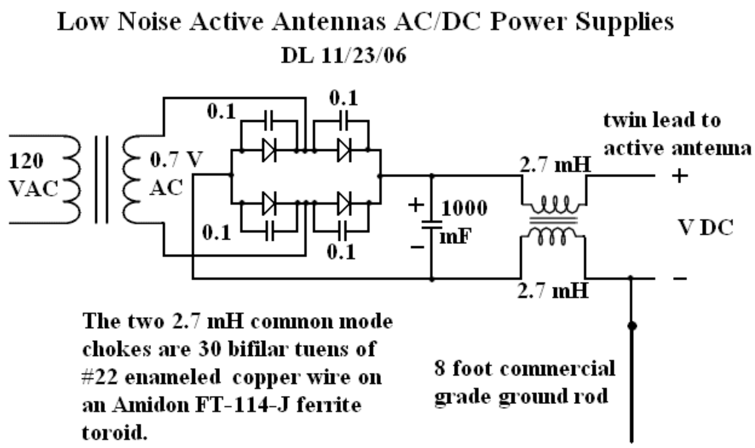
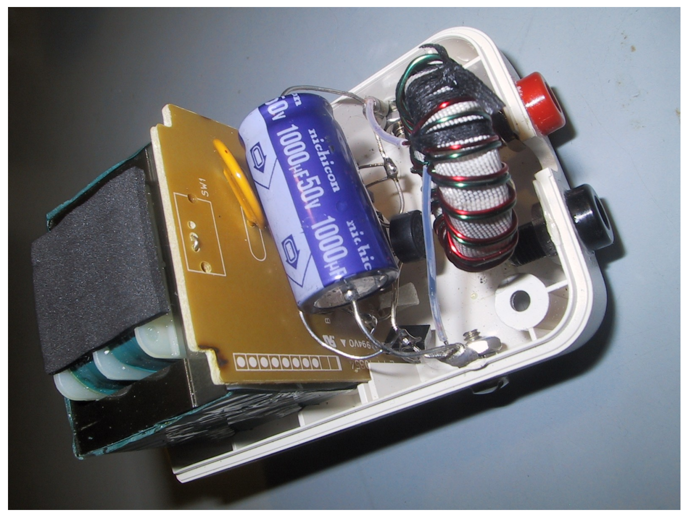
Low Noise Active Antennas AC/DC Power Supplies

Dallas Lankford, 11/26/06, rev. 2/17/07

By using battery power it can be shown that AC/DC power supplies for active antennas often introduce noise into the signal path. With the power supplies I have used the noise usually begins in the NDB band and increases in intensity as frequency decreases. For some AC/DC power supplies the noise begins in the MW band and may even begin in the SW bands. This noise and the difficulty of eliminating it are the main reasons I have not used active antennas in the past as my main antennas.



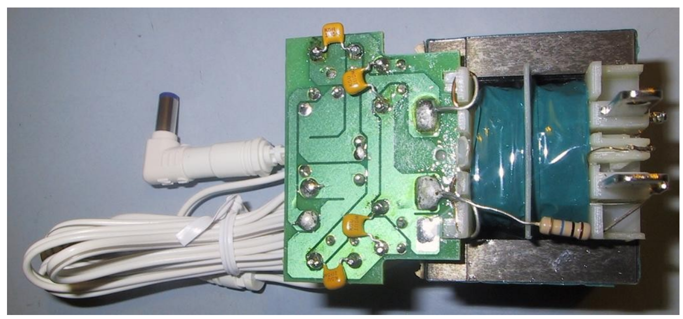
Common mode chokes often eliminate the noise in active whips due to AC/DC power supplies and other reasons for MW and higher frequencies; see “Some of my favorite small antennas for MW and LW” in The Dallas Files. For active antennas I have used common mode chokes both at the antenna, as shown in the article above, and at the power supply, as shown in the schematic here. However, common mode chokes alone usually are not sufficient to eliminate noise due to AC/DC power supplies for the lower NDB band and VLF band. For several AC/DC power supplies I tried much larger common mode chokes, as large as 1 Henry, but obtained no additional reduction in noise over the 2.7 mH specified in the schematic above.

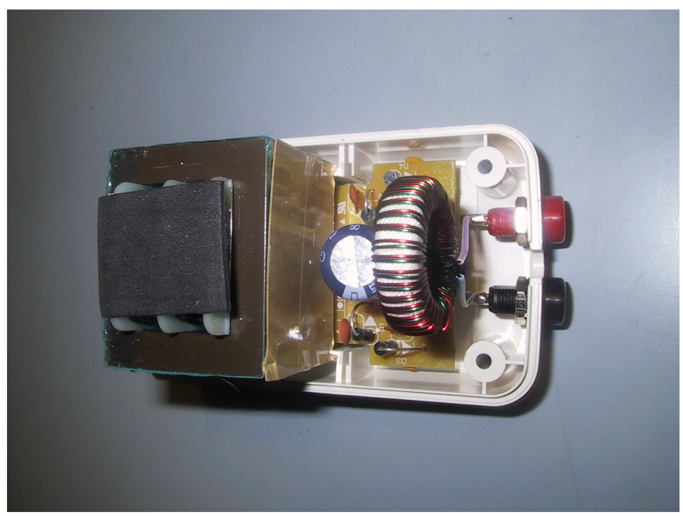


Recently I bought a Radio Shack # 273-1690 18/24 volt AC-AC adapter, thinking I was buying an AC/DC adapter. Fortunately, there was adequate space inside to convert it to a AC/DC supply, which I did. I used the 18 VAC output (1.4*18 = 25.2 VDC nominal, 25.7 VDC measured, which is close enough to 24 VDC), a 100 volt 1.4 amp full wave bridge rectifier Radio Shack # 276-1152, and a 1000 mF 50 volt electrolytic capacitor. Talk about noisy. The noise started at the low end of the MW band and increased as frequency decreased. Bypassing the negative DC lead to the AC neutral lead moved the beginning of the noise down into the middle of the NDB band, about the same as for other AC/DC power supplies I have used with active antennas. But again, using a larger common mode choke did not reduce the noise further.

I happened to mention this noise problem to Terry Fugate, who advised me to parallel each diode of the bridge with a 0.1 capacitor. And he sent along a reference from which I quote from as follows. ***I have also run into***

that [noise] ***problem*** [...] ***on LW. The mechanism that causes all of that noise is the rectifier diodes. If you use diodes that have a long minority carrier lifetime, no problem, but with the faster diodes that are being used nowadays, it sounds as if florescent lights are running, once you get below 600KHz. The cure is quite simple; I have posted it on this NG*** [rec.radio.shortwave] ***before. First of all, you need to connect .01uF capacitors across each of the rectifier diodes, so that they do not rectify RF. Next, you need to bypass each leg of the secondary of the power transformer with a 1uF non-polarized capacitor; a mylar or polyester would do fine. This will give you a power supply that is quiet, all the way down to 10KHz or so. I have done this mod on the power supplies for the Yaesu FRG-100, the ICOM R75, the AOR3030, the AOR7030, the Palstar R30, the Collins KWM-380, and even that old Radio Shack long range AM receiver that was sold in the 70s. Doug DeMaw gets the credit for bypassing those power supply diodes; I came up with the idea for bypassing the power transformer secondary. Pete KE9OA.*** I modified my AC/DC power supply as Terry recommended , using 0.1 caps across each diode of the bridge as shown on the schematic above, and low and behold most of the noise was gone. Next I unsoldered the secondary bypass to AC neutral in order to to evaluate that part of the mod. Curiously, bypassing the secondary to the AC neutral seemed to increase noise slightly, so I removed that part of the mod. Some additional noise reduction was obtained by grounding the negative DC lead on the antenna side of the power supply common mode choke to an 8 foot commercial grade ground rod. Two photos of the 24 volt AC/DC power supply are included above.

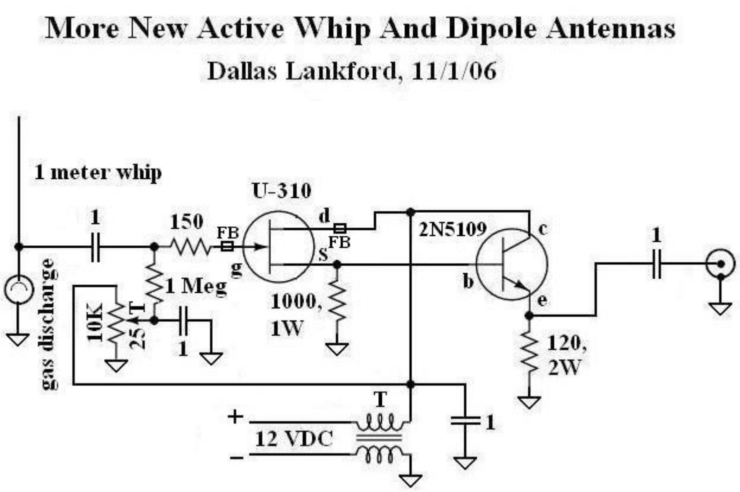




I intended to use the 9 VAC part of a dual 9/12 VAC radio shack transformer for a 12 VDC transformer (1.4*9 = 12.6 VDC nominal), but my local Radio shack did not have any. So I used a 12 volt AC/DC # 273-1776. It used individual rectifiers for the full wave bridge and a PC board which made it relatively easy to modify using small 1 mF 50 volt ceramic capacitors as shown in the photo here. The capacitors and their leads do not touch the PC board traces, but are about 1/32 inch above the trace surfaces which leaves adequate clearance between the bottom of the PC board and the inside bottom of the case. It turned out that the diodes in this power supply were not noisy like the diodes in the bridge I used for the 24 VDC supply because bypassing them with the 1 mF capacitors did not reduce noise at the lower end of the NDB (there was very little excess noise to begin with). Also, the dual 2.7 mH common mode chokes did not reduce noise at the low end of the NDB band either (again, there was very little excess noise to begin with). However, grounding the negative DC lead with an 8 foot commercial grade ground rod did reduce noise at the low end of the NDB band. I considered omitting the common mode chokes in the 12 VDC supply, but decided to include them in case common mode noise makes its way into my house from the outside. On both power supplies I used insulated banana jacks, Radio Shack # 274-725B. The flimsy two wire (white) DC power cords of both power supplies were removed and discarded. The PC board solder pads where the DC power cords were removed were used for the mods. Banana plugs were used to connect the twin lead power feed of the active antennas to the power supplies banana jacks.

While testing the low noise 12 VDC power supply about 2345 on 11/25/06 using my relatively new active whip (see below) I came across 183 kHz Felsberg, Germany in French relaying Europe 1 from Paris. The 183 kHz relay of Europe 1 is uncommon here and almost never produces any understandable audio. So it was a first for me to hear it producing clear audio. I switched over to my 45 foot noise reducing vertical and got another surprise; there was hardly any clear audio from the big antenna... business as usual. Just for fun I gave my ALA 100 clone a shot at 183 Europe 1; nope, no audio at all. I switched back and forth among the three antennas multiple times and got virtually identical results every time. After 183 closed down just after 0000, I tuned down to 162 Allouis, France. They are also uncommon here, rarely producing understandable audio. But on the whip they produced excellent audio, just beautiful, while the 45 foot vertical was very poor, and the ALA 100 clone was only slightly less poor. The receiver used was a modified IC-746Pro using a 3.6 kHz BW and ECSS, USB or LSB depending on which had less interference, with the automatic notch engaged.

Even though the active whip was only a few meters away from the 45 foot noise reducing vertical and ALA 100 clone, the active whip placement turned out to be the reason it produced clear audio while the larger antennas did not. However, without the modified AC/DC power supply, even with the lucky placement I doubt the active whip would have produced any audio at all from 183 Germany and 162 France. Listeners on the ECNA, and especially New England, probably hear these signals most every evening, and often like locals. So they may not care whether their active whip antenna power supply is low noise. But I do because hearing these LF signals clearly in North Louisiana is a rare occurrence, and would not occur here on an active whip without a low noise AC/DC power supply.



Here is a relatively new 12 volt whip / dipole which I used to evaluate the 12 VDC AC/DC power supply mods described above. Some might consider the 3rd order intercept somewhat low, at about 34 dBm, but the 2nd order intercept is quite good, about 69 dBm. Also, this one uses a common and inexpensive U-310 FET, and no transformers for the whip. For a dipole, build a second whip, oppose the whips, and join the two outputs with a 1:1 balun. This version is shown with coax output, but I always use a 1:1 balun and twin lead. If you use coax for the signal lead-in, you may need to use a common mode choke on the coax. The 25 turn pot is adjusted for minimum 2nd order intermod. This occurs at about 60 mA current drain for the 2N5109, so a heat sink is advisable. The U-310 draws about 18 mA, and while it runs quite warm to the touch, a heat sink is not really necessary for it. I used separate 1 mH common mode chokes for T instead of a 2.7 mH bifilar choke. The 24 VDC AC/DC power supply mods were evaluated using an ultra high intercept whip (+50 / +100 dBm II3 / II2) which I have agreed not to disclose.

Continuing the antenna comparisons the next day on MW groundwave signals, the active whip man made signal to noise ratio was often not quite as good as the 45 foot noise reducing vertical. For one signal, the 45 foot vertical produced clear audio, while the whip produced mostly noise. The ALA 100 clone signal to man made noise ratio was often not quite as good as the active whip, but on a few signals was better, due to the ALA 100 clone nulling local man made noise. On a few other signals the ALA 100 clone produced no audio at all compared to clear audio produced by the whip, due to the ALA 100 clone null being pointed at the desired signal, which illustrates one disadvantage of a large air core loop. The bottom of the whip for these comparisons was 2 meters above the ground. Placing the whip at a higher location might improve its signal to man made noise ratio. We will see.

As a result of these experiences I have revised my opinion of active whips. When used with a low nose AC/DC power supply, they are quite respectable, and with some placements and at some frequencies are superior to full size antennas.