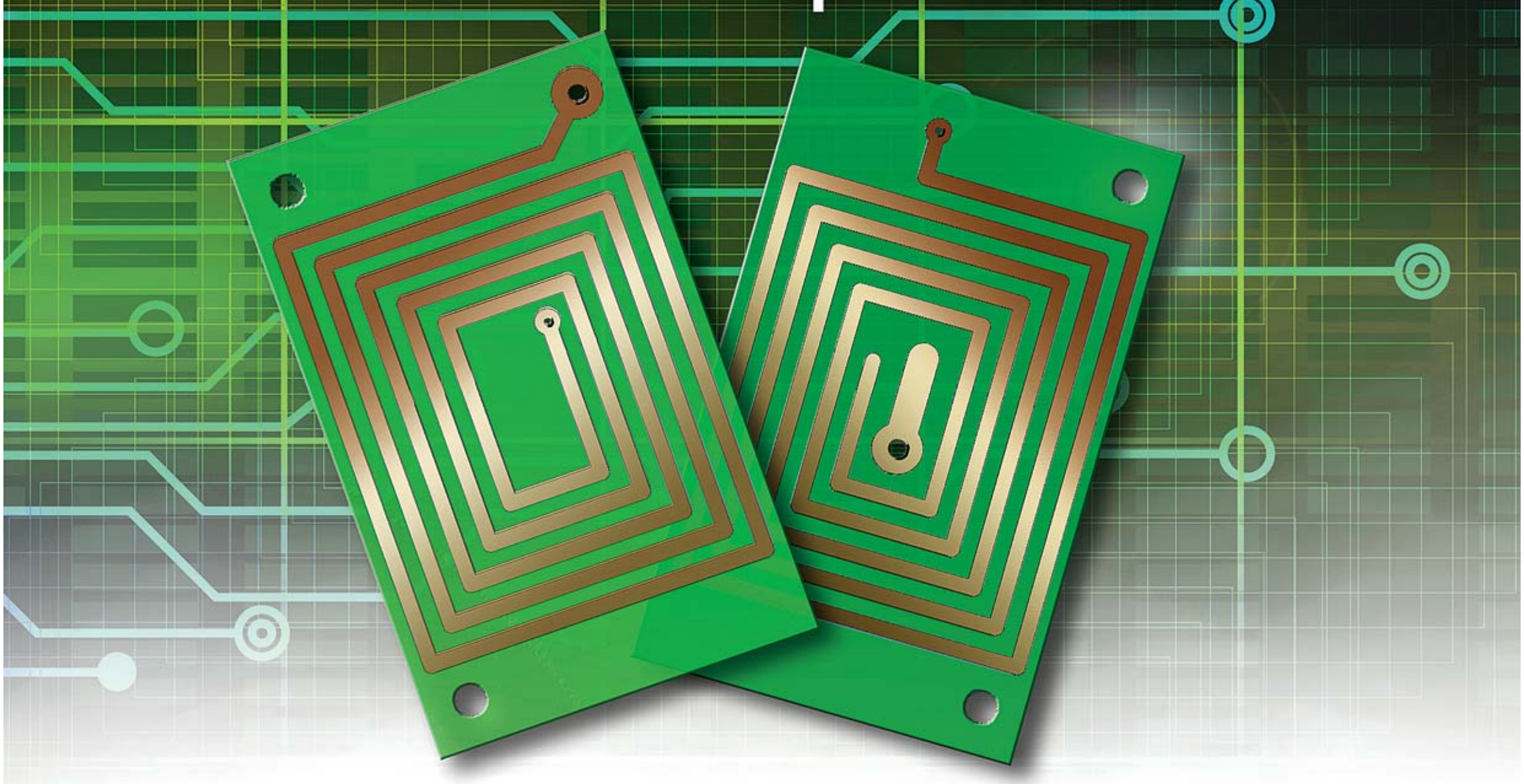
Printed Circuit Board Antenna Traps for HF



Light and rugged construction makes these traps ideal for multiband portable and backpacking antennas.

John Portune, W6NBC

Antenna traps enable a single antenna to be tuned to multiple bands for efficient transmission — the more traps, the more bands. A favorite homebrew construction method wraps a length of coax around a PVC pipe form and cross-connects the shield and inner conductor. While this is efficient for fixed installations, it is too heavy and bulky for lightweight portable operation. The method described here, adapted from printed circuit board stripline technology, is light, compact, and just the thing for those who like to tote their rigs to the back country to work mountaintop multiband low-power DX.

How Traps Work

A trap is a parallel LC circuit, which, at or near resonance, has a high impedance. Think of it as a frequency-dependent switch that is open at or near resonance and closed at all other frequencies.

Conceptually, a multiband wire antenna made with traps starts with a length of wire tuned to the lowest band of interest. A trap is then inserted at the length that would tune the antenna to the next highest band of interest, which effectively removes the excess length, due to the trap's high impedance. Repeat for the next highest band, and so on. As stated, this is a conceptualization, and in a real system there are interactions and other effects that will be discussed later.

PCB Traps

My PCB traps (see Figure 1) are comprised of two congruent rectangular stripline spirals made with ⅛-inch-wide traces, mirrored on both sides of a 1⁄16-inch FR-4 glass-epoxy printed circuit board. [*See the* QST *in Depth web page*, **www.arrl.org/qst-in-depth**, *for a tutorial on making printed circuit boards. — Ed.*] Jumper JP1 makes the crossover connection and JP2 and an adjacent trace cut set the trap's frequency (see Figures 2A and 2B). The antenna wire is anchored to the trap through ¼-inch strain relief holes. Placing the holes at the corners of one edge of the board minimizes wind flutter, which could eventually fatigue the antenna wire. Connections to the spiral are made with 6-32 brass hardware and crimp-on ring terminals.

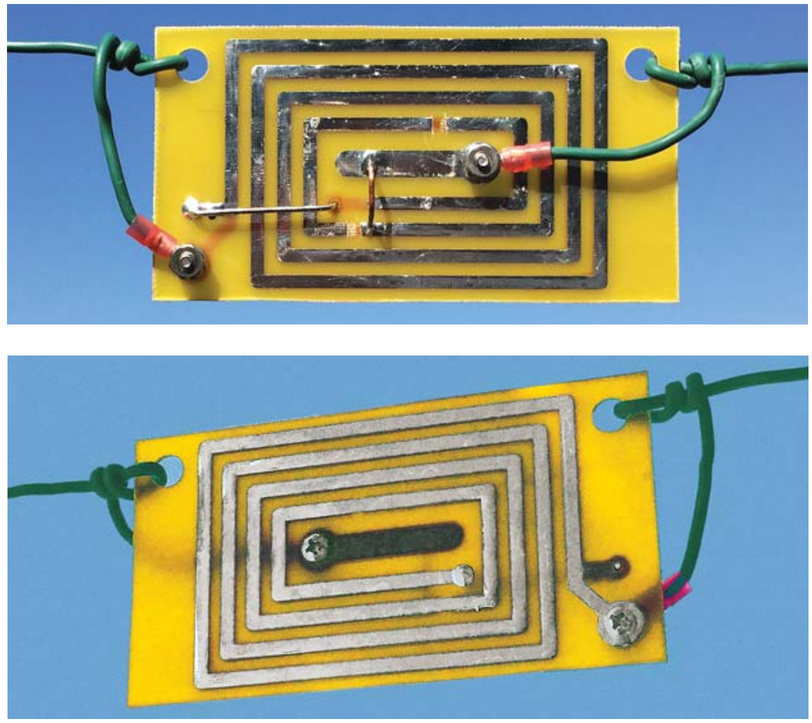


Figure 1 — At the top is the front of the printed circuit board antenna trap. Note the crossover jumper and the tuning jumper next to the tuning gap used to shorten the active portion of the spiral. Below, you can see the back side of the PCB trap with a stripline spiral congruent to the spiral on the front.

Trap Tuning

The length of the stripline sets the trap's frequency. You can easily reposition JP2 to use as much of the stripline as you need. The tuning range is very wide. There are three full-size patterns available for download from either the *QST* in Depth page or **www.w6nbc.com/traps**. 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. Also, any trap can be used at a higher frequency. Reducing the board size merely saves on weight.

Tuning Procedure

This procedure relies on a technique known as *dipping*. The term derives from a versatile instrument originally known as a *grid-dip oscillator*, which would indicate by a dip in grid current that its tunable LC oscillator was resonantly coupled to another LC circuit. Today, the grid-dip oscillator has been largely supplanted by the antenna analyzer. I use a Comet CA500 MK-II. However, an MFJ-259B or similar antenna analyzer would be fine. You could even use an old-fashioned grid-dip meter.

A probe coil loosely couples the antenna analyzer to the antenna trap spiral loop. The probe is comprised of a 1-inch-diameter loop of solid wire at one end of a short length of coax, with a suitable connector for your antenna analyzer at the other end. Use the following procedure to tune a trap to a particular band:

1. Start with JP2 set to use the entire spiral.
2. Suspend the trap well away from other objects. Note that the trap cannot be dipped while connected to an antenna, so do not connect any wires to the trap during this procedure.
3. Make your first reading with the probe coil close to the trap. Sweep the analyzer frequency upward from below the band until you find the first deep dip. Disregard any dips at higher frequencies.
4. Move the coil away from the trap a little and again find the first dip, which will now be shallower. Trap frequency measurement is correct only when the dip is very shallow because the proximity of the probe coil to the trap spiral detunes the trap.
5. Now move JP2 to use less of the spiral. After each small move, cut a gap in the stripline trace just behind JP2 so that the unused portions are disconnected.
6. Repeat steps 4 and 5 until the trap is tuned 1 – 5% below the band. Tuning slightly outside of the band reduces the stress on the trap because the voltages across the trap will peak at resonance. If you go too far, solder a small wire across the gap. It is not critical that both traps for a band be tuned exactly the same.

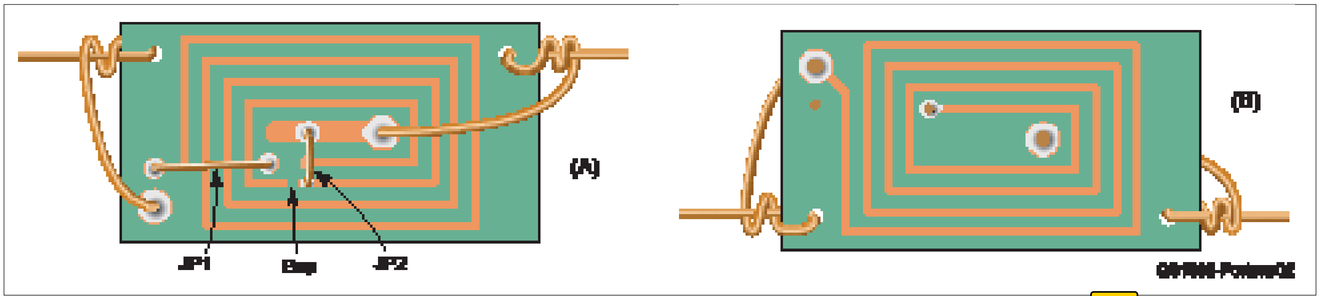


Figure 2 — Schematic of PCB antenna trap showing mounting holes, jumper positions, and a typical tuning cut. Note that the jumpers JP1 and JP2, along with the tuning gap, are all on the front side (A) only. The congruent spiral on the back (B) is not cut during tuning (see text).

Setting Up a Trapped Dipole

Below is a step-by-step procedure for configuring a multiband trapped wire antenna. A 1:1 current (Guanella) balun at the feed point is essential during setup to prevent the feed line from compromising 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 feet 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 lengths of the wires just inboard (toward the feed point) of the traps until the antenna tunes inside the band. Remember, the antenna tuning frequencies are not the same as trap frequencies, which were set slightly below the band frequencies.

4 Move outward one band at a time and install the next lower frequency trap pair. The distance to them for each lower band will be less than a quarter wavelength because residual inductance of the inboard traps shortens the dipole.

5 Go back and again, working outward from the feed point, make adjustments to all bands as needed.

6 Lastly, shorten the end wires to set the frequency for the lowest band. Add end insulators and support lines.

Power Handling

Clearly, these traps are intended for lower-power application. However, should you encounter a situation where higher power is required, note that the maximum power a trap can handle is limited primarily by dielectric heating of the trap's capacitor, which in this case is the circuit board material itself. Common glass epoxy PCB, with its 2% dissipation factor, is frankly not an ideal dielectric. Roughly, this means that 2% of the power through the trap will in turn heat the PCB. For 1,500 W PEP, a trap would have to be able to dissipate 30 W PEP. Better laminates, such as polyimide, Teflon (PTFE), and even ceramic are available, but they are expensive. Remember that heating will be greater on higher frequencies.

That said, I use my portable antenna only below 100 W PEP phone on all bands and limit PSK and JT-65 transmissions to 5 W.

Photos by the author.

John Portune, W6NBC, is an ARRL member and frequent contributor to *QST*. He has been licensed for 52 years and has held an Amateur Extra-class license since 1972. John has a B.S. in physics and also holds FCC Commercial General Radiotelephone Operator and FCC Radiotelegraph licenses. He retired as a broadcast television engineer and technical instructor at KNBC in Burbank, California, and then from Sony Electronics in San Jose, California. You can reach John via e-mail at **jportune@aol.com** or through his website at **www.w6nbc.com**.

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