Durable Light-Weight HF Antenna Traps Made From PC Board

A new and easy way to make home brew antenna traps. They're especially well-suited for multi-band portable and back-packing antennas.

By John Portune W6NBC

Home-brew HF antenna traps have long been a ham DIY favorite. A length of coax wound around a PVC form, has been the preferred method. Here is an alternate method, adapted from PC board stripline technology. They're superior to coax traps in weight and durability. We'll also see how to set up a trapped dipole. But first, three brief enabling concepts.

(1) The Essence of a Trap

The essence of a trap is a parallel L/C "tank" circuit, a coil and a capacitor in parallel. In commercial traps, L and C come from an actual coil and capacitor. In a PCB or a coax trap, L and C come from the distributed inductance and capacitance of a short length of transmission line. The key here is that a parallel tank circuit reaches a high impedance at resonance. If it is placed at the right place in an antenna, the high impedance automatically disconnects portions on the antenna, thereby permitting multi-band operation.

(2) Getting the L and C in Parallel

Also essential is a crossover connection that causes the RF to pass through the trap twice. Trace the path for yourself in Figure 1, a diagram of a coax trap.

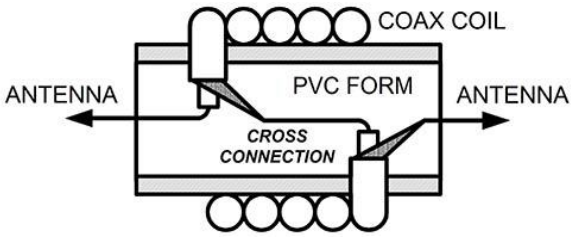

Figure 1: Coax trap with shield and center-conductor cross connected.

On the first pass, the RF runs on the outside of the shield. There it encounters distributed L. On the second pass, it runs inside of the coax, where it encounters distributed C. Voilá, a parallel L/C tank circuit, the essence of a trap.

(3) Antenna vs. Trap Frequency

Often omitted from trap-building directions, is the difference between trap frequency and antenna frequency. The common opinion is: tune traps in the middle of the band. For example, a 40m trap should be tuned 7.0-7.3 MHz. Not so. As stated above, a trap is a high impedance parallel L/C tank circuit. If the antenna is operated exactly at the trap frequency, voltage and current in the trap will reach high levels, and the potential for trap breakdown is highest.

Internal components in a trap set its frequency, whereas wire length sets the antenna's operating frequency. The two are not the same and are independent. Traps should be tuned 1-5% outside of the band, preferably low. The stress on the traps will be much less. A small adjustment of antenna length will compensate for the tuning difference and enable the antenna's to operate inside the band, and nothing will be lost.

PCB Traps

Figure 2 is a drawing of both sides of a PCB trap. 1/8 in. wide spiral PCB traces, mirrored on both sides of the board, constitute a coiled double stripline. It serves the same function as the coiled coax of a coax trap. J1 provides the cross-over connection and the placement of J2 sets the trap's frequency.

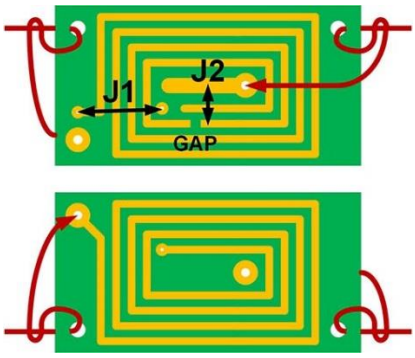

Figure 2: Both sides of a PCB trap made from 1/16 in. common FR-4 glass-epoxy board. J1: crossover connection, J2: tuning jumper. Notice gap in the trace (see text).

The antenna wire loops through ¼ in. holes, and is secured by a single self-wrap. Crimp-on ring terminals and 6-32 brass screws and nuts make the connection. I generally use 18 AWG Davis Stealth-Flex, non-stretch, copper-steel, polyethylene-jacket antenna wire, though any similar-gauge insulated stranded wire is fine. Putting the holes for the wire at the side of the board minimizes trap flutter in the wind and possible wire breakage. A metal grommet may be crimped into the holes for added strength.

Tuning the Traps

The length of the stripline sets the trap's frequency. You can easily re-position J2 to use as much of the stripline as you need. The tuning range is very wide. The large trap tunes down to 6.8 MHz, the middle size to 11.8 MHz and the small one to 16.9 MHz. All HF bands can be reached with one of the three. And any trap can be used at a higher frequency. Board size merely saves on weight. A small-scale view of the etching patterns is seen in Figure 3. Full-size patterns are free for download at w6nbc.com/traps.

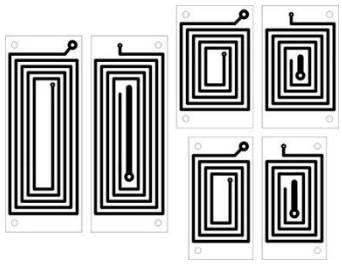

Figure 3: Small-scale view of PCB etching patterns. Full-size patterns may be downloaded free at w6nbc.com/traps.

Trap Tuning Procedure

Make up a short coax pigtail with a loop of solid wire on one end (roughly 1 in. Dia.) and a connector on the other, for use with an antenna analyzer. Mine is a Comet CA500 MK-II. An MFJ-259B or similar is fine too. So is an actual dip meter.

1. Set J2, to begin with, to use the entire spiral.
2. Suspend the trap away from other objects. (I used string tied to my workbench light.) Also, have no wires connected to the trap. (Traps cannot be dipped in an antenna.)
3. Make your first reading with the dip coil close to the trap. Sweep the analyzer frequency upward, from below the band, until you find the first deep dip. Avoid any higher dips.
4. Then, move the coil away from the trap a little and again find the dip. It will be shallower. Measurement of trap frequency is correct only when the dip is very shallow; the dip coil to detunes the trap.

5. Now move J2 to use less of the spiral. After each small move, cut a gap in the stripline traces, just behind J2. The unused portions need to be disconnected. Repeat until the trap is tuned 1-5% below the band. If you go too far, solder a small wire across the gap. It is not critical that both traps for a band are tuned exactly the same.

Power Handling Capacity

The maximum power a trap can handle is limited primarily by heating of the dielectric of the capacitor, in this case the circuit board material itself. Common glass epoxy PCB is frankly not an ideal dielectric. It has a 2% dissipation factor. Very loosely this means that 2% of the power is handling will turn to heat in the trap. For 1500 W PEP a trap would have to be able to dissipate 30 W PEP. Better laminates, such as polyimide, Teflon or even ceramic, are available, but they are expensive.

I use my antenna portable and only below 100 W PEP phone on all bands, or for PSK and JT-65 at lower power. But I did break out my linear for some simple steady-carrier power tests, lasting roughly the time of a typical “over.” I monitored trap temperature with a hand-held remote-reading thermometer. These tests were by no means comprehensive, but I feel they do yield a reasonable picture of permissible power.

They are, for phone operation of moderate length: the large trap on 40m is fine for 1500 W PEP. the medium trap on 20m and 17m should tolerate 500 W PEP and the small trap on 15m and 10m is good for at least 100 W PEP, maybe more. Remember, the higher the frequency the greater the heating. Go slowly until you know your limits, and if you come to any conclusions, let me know.

Setting up a Trapped Dipole

As promised, here is a step-by-step procedure for configuring a multi-band trapped wire antenna. A 1:1 current (Guanella) balun at the feed point is essential during setup. Otherwise, the feed line will compromise the adjustments.

1. Begin with a full-size half-wavelength dipole for the lowest frequency you intend to use. It should be at least 5-10 ft. off the ground. An inverted V configuration is fine.
2. Connect an antenna analyzer to the feed line and work from the center outward. Install traps one pair at a time. Begin by placing the highest frequency traps, a quarter wavelength away from the feed point.
3. Adjust the length of the wires just inboard of the traps until the antenna tunes inside the band. Remember, antenna tuning is not the same as trap frequency.
4. Then, moving outward a band at a time, install the lower frequency trap pairs. The distance to them for each lower band will be less than a quarter wavelength. Residual inductance of inboard traps shortens the dipole.
5. Lastly, shorten the end wires to set the frequency for the lowest band. Add an insulators and tie-down line.

6. Now, go back and “fine tune” all bands as needed, working again outward from the center.

Final Considerations

You should waterproof the traps for a permanent location. Krylon clear spray, Sprayon EL601 Red Insulating Varnish, or any of the several brands of spray-on conformal PCB coatings, is fine. I prefer clear silicone RTV adhesive, thinned with turpentine. Avoid ordinary paint. As my trapped dipole is used only on RV trips, I have not coated the traps.

Stowing the antenna with its traps is a little tricky. I lay it out straight on the ground, with the two dipole halves beside each other. Then I wrap both at the same time around a cardboard box beginning at the feedpoint. Like all wire and cable, the antenna has a mind of its own if you just wind it on itself.

The author will be pleased to correspond: John Portune W6NBC, 519 W Taylor St. Unit 111, Santa Maria CA, 93458, jportune@aol.com, w6nbc.com.