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Shortened Antennas for 75 and 80

—designs which fit your QTH

Slopers exposed.

During 1975 and 1976, I tested various 75 meter antennas with several ZLs and VKs. This band is generally open from there to the United States during the early mornings (local US time) around 1000 to 1200Z. I have been trying to determine if there is any particular 75m antenna best suited for this 7- to 8-multihop 8000-mile-plus path. There are usually a number of US hams working the ZLs and VKs on SSB between 3775 and 3850 kHz. The ZLs are permitted to work this portion of the band. As the VKs' highest frequency end is 3700, they generally transmit SSB between 3680 to 3695; therefore, split operation must be used with them.

75m antennas tested here during 1975-76 were: several dipoles at various heights (40 to 70 feet); three delta loops; a two-λ horizontal quad at 70 feet; two ½-λs in phase, colinear at 70 ft. (broadside to NZ); several ¼- and ½-λ verticals; a 3-element yagi at 60 feet; and three horizontal monoband dipole log periodics (DLP), one 3-element, one 4-element, and one 5-element, all at 60 feet.

At times, I have had as many as 3 or 4 75m antennas up at the same time for making direct comparisons between the various types. During the tests, the best reports from the ZLs and VKs have been with the log periodics and the yagi. As all of my antennas are supported by pine trees, the maximum height above ground for the horizontal antennas is limited to 60 to 70 ft., or approximately only ¼ λ above ground at 3.8 MHz. These are, of course, fixed-wire beams.

At times, the yagi or the log periodic would be reported as much as 10 dB better than some of the other types being tested. The yagi and the LPs were all beamed west or SW.

The log periodics and

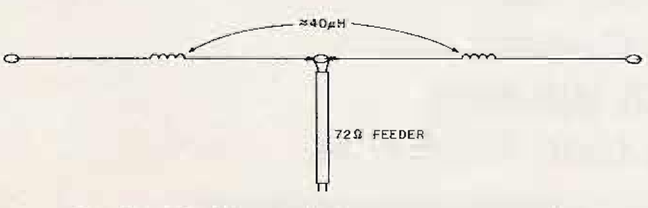
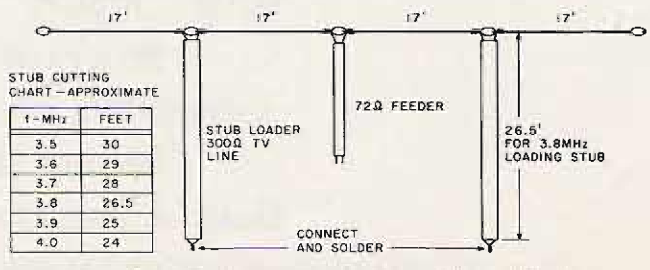


Fig. 1(a). Coil-loaded shortened ½-λ dipole.



f-MHz	FEET
3.5	30
3.6	29
3.7	28
3.8	26.5
3.9	25
4.0	24

Fig. 1(b). Stub-loaded shortened ½-λ dipole.

the yagi, although producing the best reports from "Down Under," are quite large, requiring a width of approximately 150 feet and a boom length of at least 100 feet. The general design of the 5-element monoband log periodic is given in reference 1, Fig. 6, reference 2, Fig. 2, and reference 3, Fig. 4. The dimensions for the frequency range 3.8-4.0 MHz are given by reference 2, Table 1. This LP was supported at about 60 feet by 8 pines.

As an antenna of this size is generally impractical for the average ham on a city lot, during 1977 I tested 75m antennas requiring less space but still giving some gain and more directivity than the usual 75 or 80m dipole or inverted vee when limited to a height of only sixty to seventy feet. These are described in the following.

Shortened Dipole Slopers

During the tests with the ZLs and VKs, it was noted that W2GO, one of the more consistent early morning DXers, uses a single shortened (66-foot) dipole as a sloper to the west with very good reports.

Shortened dipoles using off-center loading coils were well covered by Jerry Hall K1PLP (*QST*, Sept., 1975, page 28). By use of two 40-μH loading coils, the 75m dipole was shortened to 66 feet. This is the type used by W2GO for his shortened 75m centerfed ½-λ sloper, which requires only a single 60- to 70-foot pole, tower, or tree support. It is sufficiently compact to be used on a small lot. This was the type which I selected as being the most simple and compact antenna requiring minimum space.

As I did not have a pair of loading coils as specified in the *QST* article and did not wish to take time to wind them, I used instead two lengths of 300-Ω TV line as loading stubs for the shortened dipole. See Fig. 1(b). As a start, I used 30-foot stubs which resonated the shortened 68-foot dipole at approximately 3.5 MHz. Resonance can be determined by a GDO or by running an swr.

Next, the stubs were each pruned about 6 inches and the resonance was again checked, and then another 6 inches were removed and the frequency checked. This procedure was continued until the dipole resonated at 3.8 MHz. A total of 3.5 feet had been removed from each stub, making them each 26.5 feet in length. These loaded the dipole to the desired center frequency, 3.8 MHz. An swr was then run to determine the usable bandwidth of the shortened stub-loaded dipole, illustrated in Table 1. It will be noted that the bandwidth is quite narrow but usable ±100 kHz covering the DX portion of the 80m phone band.

This shortened or loaded dipole was then suspended as a sloper (Fig. 2) from the top of a 70-foot tree and sloped SW for tests with the ZLs. Although the overall length of the sloper was only 68 feet, it worked surprisingly well, considering its simplicity and ease of construction. It was fed with 72-Ω twinlead connected via a 1:1 balun to a buried coax to the shack.

For a dipole-type sloper to be effective for DX, or rather to have a fairly low angle of radiation, it should form an angle of at least 60° to ground. 70° to 80° would probably be better. It, no doubt, acts as a ½-λ vertical or semivertical. Being centerfed, the necessity of an elaborate ground radial system as required with a ¼-, ½-, or basefed vertical is probably not as important. None was used during these tests. If the slope angle is less than 60°, say 45°, it will probably have more horizontal polarization and higher angle radiation and would become more like a low horizontal dipole with the major radiation lobe at 90° or straight up. In this configuration, it would no doubt show an improvement with nearby stations up to a few hundred miles, but DX operation would suffer.

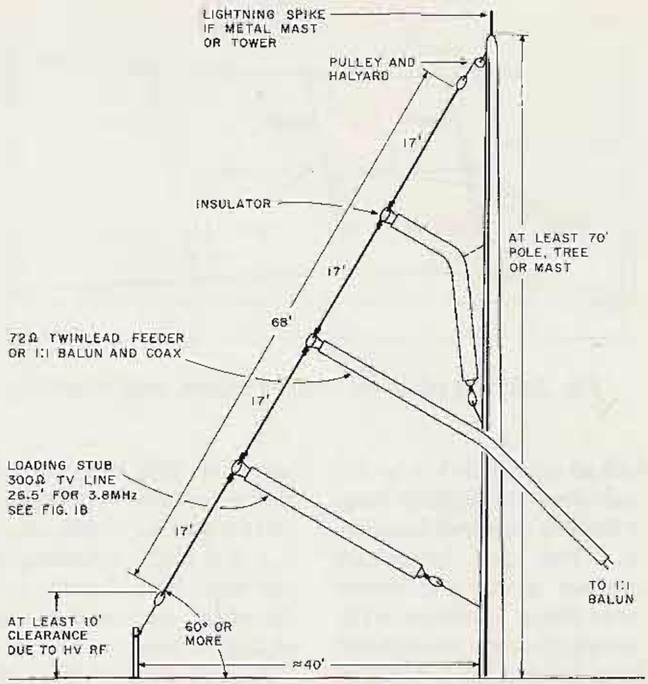


Fig. 2. Shortened ½-λ dipole sloper, stub-loaded.

A second sloper using an old Hy-Gain 40/75 trap dipole (overall length about 110 feet) also was tried, suspended from a 100-foot tree and aimed SW. This sloper seemed slightly better than the original 68-foot stub-loaded sloper. This was no doubt due to greater overall radiating length, more effective height, and an angle of about 70°. It had the advantage of also being usable on 40, though no extensive tests have been made with it on this band.

Phased Slopers—Endfire Array

As above slopers gave fair results considering their simplicity and ease of construction, it was decided to try a 3-element phased sloper (all elements driven) in a log periodic, endfire sloper array configuration. This was constructed by using a nylon line catenary stretched between two high pines separated by about 200 feet and oriented to give a beam at about 225°. The higher, rear tree was about 75 feet in height and the forward tree was about 60 feet high.

As the use of stub-loaders was not desirable due to complications in suspending the stubs so that they would come off at about 90° with respect to the sloper elements, it was decided to use end loading instead of stubs. This was accomplished by folding about 25% of each element end to the rear and securing them to the top and bottom catenaries, as illustrated in Fig. 3(a).

As it was desired to operate this beam centered on 3800 kHz, it was adjusted so that the longest rear element, #1, resonated at 3.7 MHz, #2 at 3.8 MHz, and the short forward element, #3, at 3.9 MHz. The easiest

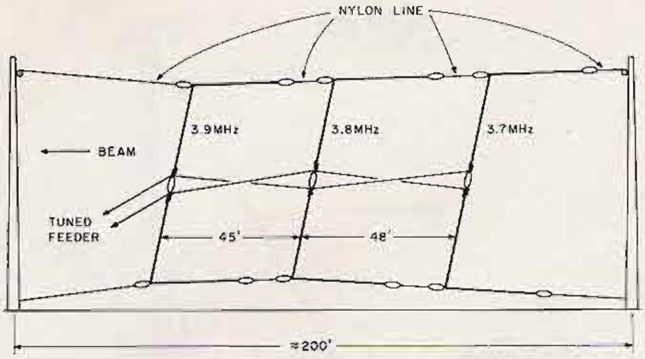


Fig. 3(a). Log periodic phased sloper, end-loaded.

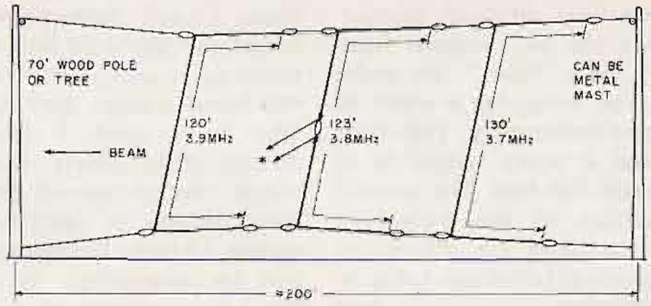


Fig. 3(b). Yagi phased sloper, end-loaded.

way to adjust this is to cut each element slightly longer than its required frequency. Then put temporary jumpers across the center insulators (feedpoints). Secure the ends of each element (folded back portion) to the catenaries and then raise the array to its normal suspended height. At this point, the 2-wire center feeder is not used.

Next, check resonance of each of the three elements separately by holding the GDO near the horizontal section at the bottom of the catenary, and pruning the ends as necessary to the three frequencies, 3.7, 3.8, and 3.9 MHz, as mentioned above. This must be done with the array suspended at its final location due to variations of resonance depending on the height of the three elements above ground. These three frequencies were selected so that the completed antenna would be centered on approximately 3800 kHz, and also to allow the array to operate as a log periodic.

Once the three elements are tuned, the array can be lowered, the jumpers across the three center insulators removed, and the 2-wire open feeder or phasing line connected as shown in Fig. 3(a). Note the transposition required for the array to perform as a log periodic or an endfire array. Each element must be out of phase with its neighbor, as required of any log periodic. The construction of the feedline is presented by the articles in references 1, 2, 3, 4, and 6, covering log periodic wire beam construction, and will not be repeated here.

A large array of this type for 75, even though using only 3 elements, must be assembled and tuned on site for its particular surroundings and height above ground. Table 2 is overall swr covering 3.5 to 4.0 MHz, after adding the center feeder to the array. It then centered on about 3.7. However, as the swr at 3.8 was only 1.25:1, no further changes were made since the beam was usable between 3.6 to 3.9 MHz.

Although this phased-sloper log periodic was only tested for about one week, it appeared to have gain and directivity as hoped. During one of the tests on 3808 kHz, Bob Tanner ZL2BT advised that it was about the same as the 3-element horizontal yagi at 60 feet which I was using at the same time.

The main advantage of the above phased sloper is that only two trees or masts are required, as compared to 6 or 8 necessary to support the 3-element yagi or an equivalent 3- to 5-element DLP. Further, the phased array, being primarily vertically polarized, should have a lower angle of radiation. Since the radiating elements are semivertical dipoles (centerfed), a ground screen or counterpoise was not used during the tests. Although the length requires about 200 feet of mast spacing, its width is less than 1 foot, compared with the 150-foot width of a 75m dipole log periodic or yagi.

For those who prefer yagis, the same 3-element sloper could, no doubt, be arranged as a 3-element yagi by deleting the open wire center feeder, deleting the center insulators from elements #1 and #3, and feeding the center of #2 element directly with 72-Ω twinlead or, better still, with an open tuned line. See Fig. 3(b).

The array would then become a yagi with #2 the driven element, #1 a parasitic reflector, and #3 a parasitic director. The yagi sloper array would, no doubt, have a more narrow bandwidth (possibly no more than ±50 kHz) than the bandwidth of the log periodic configuration. I have not tested the sloper array as a yagi, but, on previous tests comparing a 3-element horizontal monoband DLP with an equivalent 3-element yagi, a greater bandwidth was given by the log periodic.

Test Results

Shortened loaded slopers—

From the tests made with ZLs and VKs on these 75m antennas, and also from comparing notes with the previous tests with ZL1BKD during 1975-76, it appeared that the single shortened loaded-dipole sloper was equal to the larger delta loops, 2-λ horizontal quad, verticals, etc., which were tested then versus the large 75m yagi and/or log periodic (horizontal dipole-type) beams. The latter did average out about 10 dB better than the more simple antennas, including the slopers.

Considering the simplicity and ease of building the loaded sloper, and the fact that only one support is required as against 6 to 8 to support my large beams, it is believed the loaded sloper is the least expensive 75m DX antenna and about the only one suited for a city lot except, possibly, a single ¼- or ½-λ vertical, which can be quite expensive if a 60- or 120-foot tower or mast is used and the required 60 feet or more of ground radial system buried. The latter may also be a problem on a city lot.

During the tests, the large beams would show as much as 15-dB increase over some of the more simple antennas, but these differences would vary from day to day. The 10-dB gain over the more simple antennas was more the average.

Comparing the simple sloper with the delta loops, the type with apex topside requires only one high support but needs about 120 feet of space for the lower horizontal section. The type with the horizontal section up and apex down requires two supports spaced at about 120 feet.

Comparing it with the

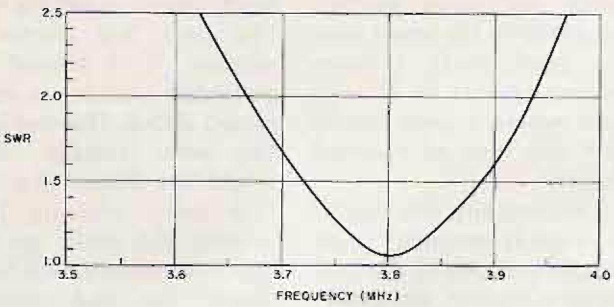


Table 1. Shortened dipole sloper.

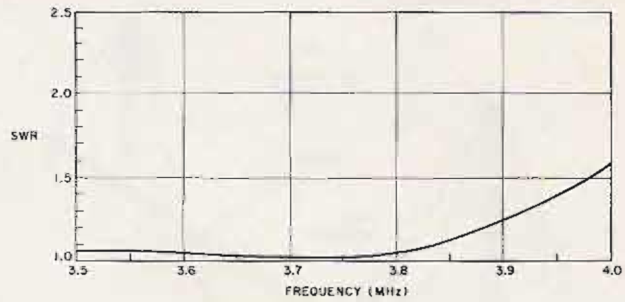


Table 2. Log periodic as in Fig. 3(a).

horizontal 2-λ quad, the latter requires four supports arranged in a square with about 130-foot separation, hardly suited for a city lot. The delta loops and quads also require more wire. 75m phased verticals are also impractical in a small space.

Therefore, the simple loaded-dipole sloper is recommended as a good all-around and inexpensive DX antenna if one does not have an open space of about 150 x 150 feet for a large beam to provide gain. Further, the latter, requiring 6 to 8 supports, also requires considerably more wire, insulators, etc., and a great deal more effort and labor!

For anyone not interested in 75m DX, a shortened or loaded sloper used as a high-angle radiator, either as a sloper at about 45° or as a low dipole at about ¼ λ or at approximately 60 feet above ground, will be a good average short-haul antenna for several hundred miles.

One suggestion would be to have two anchor posts for the bottom end, one to provide a slope angle of at least 60° for low-angle DX, and the other to give about a 45° slope for general short-haul communication.

The 3-element phased sloper—

Although this is a more elaborate beam, having gain, it is not generally suited for a city lot, since two masts with a 200-foot separation are required. It does have an advantage in that very little width is required, but it does require considerably more wire, insulators, and labor to assemble. It did appear to be about neck and neck with the yagi (also being used at the same time) from the ZL and VK reports. It may have been just a bit noisier on reception due to being more nearly vertically polarized. However, I did not have time to determine this for sure. It did make a good showing "down under" when compared directly with the yagi being used then.

A 3-element wide-spaced horizontal log periodic beamed west was set up later, which Bob Tanner ZL2BT advised was the best antenna tested here over the past 3 years.

I might add that, when comparing the various 75m antennas during this period, if the ZL or VK reported a 1 or 2 S-unit or 5- to 10-dB increase or difference between two antennas, the same difference on reception of their signal would generally be noted, as would be expected.

On this multihop 75m path, there is generally less QSB than on the higher bands. When there is fading, it is usually slow, unlike rapid QSB on 20.

For the information of those who do not work 75m DX, the VK and ZL signals generally have a slow buildup about 15 minutes before sunup, when they peak. They remain peaked for 15 to 30 minutes, and then start a decline for 30 minutes to 1 hour after sunup, local time.

As yet, I have not determined if the sunrise peak is due to "gray line" propagation or possibly due to a change in ionization of the F-layer, causing less attenuation at this end or possibly in the last hop (received at this end), thus giving the 5- to 10-dB signal increase which is generally noted at sunup.

It is doubtful that "gray line" affects the US-NZ path since they are in total darkness approaching midnight (sunup here in the east). "Gray line" might affect the W-VK path since sunup here is about sundown in certain parts of Australia.

To get more firsthand information on this, I am now (as of this writing) in the process of putting up two beverage receiving antennas, one N-S and one E-W. These are 2-wire reversible-direction beverages, each 520 feet in length, for use on 160, 80, and 40. Some very excellent data, suggestions, and material have been made available to me by Paul W6PYK for this test, for which I am very grateful. I had previously tested several simple single-wire beverages, resistor-terminated, to improve S/N.

The beverage project was started here originally to try to improve reception which is extremely poor, especially on 75, at this QTH. This is due to very poor ground conductivity, extremely high noise level (both QRN and man-made) on 75, and the fact that it is surrounded by high pine trees (60 to 90 feet) except to the NE and E. They extend for several miles to the SW and W.

For this reason, there is little open space for verticals, since trees higher than a ¼-λ vertical would surround it. There would be some trees separated from them by less than 50 feet, very thick in the direction of the ZLs and VKs. The two single-wire slopers which were tested were suspended from trees in open areas, although there were trees within about 100 feet to the W and SW.

For those who may become interested in 75m DX, there are some very good suggestions on propagation, "gray line," 75m antennas, receivers, a list of 75m DXers, beverage antennas, etc., presented in John Devoldere ON4UN's ham book *80 Meter DXing*, published in 1977. He includes a very complete list of 86 previously-published articles in the various ham publications covering these subjects.

Other Suggested Sloper Designs

In addition to the shortened loaded sloper and the 3-element phased sloper described above, the following are several suggested slopers and phased slopers. I have not actually tried these, but they are described briefly for anyone wishing to experiment or

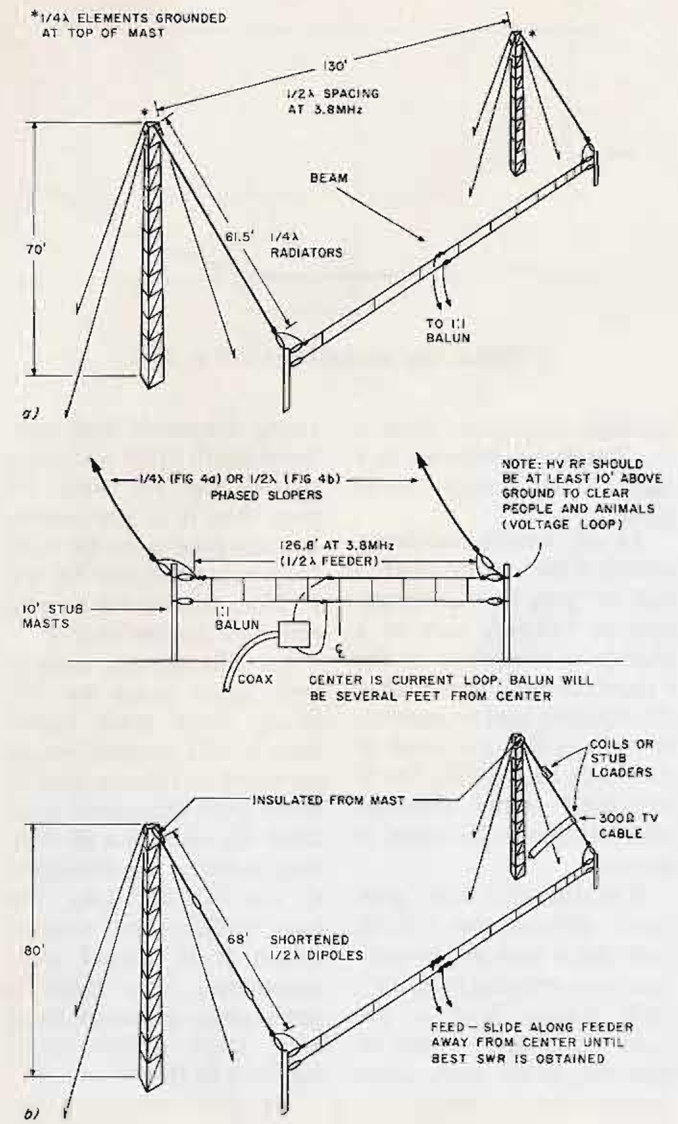


Fig. 4.(a) ¼-λ phased slopers. (b) ½-λ shortened phased slopers.

who is interested in antenna design.

Multidirectional slopers—

If there is sufficient open area around a single high mast or tree, 3 or 4 of the shortened 75m dipole slopers could be used for several directions as per K1THQ's 40m four-direction sloper described in the *ARRL Antenna Book* (Figs. 8-12, page 200, 13th edition). According to his measurements, the forward gain was about 4 dB and front-to-back up to 20 dB. Note that the coax to the relay box must be just over 3/8 λ. At 3.8 MHz, this length would be approximately 63.4 feet of RG-8/U or RG-58/U (VF = 66%), or 74.9 feet of RG-8/AU or RG-58/AU (VF = 78%).

I have not tried this 4-directional sloper, but it sounds interesting for anyone having the room and needing a lobe in more than one direction. If a mast at least 130 feet in height is available, full ½-λ sloping dipoles could be used without loading and would no doubt be more effective. The dimensions would then be about double those given for K1THQ's 40m switchable sloper.

¼-λ slopers—

Not having a tower, I have been unable to test a ¼-λ inverted sloper fed by coax at the top of the tower (with the coax sheath grounded to the tower near the feedpoint). I have worked several on 75 who have reported good results with this type of inverted sloper.

Theoretically, this should be a good antenna, since the current loop of the ¼-λ sloper is topside and generally in the clear. The tower provides a ground plane or acts as a reflector, which should give some directivity. However, this type appears to be tricky (and they either work or they don't). No doubt the ¼ wavelength and the angle between the sloper and the tower are critical, probably affecting the impedance at the top feedpoint, which is probably low. Possibly a matching network between the coax and the feedpoint would help, or possibly the top of the ¼-λ element could be grounded directly to the towers and the lower end voltage fed at the bottom with a tuner or a ¼-λ tuned line used to voltage or end feed, similar to the old Zepp. Using voltage feed at the bottom also saves the length of coax from bottom to top of tower.

I have one friend, YV5DLT, who put up two of these ¼-λ inverter slopers (topfed), one for 75 and one for 40. He said the 75 worked with no problem, whereas the 40m refused to work. I have noted that about 25% of those using the ¼-λ sloper have gotten them to work; the rest had problems or became discouraged if they did not work right away.

Possibly those using these successfully can give some suggestions. Also, the estimated angle of radiation, H-plane pattern, etc., would be interesting.

Dual ¼-λ phased slopers—

Possibly, using two of these side by side, in phase, spaced ½ λ broadside to the desired direction, might be of interest, as per Fig. 4(a). The two ¼-λ elements spaced ½ λ would be grounded topside, as mentioned above. The two bottom ends (voltage loop) would be voltage-fed with a ½-λ open phasing line feeding the ends, so the two ¼-λ radiators will be in phase. The ½-λ phasing line is current-fed, slightly off center directly with the coax or with a 1:1 balun. For 3.8-MHz operation, the two ¼-λ slopers would be approximately 61.5 feet and the 2-wire open phasing feedline approximately 126.8 feet long. This beam requires two 70-foot towers spaced about 130 feet apart and oriented broadside to the desired direction. A few wire reflectors between the towers might improve the lobe in the desired direction.

This array would be similar to the broadside or side-by-side phased slopers described below, except ¼-λ slopers would be used in place of the ½-λ shortened dipoles. See Fig. 4(b).

½-λ phased-sloper or vertical-dipole arrays—

If a mast at least 130 feet high is available, it could be used to support a full ½-λ phased sloper or vertical dipole endfire array. The elements would then be a full ½ λ (no endloading required), thus being more efficient and having greater effective height.

Another advantage of greater height would be the possibility of having the three elements near or exactly vertical, so the array would then become a 3-element vertical (dipole) log periodic or 3-element vertical yagi (whichever configuration is preferred) as was described above under "Phased Slopers—Endfire Array."

With the shortened dipole sloper or multi-element sloper arrays, the loaded elements probably reduce efficiency about

50%, as the shortened radiating portion is only approximately ¼ λ. Their ¼-λ radiating portion should be about the same as the vertical radiating portion of a Bruce array.

The end-loaded sloper array might be considered as a 3-element endfire array, as opposed to a 3-element Bruce array which is a bidirectional, broadside one using ¼-λ radiating elements in phase spaced ¼ λ. The 3-element endfire array would be unidirectional and should give greater gain. The Bruce would, however, probably have a greater null to the sides (180°).

If a single high mast is available, it could also be used as the center support for 3 or 4 separate phased endfire arrays, thus providing 3 or 4 separate beam headings or separate selectable lobes at 120° for 3 arrays or 90° for 4, for beaming N, E, S, or W.

Granger, Trylon, and Hy-Gain manufacture commercial or military fixed-wire monopole and vertical dipole log periodic wire beam arrays of these types for frequency ranges 2.5-32, 3.0-32, 4.0-32, and 6.0-32 MHz. These are recommended for long-haul HF circuits. See the Hy-Gain commercial catalog E, 1969.

Incidentally, if any hams are interested, these commercial wire beams are generally in the $20,000 to $50,000 class. However, this does include an 100- to 240-foot steel tower. A 3- to 5-element vertical (monoband) dipole log periodic for 75m can generally be ham-built for $100.00 or less for wire, insulators, etc., less tower and coax.

Broadside or side-by-side shortened slopers— Another suggested phased sloper could be the use of two shortened 78-foot ½-λ (loaded) sloper dipoles suspended from two 70-foot masts spaced ½ λ (approximately 130 feet at 3.8 MHz). See Fig. 4(b). The two slopers would be operated in phase with 130 feet of separation. A ½-λ tuned feeder/phasing line would be required for feeding and phasing the two slopers, similar to the dual ¼-λ phased slopers described above in Fig. 4(a).

Better still, if the two phased slopers could be a full ½ λ (requiring two 130-foot masts), they should give about maximum gain to broadside for an array of this type. I believe I have heard of some ham using this type of beam.

There are, no doubt, many phased-sloper-array combinations which can be designed. I again wish to point out that I have only built and tested the loaded sloper of Fig. 2 and the 3-element (end-loaded) phased sloper of Fig. 3(a).

I would appreciate hearing from anyone who is using or has tried any phased-sloper arrays or has any suggestions along this line. ■

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✓ Reader Service—see page 211