How to Detune a Tower

By Jay Terleski, WXØB

With the advent of using wire verticals around our towers to make a phased array system, it has become apparent that the tower can affect the array's performance, usually for the worse. Many times I am asked about detuning a tower and how to do it. This short article is the result of trying one commonly cited way that did *not* work, and doing research on how the broadcast industry does it, and how we finally, successfully, detuned a tower with a 160-meter 4-Square array.

The tower in Figure 1 belongs to W5IZ, and it is a 200 foot tower with an 80-meter beam on top and four cantilevered Phillystran guys that hold up a 160-meter 4-Square system. Each vertical is one quarter-wavelength tall and is fed at ground level with buried radials. The 4-Square system is an Array Solutions optimized box that uses what has become known as the Lahlum method of tuning. (The namesake is Robye Lahlum, W1MK—see his two articles "Phase Adjustment Technique for a 4-Element Square Phased Vertical Array" and "Phase Correction for a Quadrature Hybrid-Fed Antenna Array" in the May/June 2005 issue of *NCJ*). The object of this method is to increase the front-to-back ratio and gain of the array by using optimized phase settings of the elements.

We installed the system and noticed the F/B of the array was down from the predicted pattern, which should have been on the order of 30+ dB. We were only seeing about 12 dB of front to back using a signal source that was carefully placed to give us a good reference to adjust the array. By measuring the currents in the tower legs we could see there was significant amounts of current as viewed on an oscilloscope (that had a current probe around a leg of the tower) when we transmitted on the array. This was not predicted in the *NEC* model of the tower we made. What to do? We needed to detune the tower.

Method 1

Doing some Internet research, we found that one solution was to create a loop around the tower at some midpoint. Then, we could drop a wire down below it at 40-60 feet and put a capacitor in series to tune the circuit to resonance. We tried this at various heights and we spent a lot of time without success. The tower was just not going to be detuned using this method no matter if we resonated the "loop" by increasing or decreasing the currents in it. We still had significant currents in the tower and this disturbed the pattern.

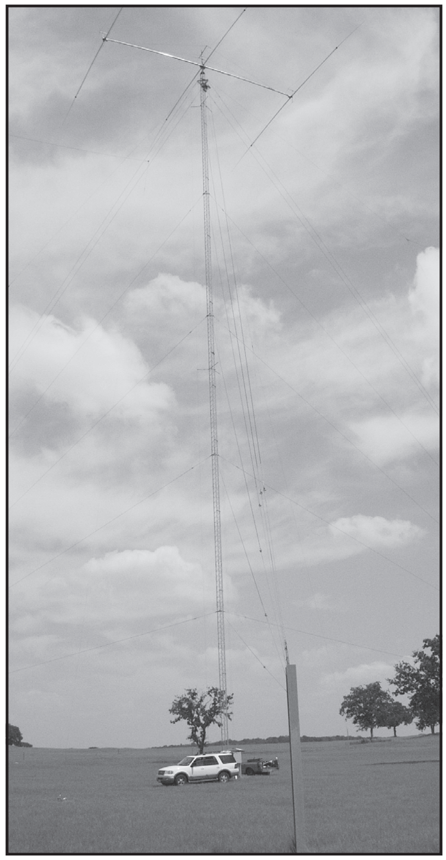

Figure 1—The 200 foot tower at W5IZ, with an 80-meter Yagi on top and a 4-Square system around it.

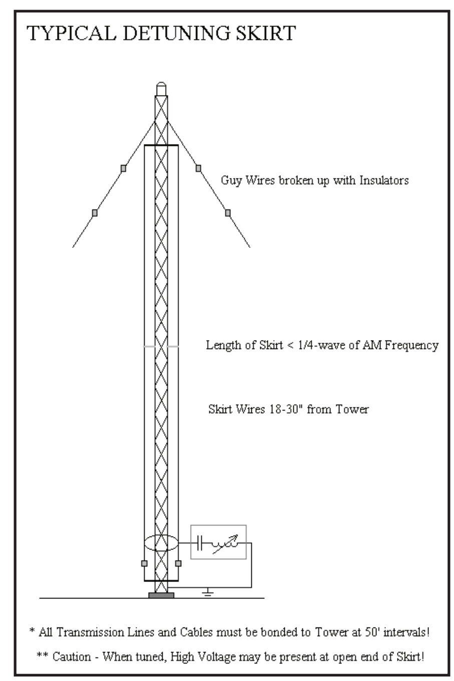

Figure 2—A typical detuning skirt.

Method 2

I knew the broadcast industry often grappled with this problem, so I started doing more research about AM broadcast detuning systems. This is a serious issue in the broadcast industry. An AM broadcast station has to maintain a pattern based on FCC regulations. If the pattern is changed by a newly erected cell tower, for example, the cell tower owner is required to detune his tower so as not to affect the pattern of the AM broadcaster. There are several companies that make "tower skirts" to accomplish this.

As you drive around you may notice that some cell towers have these skirts around them. This is a sure sign that they are located near AM broadcast stations—and that their presence has disrupted the stations' patterns.

I called my friend Goose Steingass, W8AV, who is a broadcast engineer, and he agreed the best way to detune a tower was to skirt it. With the W5IZ tower he recommended to skirt the whole thing to make it "disappear," versus just detuning one quarter-wavelength of it.

Figure 2 shows a schematic diagram of a typical detuning skirt. It usually has 3 or more detuning wires running the full-length of a tower. The top wires are electrically attached to the tower. The lower end of the skirt is insulated from the tower, tied together in a halo around the tower

Figure 3—W5IZ's tower with the detuning skirt (you have to look closely to see the wires around the tower).

Figure 4—The insulated bottom of the skirt. Note the halo wires that tie the skirt wires together.

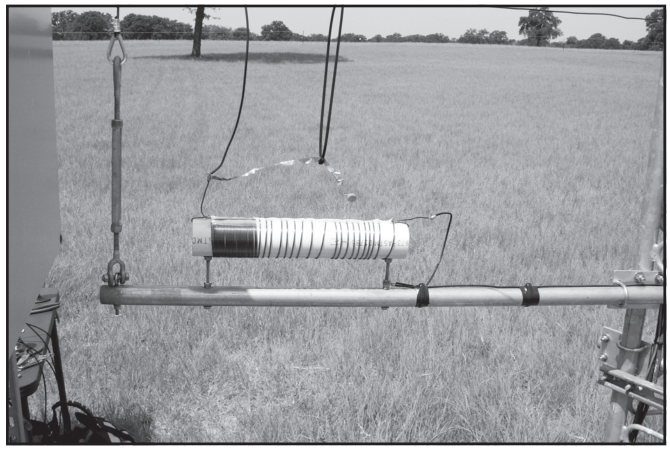

Figure 5—The LC network used to used to detune the tower. It's made of a coil of enamel wire and an RF capacitor.

and attached to a detuning LC network to adjust the skirt to be nonresonant at the desired frequency. This is a much more rigorous application to build versus the Method 1 approach, but that's what we had to do. We built a 3-wire skirt using water pipe standoffs at the top, midway down (which were insulated), and at the bottom. See Figures 3 and 4.

At the bottom of the tower the three wires were tied together and held down from the top with turnbuckles and an insulator to electrically isolate them from the water pipe standoffs. I built an LC network (see Figure 5) just out of trial and error with #12 AWG magnet wire. We brought down one wire from the skirt and tied it to one end of the coil. I scrapped insulation on top of the magnet wire to allow me to adjust a jumper from the coil. I also had a handful of RF capacitors.

For measurement we used a 500 MHz oscilloscope and placed a current probe in the wire that was feeding the coil from the skirt. The trick is to minimize the current in the skirt, or the voltage read on the scope.

The current probe can be made simply with just some hook-up wire. Place five or more turns around your network wire, or just enough turns to easily produce 1-2 volts on your scope when transmitting into the array with 10 W or more. The 'scope I used easily picked up the transmit signal. As a reference, we adjusted the scope down to the millivolt scale and we could see AM broadcast signals moving the trace. Al, W5IZ, lives way out in the country and has no nearby AM broadcasters, so these signals were in the range of 2-3 millivolts. We knew we probably could not make the 160-meter signal *that* weak, but we could try.

Adjusting the coil and capacitance values I found a sweet spot for a tap point on the coil that minimized the 160-meter signal being transmitted. I was further able to reduce the signal by changing different values of capacitors. I ended up using a 100pF cap soldered to the coil to form a T-network. Al and I were amazed that yes, indeed, the signal on the skirt was down at the same level as the AM broadcast stations. Now to see if it worked!

We set up the measurement system and, lo and behold, the F/B had jumped up 18 dB or more. I readjusted the 4-Square system and we saw 30 + dB of F/B.

The moral of the story is towers can significantly adversely affect the vertical phased arrays we hams build around them. The good news is we can fix the problem by carefully building industry-standard skirts. But you get what you put into it, and trying to cut corners just may not pay off in the long run.

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