is done via a menu setting. But the first "dit" of each new transmission would always result in an initial full power spike which would badly overdrive the amplifier.

I solved these issues by simply putting a 2dB pad in series with the transceiver's output. This permits me to leave the radio set for full power all the time, while the resulting power to the amplifier holds constant at about 60-65 watts. And with the transceiver set for full output power, a high power spike won't occur. The 2dB attenuator has no effect on the receiver signal-to-noise ratio, and makes a negligible reduction in receiver sensitivity. And finally, the attenuator even improves the match to your transceiver when feeding a less-than-perfect tuned amplifier input network – like you might have when trying to use an amplifier on a WARC band. As an example, a 2:1 load SWR becomes a 1.5:1 SWR when the 2dB pad is placed in-line.

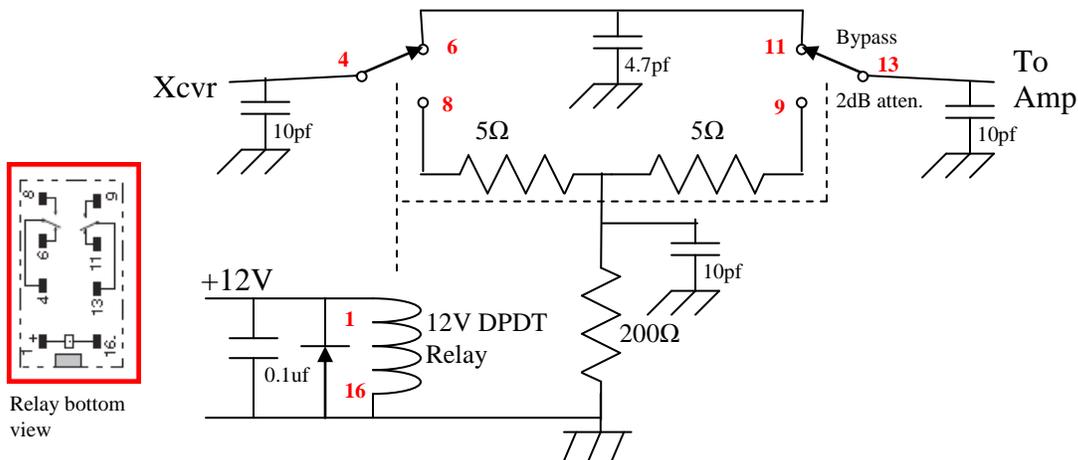


Figure 1: In-Line 2dB Attenuator

Figure 1 is the schematic of the 2dB attenuator, and Table 1 lists the parts needed. While this is not a precision attenuator, it is certainly close enough for our purposes (1.04:1 SWR when terminated in a perfect 50 ohm load, and 1.95dB loss). The resistors are

Caddock 15- and 30-watt thick-film resistors which are purely resistive well up into the VHF range. The 5-ohm resistors dissipate about 7-watts each at full power so you can use 15-watt rated resistors. The 200 ohm resistor dissipates about 20 watts so the 30-watt rated resistor is used. An internal DPDT relay bypasses the 2dB attenuator when operating barefoot. The relay contacts are rated to 3-amperes, which is more than sufficient for a 100-watt transceiver. Note that the relay coil is polarity sensitive. If desired, you may wish to use a DPDT switch instead of the relay. Point-to-point wiring is used, which works pretty well for HF operation. However, there is some stray inductance that I tuned out with the 4.7- and 10-pf capacitors shown on the schematic. While I tend to be a little anal about making things perfect, this tuning is really unnecessary for most HF applications as the SWR is less than 1.2:1 through 30 MHz without the capacitors. For your reference, Photos A & B show the untuned and tuned SWR plots of the bypassed attenuator, and photos C and D showed the untuned and tuned SWR plots of the 2dB attenuator in-line.

Table 1: 2dB Attenuator Parts List

<u>QTY</u>	<u>Description</u>	<u>Source/Part Number</u>
2	5Ω 15-watt thick-film resistor	Mouser 684-MP915-5
1	200Ω 30-watt thick-film resistor	Mouser 684-MP930-200
1	12V DPDT 3-amp signal relay or DPDT slide switch	Mouser 653-G6A-274P-DC12 Mouser 629-GF11261110
1	0.1uF 50V capacitor	Mouser 140-50U5-104M-RC
1	1N4003 diode	Mouser 625-1N4003-E3/73
3	10pF 200V ceramic capacitors	Mouser 80-C315C100J2G
1	4.7pF 500V ceramic capacitor	Mouser 140-500N2-4R7C-RC
1	2.1x5.5mm DC Power connector	Mouser 163-4304-E
*1	Cast aluminum box	Mouser 563-CU-5123 or 563-CU-123
**2	SO-239 Connectors	Mouser 601-25-7350 or 571-5-1814815-1
1	Heat Sink (depends on application)	All Electronics HS-151 or similar
Misc: #4 mounting hardware for MP930, #2 mounting hardware for MP915		

*The CU-5123 has flanges on the cover for mounting, and the CU-123 does not. So you will need to drill mounting holes in the CU-123. I used the CU-123 in my application, but I wanted to list the other option for those who prefer the mounting flanges.

**The 601-25-7350 is a standard 4-hole mounting UHF connector. You may prefer to use the 571-5-1814815-1 single-hole mount connector so you don't need to worry about drilling/tapping connector mounting holes.

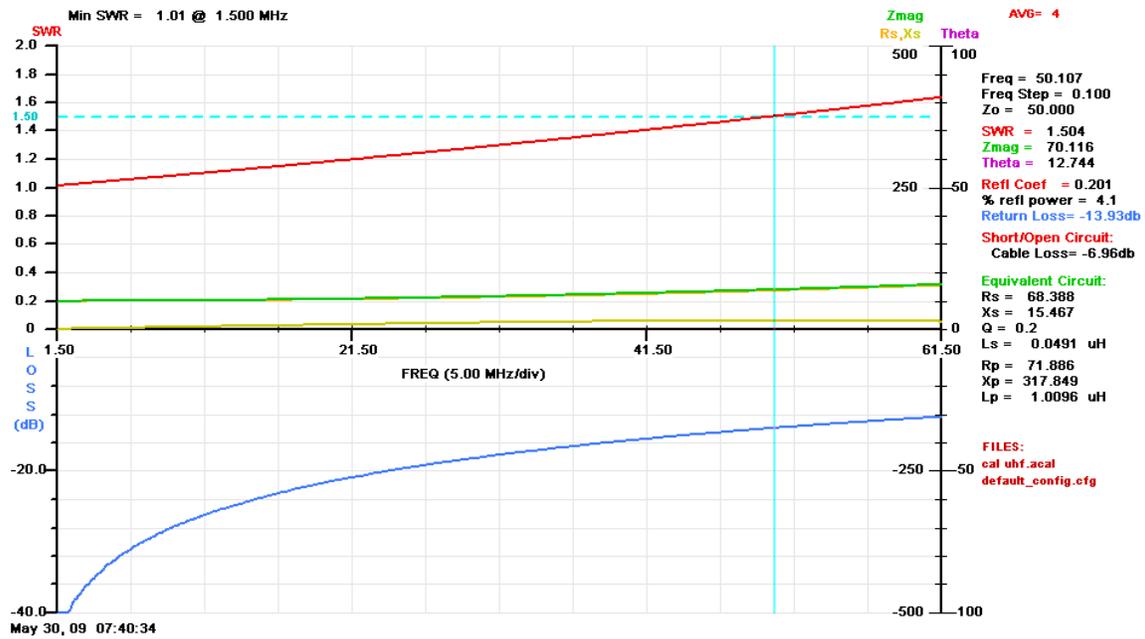


Photo A: SWR/Return Loss plot: Bypassed attenuator without tuning capacitors

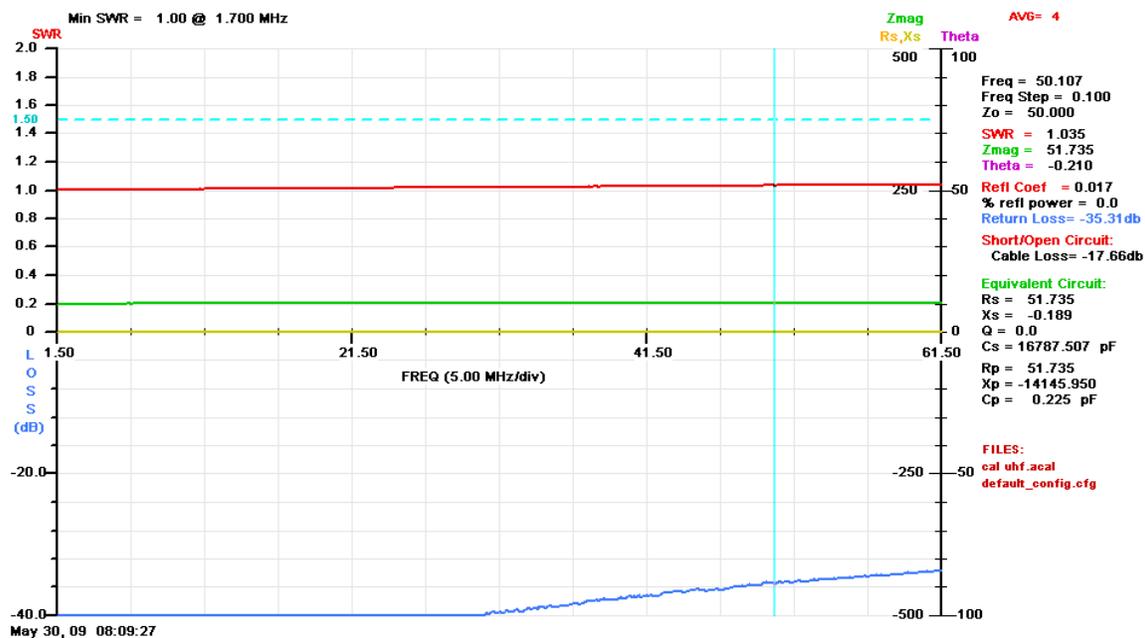


Photo B: SWR/Return Loss plot: Bypassed attenuator with 5pf & 10pf tuning capacitors

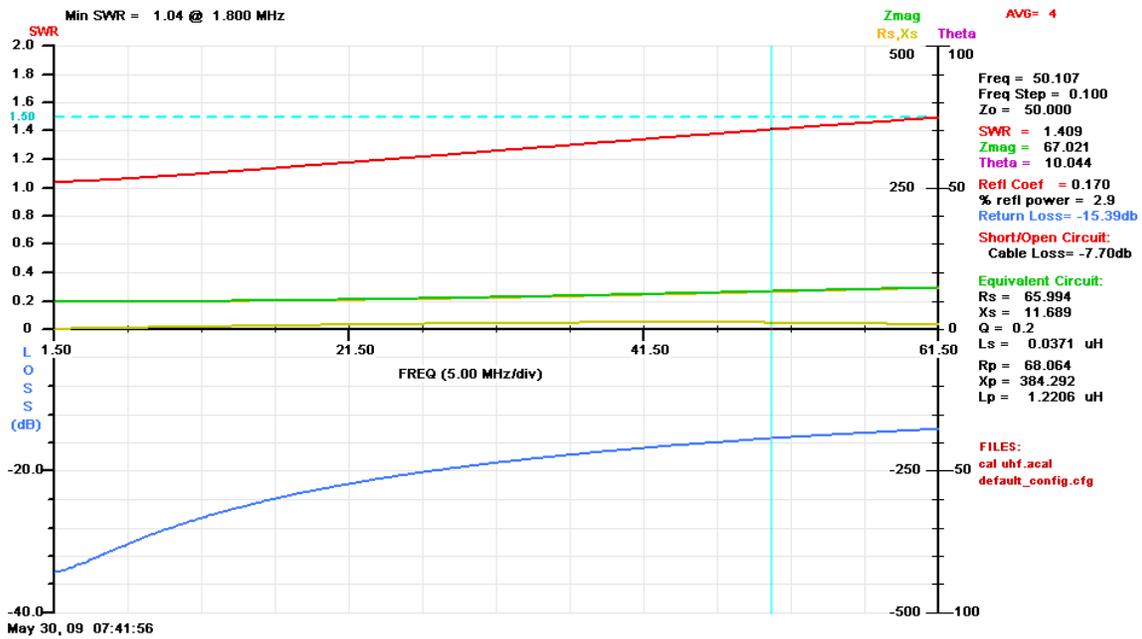


Photo C: SWR/Return Loss plot: 2dB attenuator without tuning capacitors

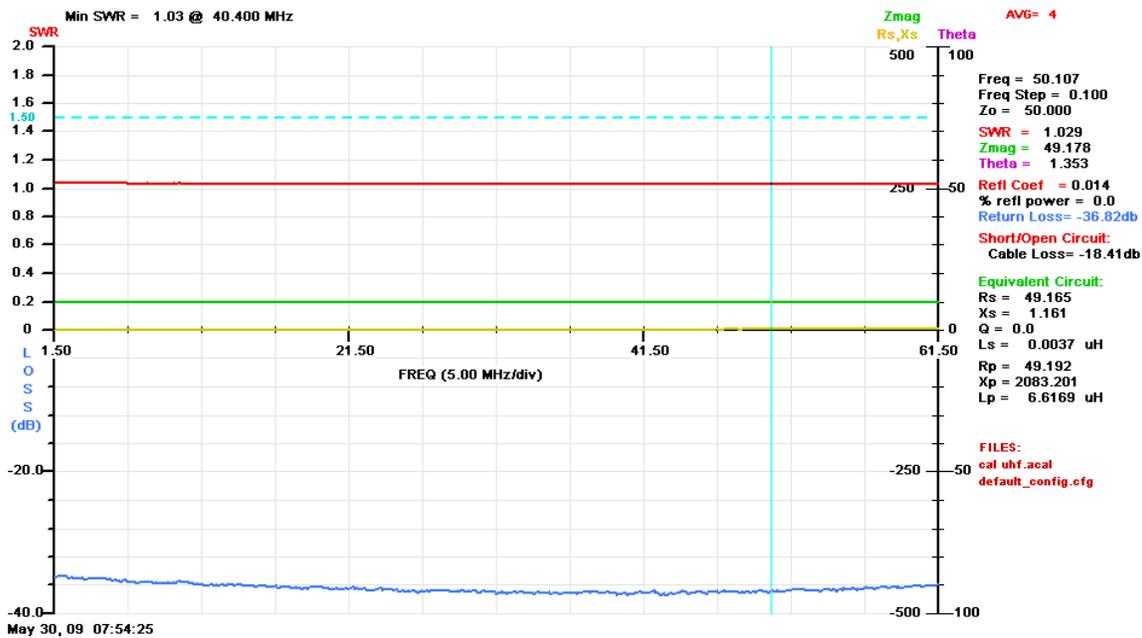


Photo D: SWR/Return Loss plot: 2dB attenuator with 5pf & 10pf tuning capacitors

Photo E is an internal view of the 2dB attenuator built into a cast aluminum box which also serves to dissipate the heat, especially for low duty cycle CW and SSB applications. However, additional heat-sinking may be needed as 35 watts is dissipated in the attenuator (key down). I mounted the attenuator directly to the cover of my ALS-600 (Photo F) which provides all the power dissipation I need. For a stand-alone attenuator, an inexpensive heatsink can be used (see Table 1).

The relay is mounted upside down to the box using double-sided 3M outdoor tape (get it at Lowes or Home Depot). For drilling the UHF connector hole in the cast aluminum box, a step-drill works great for the UHF connector (I use a cheap Harbor Freight step drill). Place a ruler diagonally across the end of the box and mark the center with a Sharpie ultra-fine point pen. Center-punch, drill out the hole, put the UHF connector in backwards and mark the mounting holes. Then drill and tap the mounting holes for #4-40 screws (there is no space inside the box for normal #4 nuts). You may prefer to use a single-hole mounting UHF connector (alternative in the Parts List) to keep from having to drill/tap 4-40 mounting holes.

Also, you can use a pendant cable for DC instead of mounting the DC jack on the attenuator. Just cut a phono-plug cable to whatever length is needed (the ALS-600 has a phono jack on it for the 12V accessory socket), insert the cable thru a small hole in the box and hold it in place with a tie-wrap.

By powering the attenuator relay from the +12VDC RCA accessory jack on the back of the ALS-600, the attenuator automatically goes in-line whenever the amplifier is turned on. A truly “stupid-proof” implementation for me, as there is no thinking necessary about drive power when I want to use the amplifier.

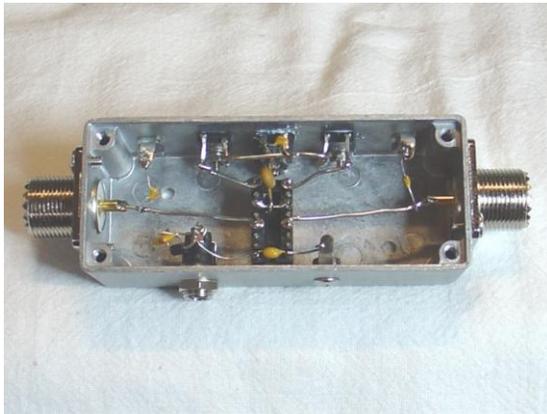


Photo E: 2dB attenuator inside view



Photo F: Attenuator mounted on ALS-600

Other Attenuator Values

Some amplifiers need even less drive power for full output, and so more attenuation may be needed. The attenuation needed is easily calculated as follows (assumes your transceiver output is 100 watts):

$$\text{Attenuation(dB)} = -10 \text{ LOG (Desired Power/100)}$$

Figure 2 is the schematic of a 3dB attenuator that also uses readily available thick film resistors (see Table 2). As the 10-ohm resistors dissipate 14 watts at 100 watts input power, 30-watt thick film resistors are used to give some margin. The 150 ohm resistor dissipates about 25-watts, so a 30-watt thick film resistor is used. Again, this is not a perfect 3dB attenuator, but it is very close (1.06:1 SWR when terminated in a perfect 50 ohm load, and 3.2dB loss). While not shown in Figure 2, use the same compensating

capacitors as in the 2dB attenuator for a perfect match. As discussed before, these are not really necessary – especially if you use the DPDT slide switch which has less stray inductance.

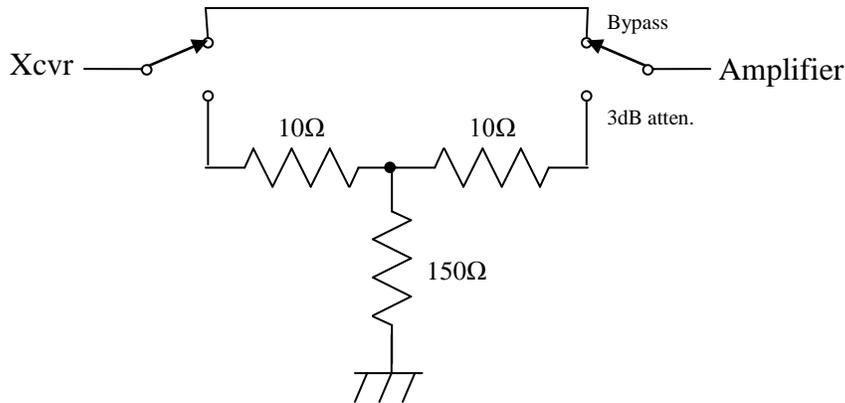


Figure 2: In-Line 3dB Attenuator

Table 2: Resistors for 3dB Attenuator

<u>QTY</u>	<u>Description</u>	<u>Source/Part Number</u>
2	10Ω 30-watt thick-film resistor	Mouser 684-MP930-10
1	150Ω 30-watt thick-film resistor	Mouser 684-MP930-150

If 2- or 3dB attenuation is not enough, within the same cast aluminum box you can cascade two attenuators as necessary to achieve 4-, 5- or 6-dB attenuation using these inexpensive and readily-available thick film resistors.

I built a DPDT slide switch version of the 3dB attenuator that I use on my lab bench for testing purposes with my IC-706MKIIG. It is built into a Mouser 537-M00-P aluminum box as I only use it intermittently at 100-watts of power. Photos G and H show my final unit, and the wiring diagram is shown in Figure 3. I used a Casio labeler with “black on clear” tape for labeling. I also added stick-on rubber feet to the bottom of the unit.



Photo G: 3dB attenuator inside view



Photo H: 3dB attenuator outside view

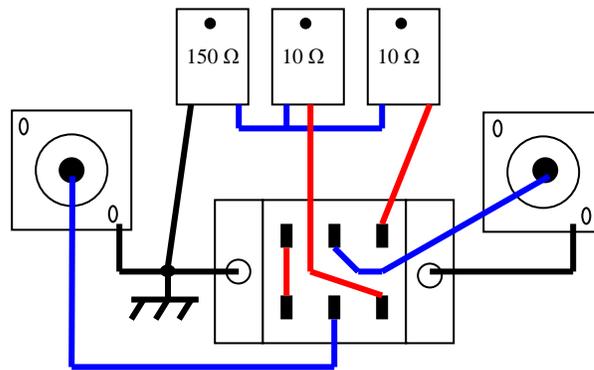


Figure 3 – 3dB Pad Physical Wiring

Conclusion

I've described a simple and automatic means of reducing transceiver power when driving an amplifier. This eliminates having to remember to turn down your transceiver's output power when driving the amplifier, and also eliminates an initial high power spike output by some transceivers when they are adjusted for less-than full power. And it will even improve the match if you have a compromise amplifier input SWR when operating on the WARC bands. Build this inexpensive accessory and make amplifier operation more convenient.