

A Shortened 40-Meter Four-Element Sloping Dipole Array

Instant Azimuth Change by Switching Characteristics of Each Element

by

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This article was first published by ham radio magazine, May 1988, pp 74 - 78. Antenna analyzing software was not available for us at that time, but our results with this antenna were very satisfying. Nevertheless the author suggests to do some modeling, especially for the length of the stubs when using rather short elements. This way it might be possible to improve the F/B -ratio a bit.

Here's how to build a four-element sloper system for 40-meters on a small city lot using the same mast that supports your triband Yagi.

One of the best low angle radiators for the lower bands is a vertical dipole. It concentrates the radiation at low angles and lessens dependence on a radial system, often a problem in vertical arrays. The radials are not as necessary as are verticals that have their maximum current at ground level.

Though the dipole in this array may not be exactly vertical, the signal is vertically polarized with a low angle of radiation. To get both directivity and gain, space several elements around a single support and use a switching network to select one dipole as the driven element. At the same time, lengthen the other dipoles electrically to act as reflectors. Add a 3/8-wavelength stub to make the dipole, which is self resonant at the operating frequency, perform like a reflector. This stub looks inductive to the antenna and decreases its resonant frequency by about 5 per cent. Select one of the sloping dipoles through the switching network to electrically rotate the antenna pattern.

We live on a small city lot, and our tower with a five-element tribander at the top is a rather fragile one guyed to resist strong winds. At first it seemed impossible to use any slopers because of potential interaction with the guy wires. The problem was solved by replacing the metallic wires with strong nylon rope. Good UV-resistant nylon ropes are available in yachting shops. (Do not use ropes designed for mountain climbing!!) Four dipoles, spaced 90 degrees apart, are run along the nylon rope. Usually a tower has only three guys separated by 120 degrees. Three elements are probably just as effective, as observations of the incoming signals show that the forward lobe is rather broad. (Using a similar array for 80 meter, Fuller, W2LU, comes to the same conclusion. See reference 2).

Shortened elements

The tower is about 56 feet (17 meters) high, and two of the four guys are fastened to the house about 6 feet above ground - a serious problem. Consequently, with the maximum possible element length, shortened dipoles had to be used. My design, shown in fig.1, uses a $4,5 \mu\text{H}$ inductance in each leg. A coil 12,5 turns, 1,5 inches in diameter and 1,4 inches long, provides the value of inductance.

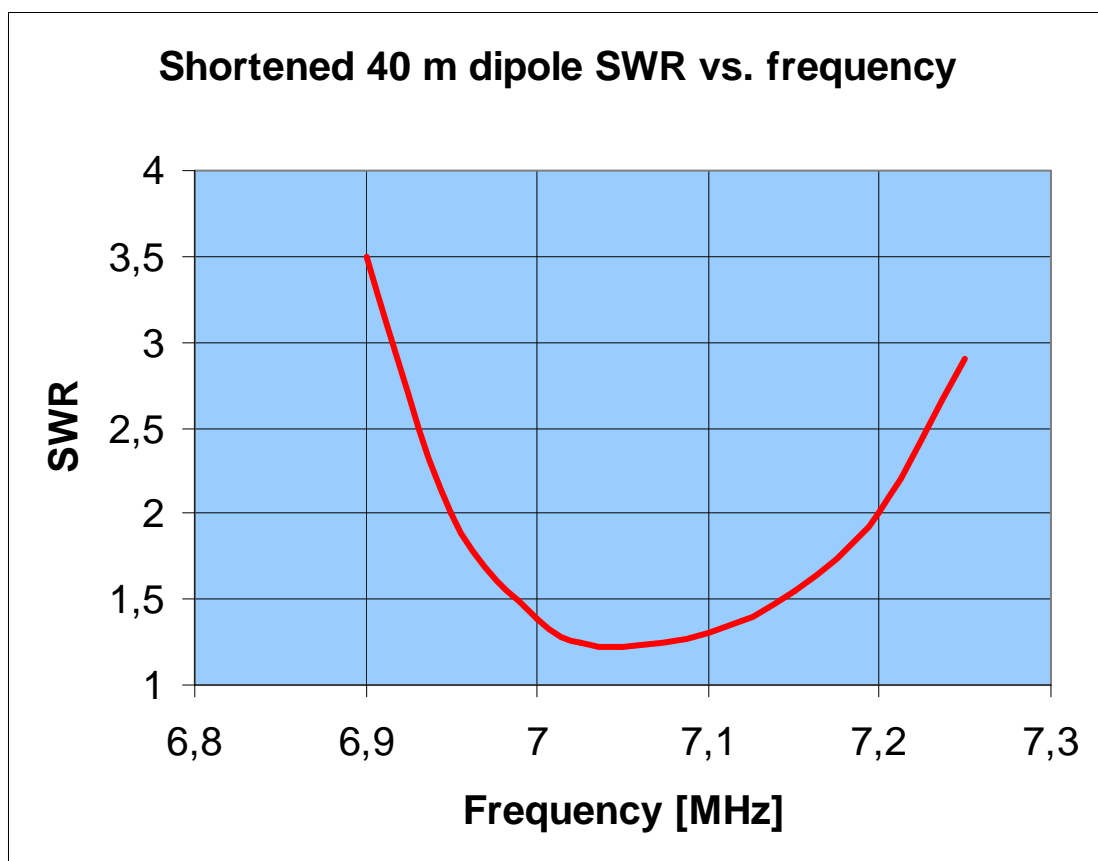
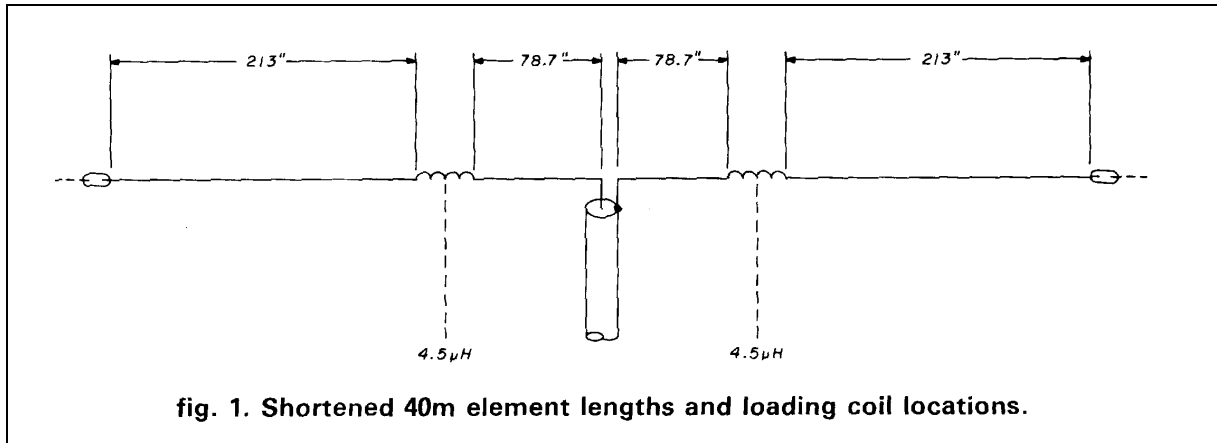
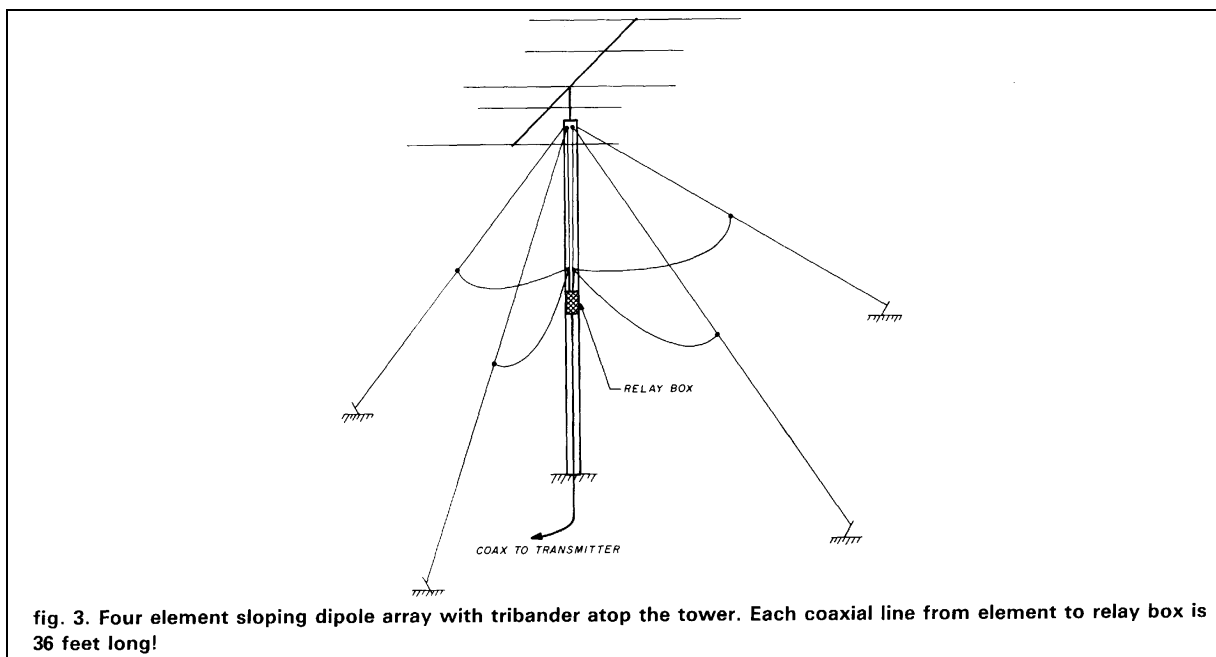


Fig.2. SWR of the shortened 40 m elements. Antenna was tuned for lowest SWR over the European segment of the band. Note the SWR is less than 1:2,0 over 200 kHz of band width.

Tuning of each shortened dipole is critical. They were tuned in a horizontal position about 13 feet above ground. As each antenna was put on the tower, the resonant frequency changed. I spent quite some time tuning the elements for resonance by connecting one element through an SWR bridge to the transmitter, while the other elements were disconnected. Though not grounded, they must be there with the required open feed line as there is always some interaction between the elements. Each element has to be tuned for the same resonant frequency and must show the same SWR across the band in order to switch direction without retuning the transmitter or linear. Figure 2 shows a plot of the SWR for one of the elements. The resonance is in the CW portion of the band. To tune for a higher frequency, just shorten the antenna.

Attaching the dipoles to the guy wires

Each element should be attached to the guy at only three points. The guy line passes through the tube of the upper loading coil, through a small loop fastened to the center insulator, and then through the tube of the lower loading coil. The upper end of the antenna is suspended from a 20-inch rope. Be sure the antenna moves along the guy freely or it may break in strong winds.



Controlling the direction

Figure 3 shows the basic antenna layout. The feed lines ($3/8$ wavelength long), which connect the various elements to the control box, are a vital part of the system. Remember that you have to consider the velocity factor of your coax cable. Equation 1 gives you the physical length for cutting your feed lines.

$$l = 0,375 \times \lambda \times k \quad \text{Eq. (1)}$$

l = physical length of the stub
 λ = wavelength
 k = velocity factor

For RG-8 or RG-58 coax k is about 0,66 so l is 36 feet. You can determine the velocity factor for other cables from antenna handbooks. When using cables like inexpensive TV coax where no reliable velocity factor value is available, you have to measure the velocity factor of the cable. This can be done with a simple dip-meter or an SWR-analyzer.

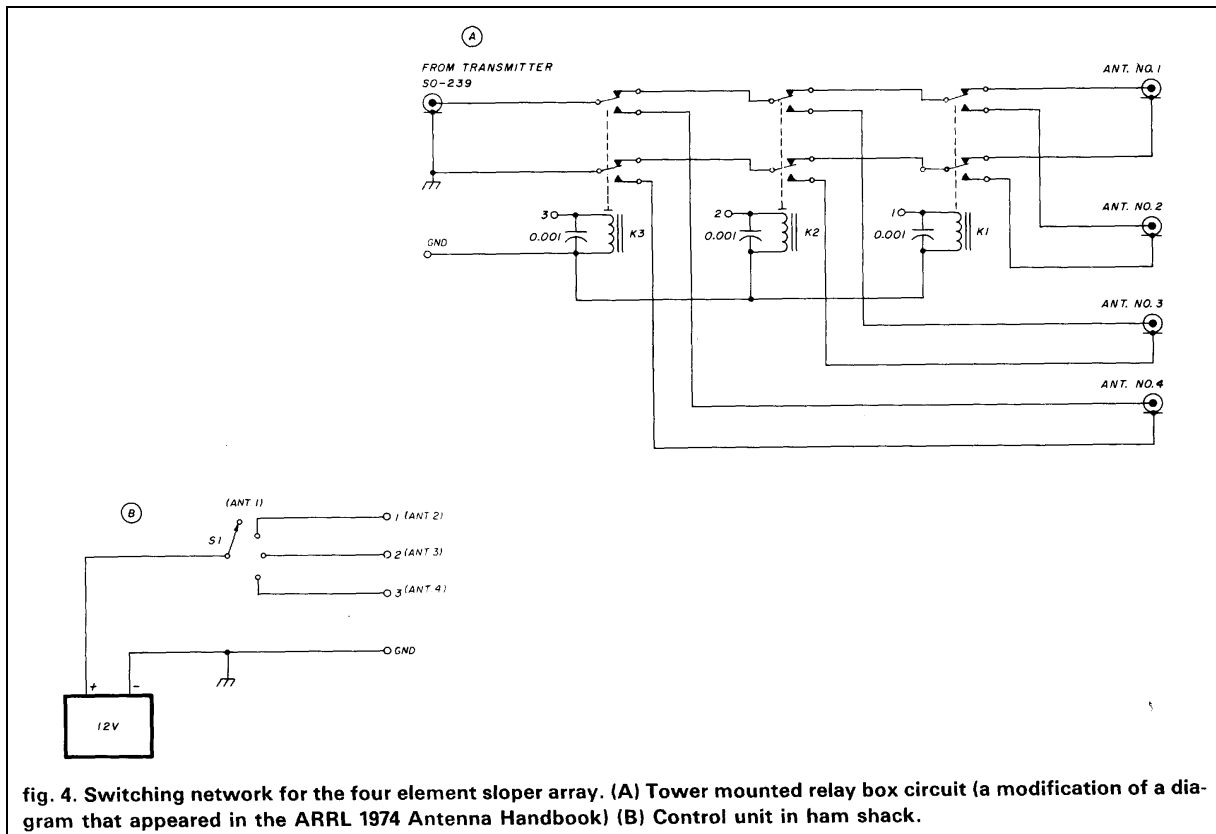
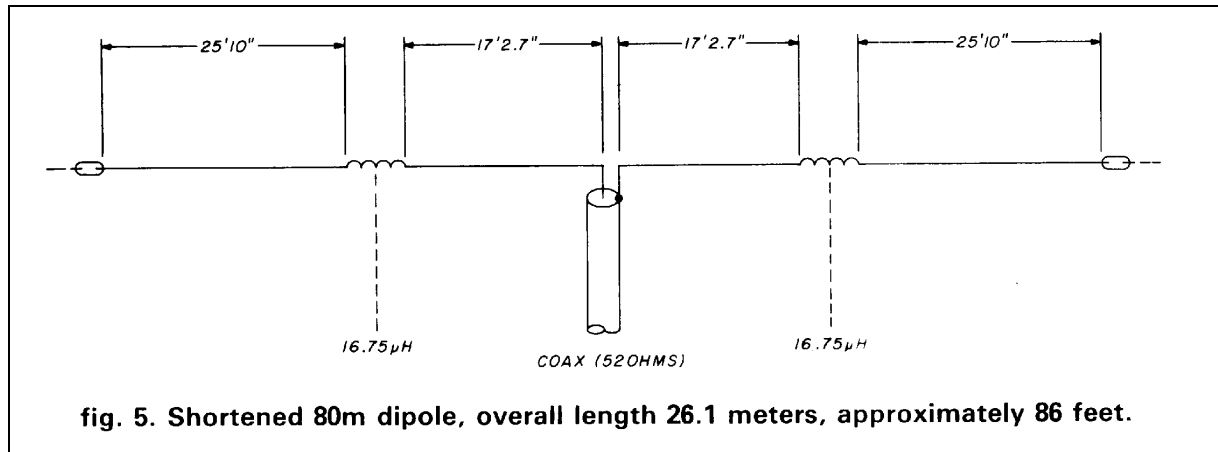


fig. 4. Switching network for the four element sloper array. (A) Tower mounted relay box circuit (a modification of a diagram that appeared in the ARRL 1974 Antenna Handbook) (B) Control unit in ham shack.

The feed line from the control box to the transmitter may be any length but should be the same type of cable as the stubs. Figure 4 is a schematic of the control box. For the four-element array, three relays are required to select the proper feed line. (If you use only three elements, you need only two relays.) The contacts should be rated for about 6 to 10 amps and contact spacing should be good for at least 200 volts. This handles up to 800 watts at low SWR. Never switch the direction when power is applied to one of the elements - hot switching may result in damage. Because the feed lines of the unused elements are not grounded, the braid of the coax is open circuited when not in use. This is the only way to achieve the proper tuning that allows the elements to act as reflectors.

Other bands

I hope this article will encourage you to build this or a similar array. If space permits, use full size elements. If a shortened dipole is needed, design data is available for other frequencies (e.g. Ref. 1). An 80-meter dipole for use at 3,8 MHz is described in fig. 5.



With an antenna tower only 78 feet high you will be able to join other amateurs with a directive 80-meter antenna. The bandwidth for such an antenna will be small, but if you use low-loss coils the antenna should be quite effective and possibly achieve 4 dB of gain.

References:

1. The ARRL Antenna Book, Newington, CT, USA
2. Fuller, Eugene B., W2LU, „Sloping 80-meter array“, ham radio magazine, May 1979, page 70

Note: The author has developed a multi band directive antenna system similar to the one described above. By using multi band dipoles (e.g. W3DZZ) it is possible to cover several bands (e.g. 40 and 80 meters) with one directive antenna. For this invention a patent has been granted. The design of the stubs in a multi band array is different to the system described above. If you would like to have more information, please feel free to contact the author (weigl+info@nexta.at).