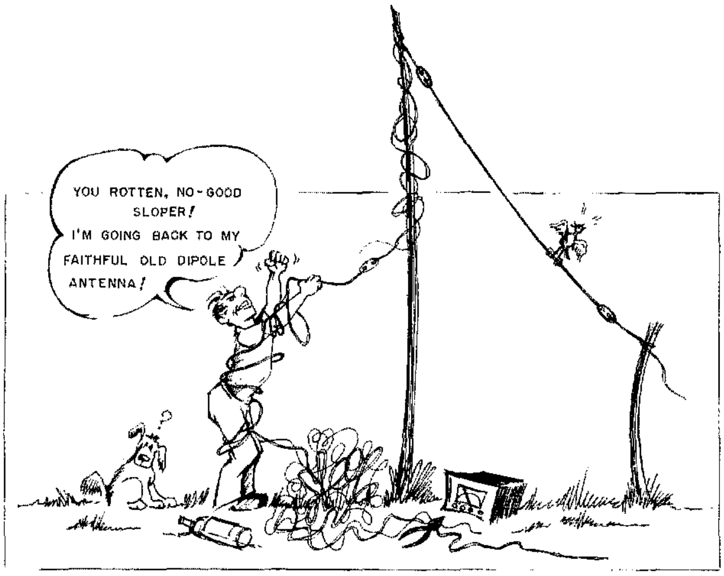
More Thoughts on the "Confounded" Half-Sloper

Half-sloper antennas don't function well for some amateurs, but others laud the performance. If you've tried them and experienced problems, these practical observations will be of interest.

By Doug DeMaw,* W1FB



"I read the *QST* articles[1] on half-slopers, built one, then found out it was no good!" We've actually received a couple of letters to this effect at Hq. But we've also had correspondence that said, "Thanks for publishing the half-sloper data. I erected one and have picked up 22 new countries on 80 meters with it!" Conflicting reports about performance have trickled in for many months, so we decided to do some testing that might reveal what had gone wrong with those slopers that performed poorly. A number of interesting observations were made, and numerous experiments were conducted at W1FB. This article will outline some of the more significant aspects of the tests that were conducted over an eight-month period.

What is a Half-Sloper?

The half-sloper is known also as the quarter-wave sloper. It differs from a full-sloper mainly by being half as long. The full-sloper is a half-wave dipole fed at the center with coaxial cable. Conversely, a half-sloper consists of a quarter-wavelength wire conductor, which is operated *in combination with* the metal mast or tower that supports it. Indeed, the tower is an electrical part of the sloper, which means that the height of the support and whatever else is attached to it play a significant role in antenna adjustment and performance (more on that later). The half-sloper is fed with 50-ohm coaxial cable at the point of attachment to the tower, as shown in Fig. 1. The center conductor of the cable connects to the slope wire, and the shield braid is attached to the tower leg or the mast. An enclosed angle of approximately 45° is used between the tower and the slope wire.

Half-Sloper Virtues

Inverted-V, full-sloper and half-sloper antennas require but one supporting structure. That's a plus factor. Unlike the full-sloper, the quarter-wave version has the current part of the antenna high above ground (desirable). The feed line can be taped to a tower leg, thereby preventing it from dangling across the property, as would be the case when using a full-sloper.

The half-sloper exhibits directivity (not gain) in the direction of the slope. This can be useful for favoring a particular DX region. In all tests at W1FB the sloper was a quieter antenna than the 55-foot (m = ft × 0.3048) vertical against which it was compared. That is, it was less responsive during receive periods to man-made and atmospheric noise than was the vertical.

Misconceptions

In reading our mail concerning the sometimes dismal performance of half-slopers, we have found that a misunderstanding of basic antenna principles caused much of the difficulty. Some amateurs used a tree or wooden mast to support the antenna. In such cases there was no place to connect the coax-cable braid, so it was left unattached at the feed point! The half-sloper requires a grounded metal mast or tower as a support, since the support is an electrical part of the system. In the most general of terms we can equate the sloper and tower to the two legs of an inverted-V dipole. The current and voltage distribution are not the same, however.

Others said that the VSWR was high, no matter how much pruning of the wire length was done. We'll address this matter

[1]See D. Atchley, W1CF, "Putting the Quarter-Wave Sloper to Work on 160," *QST*, July 1979; J. Belrose, VE2CV (ARRL TA), "The Half-Sloper — Successful Deployment is an Enigma," *QST*, May 1980; and D. DeMaw, W1FB, "Additional Notes on the Half-Sloper," *QST*, July 1979.

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later in the text. Some said that an SWR of 1:1 was easily obtained, but the antenna was very ineffective compared to a horizontal dipole at modest height above ground. It turned out that the tower in those examples was merely set in concrete without an effective ground system. The operators didn't think an earth ground was essential for this style of antenna.

Initial Investigations

The letters suggesting "black magic" concerning half-slopers arrived as winter was setting in on the East Coast. This ruled out any comprehensive outdoor evaluation of various half-sloper configurations. The practical solution seemed to be in scaling the W1FB tower, triband Yagi and sloper to 144 MHz. This would permit reasonable indoor tests during the bad-weather months. Then, the full-scale tests could be based on 2-meter results when spring arrived. Fig. 2 shows the setup used on 144 MHz to learn which factors affected the tune-up and performance of the antenna in question. Copper tubing was substituted for the Rohn-25 tower. Brazing rod was used to make the scaled-down hf Yagi, and sheet aluminum was extended 1/4 wavelength beyond the base of the short tower to simulate the buried radial system at W1FB, which consists of only 16 wires that range in length from 60 to 110 feet in rather swampy ground. No. 28 enameled wire was employed as the half-sloper wire. The scaling was not precise, but it was close enough to optimum, thereby yielding satisfactory results. A diode type of field-strength meter (calibrated in decibels) provided the instrumentation needed for pattern checks. The SWR was monitored by means of a Bird wattmeter. A Kenwood TS-700 all-mode 2-meter transceiver served as a signal source and was used in the receive mode to observe relative directivity of the half-sloper system while monitoring various repeaters in the area.

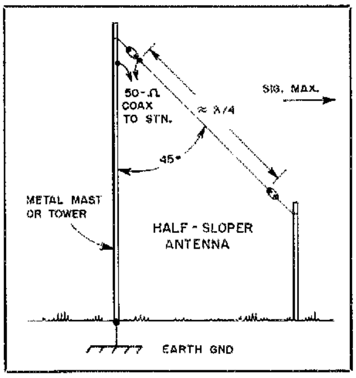

Fig. 1 — Basic half-sloper antenna attached to a metal supporting structure. The feed point is at the top of the wire. Coaxial cable is used for the transmission line, with the center conductor made common to the slope wire. The shield braid is connected to the mast or tower leg. The mast or tower must be grounded at the base. A buried radial system is preferred.

This technique is within the technical and financial means of any amateur, and is highly recommended for scaling one's tower, guy wires and beams when evaluating shunt-fed towers, slopers and other antennas that in some way depend on the tower.

Test Results

It was not too great a surprise to learn that the data gathered on 2 meters was repeatable at scale, with an accuracy of approximately 10%, the following spring. Similar results were obtained during earlier scaling tests of 80- and 160-meter shunt-fed towers. The system at that time was scaled to 10 meters. W1VD performed similar tests of his 80-foot tower (scaling to 28 MHz), and had results at scale that were accurate within 10%.

These are the significant factors that affect the SWR of a half-sloper.

1) *Height of attachment point on the tower.* The best results were had when this point was approximately 1/4 wavelength above ground.

2) *Enclosed angle of the tower/wire combination.* Varying the angle had a marked effect on the SWR, irrespective of the height of the attachment point.

3) *Other conductors connected to the tower.* The triband Yagi had a large effect on the SWR: Removing it changed the SWR from 1:1 to 4:1, indicating that the beam was related electrically to the overall system. Guy wires and other sloping antennas had a similar effect. An array (4)

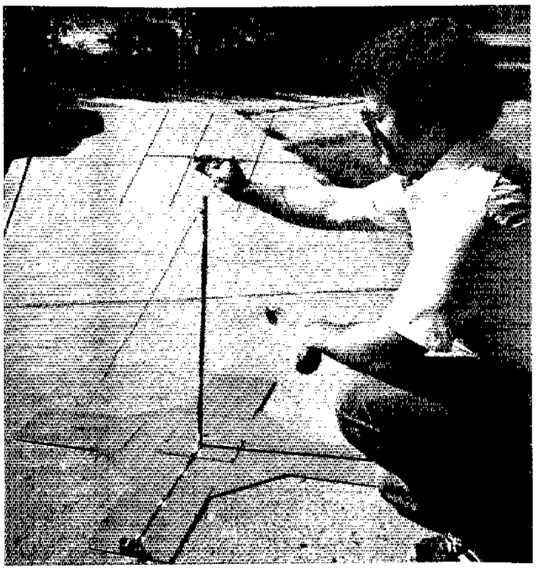

Fig. 2 — Photograph of ARRL technical staffer AK4L with the 2-meter scale model used to gather test data for the 40-meter half-sloper at W1FB. The Yagi has an alligator clip soldered to it for easy removal during tests. Aluminum sheeting serves as a ground system (see text).

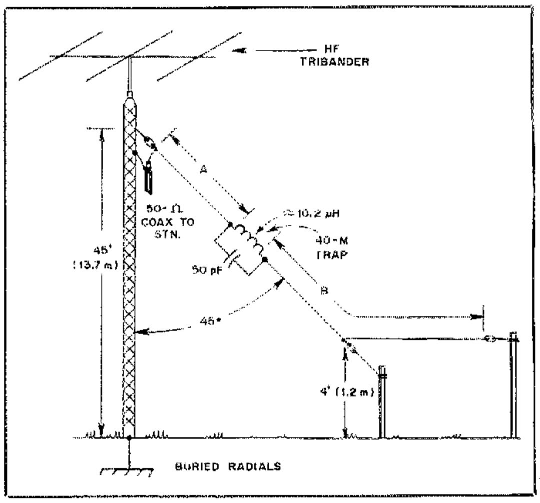

Fig. 3 — Practical circuit for the W1FB 40/80-meter, coax-fed half-sloper antenna. Owing to insufficient tower height, the lower part of the 80-meter extension is bent and routed horizontal to the ground. The feed line should be taped to a tower leg (likewise with rotator cable and other feed lines) at regular intervals, then routed to ground level. This will decouple the cables and prevent unwanted rf energy from entering the shack. The cables can be laid on the ground and brought to the shack, or they can be buried in the soil.

of half-slopers for the same band (spaced at 90° increments) made it impossible to obtain an SWR of less than 5:1 with any given sloper. This interaction was severe with only two half-slopers on the tower. Guy wires had to be broken up at nonresonant intervals and had to be insulated from the tower to eliminate SWR problems and preserve the radiation pattern of the antenna.

4) *Ground system under the tower.* The quality of the ground system (buried radials, on-ground radials or ground rods) affects not only the SWR, but also the effectiveness of the half-sloper. Removal of one half the aluminum-sheet ground system at 2 meters changed the SWR and reduced the field strength off the slope of the antenna.

An SWR of 1:1 could be obtained under most of the foregoing conditions by varying the height of the attachment point and the enclosed angle of the antenna. In all of the tests it was learned that the half-sloper needed to be slightly longer than the computed length obtained from l(feet) = 234/f(MHz). The antenna is not resonant at the operating frequency. Rather, the length is varied until the feed point exhibits a 50-ohm characteristic.

All scaling was done for a 40-meter sloper system. Extrapolation of the bandwidth from 2 meters to 40 meters indicated that the 40-meter bandwidth between the 2:1 SWR points would be approximately 150 kHz. Later tests at scale confirmed that number. As a matter of casual interest, the 2-meter half-sloper turned out to be a very effective fm/repeater antenna. From inside the W1FB QTH (antenna 4 feet above ground level) it was possible to access repeaters as far away as 40 miles when orienting the sloper toward the repeater. Power output from the TS-700 was 10 watts.

The directivity of the antenna produces a lobe that is approximately 5 dB stronger than the points along the otherwise omnidirectional pattern of the antenna. The radiated wave is essentially vertical in polarization.

A Practical Half-Sloper

Following verification of the scale-model tests in February of 1981, and after many local and DX contacts were made on 40 meters, a two-band version of the half-sloper was tested. It was designed for use on 80 and 40 meters by using a 40-meter trap in the slope wire. The system is illustrated in Fig. 3. The length of the wire A is the same as for a 40-meter single-band half-sloper. Wire sections A and B constitute the 80-meter half-sloper, with the 40-meter trap becoming part of the system. Owing to the loading effect of the trap, sections A and B combined are somewhat shorter than would be the case of a single-band 80-meter half-sloper. There was insufficient tower height at W1FB to permit a continuous slope of the wire. Therefore, the last 10 feet of the wire was run off at an angle, as shown in Fig. 3.

To permit operation at 1 kW, the trap contains a section of large-diameter Miniductor stock. A surplus ARC-5 50-pF vacuum capacitor was chosen for the trap capacitor. Transmitting ceramic capacitors can be substituted for the trap capacitor specified, but will change value when large changes in outdoor temperature occur. This effect will be noticed especially in regions where severe winters are common. The trap should have a high Q and can be tuned with a dip meter for the center of the chosen operating range before installation. Do not put the vacuum capacitor inside the coil because the metal parts of the capacitor will detune the trap and lower the Q significantly.

A compromise was made when selecting the attachment point of the antenna on the tower. It is somewhat higher than 1/4 wavelength at 7.025 MHz to permit ample height for the overall wire in the two-band format.

The SWR on 40 meters is 1.3:1 at 7025 kHz. Owing to the bent format on 80 meters, plus the less-than-prescribed height of the attachment point, a low value of SWR was not attainable. The best SWR turned out to be 2:1 at 3510 kHz. Line losses are of no consequence at 80 meters, since only 60 feet of RG-8/U is used in the system. The SB-221 amplifier loaded into the system just fine, despite the 2:1 SWR. Phone-band operation is possible by using a Transmatch (at the transmitter) for either band.

Some Precautions

The continuity of the tower sections is important to good performance, since the tower is part of the antenna system. Similarly, the tower-to-mast continuity should be ensured. This can be achieved by placing short lengths of shield braid across the joints between tower sections. A long, flexible conductor can be used between the mast and tower to provide continuity in that part of the system. If intermittents are present (especially when there is a breeze), the SWR will ramp up and down in an alarming manner! Some operators have solved the problem by merely running a continuous length of heavy conductor from the mast to the base of the tower.

On-the-Air Results

A shunt-feed arm was attached to the tower to permit using it as an 80-meter vertical. The tower was resonant at 3.8 MHz with the tribander atop it, so getting a match to 50 ohms was not difficult. The tower was rigged in this manner to permit comparisons between it and the 80-meter half-sloper during DX QSOs. A coax switch was used at the operating position to facilitate fast comparisons. It should be acknowledged that there is significant interaction between the half-sloper and tower. In an ideal situation the two antenna should be well separated from one another. Despite this condition, however, some interesting results were obtained in the spring of 1981.

During a 1-1/2 month period of casual DX chasing, 72 countries were worked by W1FB with the two antennas. The sloper was arranged for maximum directivity to the south because of property limitations. It showed a consistent 8- to 10-dB advantage over the vertical out to approximately 1500 miles in all directions. It was similarly superior to the vertical when working stations in the West Indies and South America. During QSOs with European stations, the sloper and vertical were often neck and neck, but the vertical was predominantly 5 to 6 dB better than the sloper. Had the wire been sloped to the northeast, the sloper would probably have equaled the vertical in performance, and may have exceeded it on occasion.

Since the half-sloper was the quieter of the two antennas, it often provided an advantage in weak-signal reception, even though the received signals were not as strong as when using the vertical.

Recommendations and Summary

Some amateurs have reported success when using an 80-meter half-sloper on 160 meters. This was done by placing a loading coil and capacitance hat at the lower end of the wire. An 80-meter trap was inserted between the end of the wire and the loading coil. This same technique might be applied to the antenna of Fig. 3 to make it a three-band half-sloper.

The operator should make an effort to install a ground-radial system when using a half-sloper. A practical rule of thumb is to put as much wire in the ground as possible, but not to worry if an elaborate, classical ground system isn't practical. During tune-up, experiment with the attachment point and the enclosed angle of the antenna. If an SWR of 1:1 can't be obtained, don't worry about it. The system will provide good results as long as the transmitter will load into it. If it doesn't, use a Transmatch at the rig.

A multiband sloper can be erected by using open-wire or TV-style 300-ohm line. This was tried at W1FB by cutting the slope wire for 40 meters and by using a Transmatch in the shack. Excellent results were had from 40 through 10 meters, with the sloper at times providing reports as good as those obtained with the tribander out to 1000 miles or more. The 40-meter version with tuned feeders also did a pretty good job on 80 meters.

If you have tried this antenna and found out it was "no good," perhaps you didn't experiment enough. We hope this article will give you some hints toward making your half-sloper do a proper job for you! QST