K2NY takes us from theory to practice in the development of a triband sloper antenna.

The Quarter-Wave Sloper Antenna

The Development of a Triband Sloper Antenna

BY DICK PITZERUSE*, K2NY

Having read almost everything there is to read on the quarter-wave sloper, I concluded that these could be great antennas for 160, 80, and/or 40 meter DX work. For the uninitiated, the quarter-wave sloper, also called the half sloper, is an approximate quarter wavelength of wire run from near the top of one's tower down towards the ground at an angle of 45°. The top is insulated from its support and fed with 50 ohm coax, center conductor to radiator element, and shield to the electrically grounded support. (The support must be metal, or else a wire must be run from the top to ground.)

The thing that intrigued me most about this antenna was that the current maximum was at the top of the support, up high, where mom always said it should be. This coupled with predominant vertical polarization should make the half sloper ideal for DX on 160, 80, or 40 within the confines of a suburban lot.

Conflicting information seemed to abound concerning the half sloper. Some people reported the antennas very simple to tune with v.s.w.r.'s of 1:1 easily obtained, while others reported v.s.w.r.'s as high as 6:1 at resonance. Some observed the antennas needed to be as much as 15 to 20% longer than a quarter wave, and others needed to cut the antenna significantly shorter than a quarter wave. One local amateur had placed five of these antennas on his 70 foot tower and had excellent success on 75 and 40 meter s.s.b. (using traps in the elements). He had no problem tuning them to resonance. Other information that I had read indicated that placing multiple quarter-wave slopers on a single tower would cause tuning problems virtually impossible to overcome. It appeared that everyone who tried half slopers had the highest praise for them. However, an article by VE2CV[1] had nothing good to say about the antenna; the author had modeled it at 200 MHz, found it theoretically unsound, and did not recommend its installation, although he admittedly never tried a full-size one! Indeed, everything about the antenna seemed a paradox.

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[1]Belrose, "The Half Sloper—Successful Deployment is an Enigma," QST, May 1980, pp. 31–33.

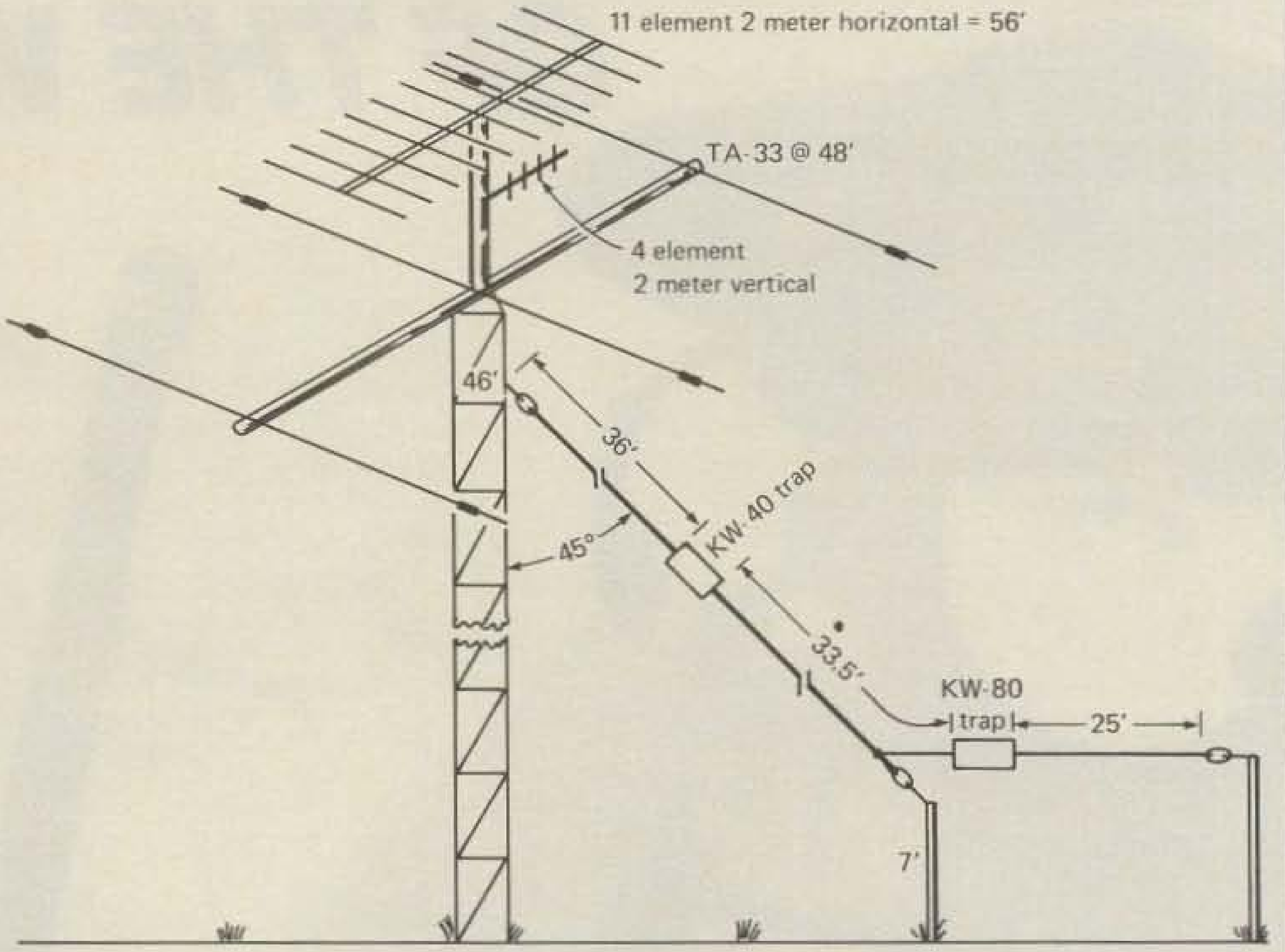

Fig. 1– The overall installation of the triband half sloper. The end of the sloper runs parallel to the ground in order to maintain an approximate 45° angle between the upper portion of the radiator (the part that does most of the radiating) and the tower. Final dimensions will vary slightly from installation to installation.

Undaunted and oblivious to consequence, I went ahead with the first half sloper. This would be for 40 meters, sloping towards the northeast with the top fastened at 46 feet on my tower. (My tower is 48 feet of Rohn 25G with 8 feet of mast sticking out of the top. On the mast is a 3-element tribander just above the tower, a 4-element vertically polarized 2 meter beam 4 feet above that, and an 11-element horizontally polarized 2 meter beam at the top. Overall height above ground is 56 feet. The tower is guyed in three directions at 22 and 42 feet with wire insulated from the tower and broken up into non-resonant lengths.) The antenna needed to be 36 feet long to resonate at 7025 kHz, about 10% longer than a quarter wave. The best v.s.w.r. I could obtain was 2:1 at resonance. Adjusting the angle between the radiator and the tower had only a slight effect on the v.s.w.r. Measurements taken with an impedance bridge at the transmitter end of the feedline showed the antenna had a resistive component of about 27 ohms after factoring in the feedline length using a Smith Chart.

Although the v.s.w.r. did not bottom out as low as I would like to have seen it, the antenna seemed relatively broadbanded, as the v.s.w.r. did not rise to more than 3:1 at the top of the phone band. As my transmitter was able to deal with this v.s.w.r., I decided to leave it and install a second 40 meter half sloper to the west.

This sloper was hung from the same height as the first one. The v.s.w.r. bottomed out at 1.3:1 on 7020 kHz. At the same time it reduced the v.s.w.r. on the northeast sloper to 1.5:1 at resonance! Measurements with the impedance bridge showed feed impedances of 40 and 35 ohms on the west and northeast antennas respectively. The two antennas were obviously interacting. Using ⅜-wavelength feeders on each antenna and floating the unused feeder should effectively lengthen the unused antenna by about 5%[2], causing it to act as a reflector for the driven antenna. A front to back of about 10 dB was realized on some signals using this scheme.

It seemed like a good time to try an 80 meter version, so a third half sloper was put out to the north-northwest, this one carefully pruned for 3510 kHz. Again I found the antenna needed to be about 10% longer; 73 feet was required to bring it to resonance. The v.s.w.r. bottomed out at about 2:1. However, measurements with the impedance bridge indicated a feed resistance of 100 ohms, much higher than the two 40 meter units. I can only attribute this to the fact that all three units were hung from 46 feet on the tower—less than a quarter wave on 80, and greater than a quarter wave on 40. Although I have not tried it, I suspect an antenna hung at exactly a quarter wave would be very close to 50 ohms. The presence of this antenna had very little impact on the two 40 meter slopers.

By this time I was really rolling, so I decided to erect a fourth sloper for 160 meters. The antenna was strung out from the same 46 foot height to the south. It was resonant on 1810 kHz at a length of 105 feet, about 20% short! Minimum v.s.w.r. obtainable was 4:1, and the feed impedance at resonance was 200 ohms resistive. This seemed to confirm my suspicions of significantly increased feed resistances at lower heights. Furthermore, the deployment of this antenna changed the v.s.w.r. on the 80 half sloper to 2.7:1 at resonance. The 40 meter elements seemed virtually unaffected. Performance of the 40 and 80 meter antennas did not seem to suffer, and the 160 meter antenna worked better than anything else I had used on that band.

[2] ARRL Antenna Handbook, *14th edition, chapter 8, pp. 12–13.*

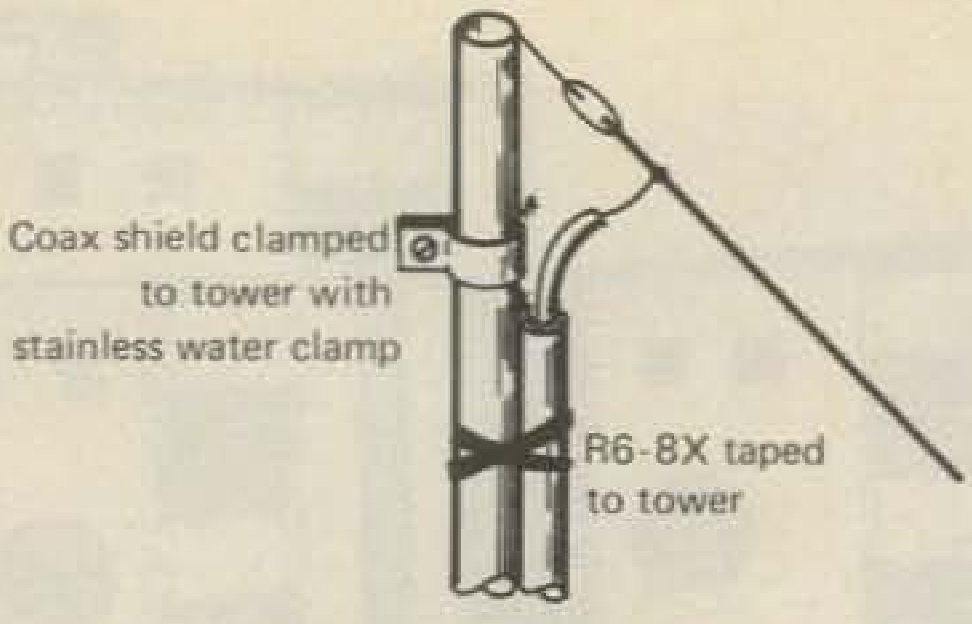

Fig. 2– Method of installing the half sloper to the tower. A stainless steel hose clamp is used to fasten the shield to the tower leg. Penetrox, or an equivalent compound, should be used to ensure a good electrical joint. Be sure to seal or tape the coax for a weather-tight seal.

Now I was beginning to receive the evil eye from my XYL as our yard was beginning to look more and more like the underside of a giant spider. It occurred to me that traps might be the answer. WA2QKU at Unadilla-Reyco here in town told me that traps resonant for 80 and 40 meters were available, but that stock traps were tuned for 3625 and 7150 kHz and operation at a kw was not recommended further than 100 kHz from the resonant frequency. However, specially wound units were available at a slight increase in price. I ordered one for 7050 kHz and another for 3550 kHz.

I removed the 160 and 80 meter slopers from the tower and simply installed the 40 meter trap at the end of the northeast sloper 36 feet from the feedpoint. I assumed an additional length of 36 feet would be required for the 80 meter section, and a length of 30 feet for the 160 meter end section. The v.s.w.r. was first checked on 40 meters and found to be just slightly changed. I then tuned the 80 meter section. The length worked out to be 33.5 feet for resonance at 3520 kHz. Finally, the 160 meter section was trimmed and a length of 25 feet was required for resonance at 1815 kHz. The v.s.w.r. bottoms out at 1.3:1 on 40, 1.5:1 on 80, and 1:1 on 160 meters. Bandwidth between the 2:1 v.s.w.r. points is 100 kHz on 40, 80 kHz on 80, and 30 kHz on 160 meters. Fig. 1 shows the final dimensions which were empirically determined for resonance at 1815, 3530, and 7030 kHz. I should point out that this determination was made with the western 40 meter sloper in place. I wanted to keep that antenna up because the front-to-back ratio that the two 40 meter slopers exhibited was very useful chasing Europeans when the midwest signals were coming through at the same time. Temporary removal of this sloper did have some impact on the bottoming out of the v.s.w.r. on all three bands, but not on the resonant frequency. Without the west sloper in place, the best v.s.w.r.'s which could be obtained were 1.3:1 on 160, 2.2:1 on 80, and 2:1 on 40 meters. That western sloper is obviously acting as some sort of tuning stub.

Conclusions

Throughout the course of the experimentation several things became clear to me. They include:

1. The length of the sloper will be longer than a quarter wave if the end does not remain near the ground for a significant portion of its length. For a single-band sloper a length of 260/F(MHz) will give you a good point from which to start.

2. If the end of the antenna is low to the ground for a significant portion of its length, or if the antenna is substantially below a quarter wavelength in height at the feed point, start out long, but the antenna will more than likely have to be shortened by as much as 25% below a quarter wavelength.

3. Any wire, resonant or not, hanging from the tower supporting the sloper may impact upon the feed impedance of the sloper. With some experimentation this can be used to advantage if desired.

4. As long as your line losses are low (as they would be with reasonable lengths of foam dielectric RG-8U on frequencies up to 40 meters), v.s.w.r.'s as high as 3 or 4 to 1 are of no particular consequence if the antenna is resonant and the transmitter can be convinced to load. However, unless the transmitter can match a wide range of impedances by itself, before you start out you must resign yourself to the possible need for a tuner to match this antenna to the rig.

5. A good ground system, although desirable, does not seem to have anywhere near the effect it does for a base-fed vertical radiator. Going from a simple ground rod to 16 quarter-wave radials under the sloper had no effect on v.s.w.r. and no noticeable effect on performance. Such a radial system with a vertical has a significant impact on both.

6. Within reason, the higher the antenna is mounted with respect to a quarter wave the lower the feed impedance appears to be. Adjusting the angle of the wire with respect to the tower from 30 to 60 degrees seems to have only a slight effect on feed impedance.

7. The antenna appears omni-directional. Although in theory the antenna may be slightly directional in the direction of the slope, in practical operation this is not apparent.

8. At this point most antenna articles tell you how you will be the loudest thing on your side of the Rockies. I make no such claims, but the antenna does perform well. I have worked a lot of DX with it and it holds its own. Best of all, it just may provide you with a very respectable signal on yet another band on a small lot.

I wish to acknowledge the assistance of N2MF in the installation of the slopers, that of WA2QKU of Unadilla-Reyco in obtaining the traps, and that of W2SY and K2PZ in providing me with information concerning their prior experiences with similar antennas.