# The California Phased Array

*Easy to build, easy to use—and even easier on the billfold!*

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If you're interested in a compact, small-footprint wire antenna for 20 meters that has an honest 3 dB gain, is electronically rotatable, requires no tuner, and can be built for less than $25, read on—because that describes the California Phased Array.

The design constraints for the original California Phased Array were my very thin billfold, small city lot, TenTec Scout (50W), and a couple of palm trees. Since the palm trees are about 50 feet tall and spaced about 40 feet apart, I figured I had a couple of environmentally-correct towers. The immediate response was to simply stretch a dipole between my "organic supports." This I did, and though it worked admirably, I pined for something with gain and directivity. The technical requirements began to form in my mind: No radials, feedpoint at least 1/4 wave off the ground, and gain of 3 dB. From these points, the California Phased Array was conjured.

## Say "abracadabra"

The antenna is actually a pair of half-wave wire dipoles, vertically oriented, and fed in phase or 180° out of phase—hence a two-element broadside or endfire array (and a "California" Phased Array because of the palm trees). Using half-wave dipoles eliminated the need for a radial system, ensured the smallest possible footprint, and elevated the feedpoints greater than 1/4 wave above earth ground (see **Fig. 1**).

The dimensions for the dipoles and phasing lines were calculated from the standard antenna formulas at 14.2 MHz, and they are specified in **Fig. 2**. Although the original California Phased

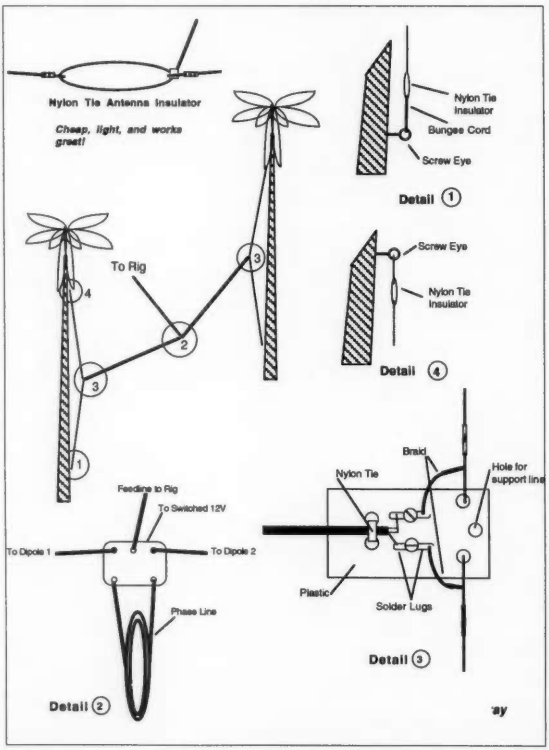


*Fig. 1. See why it's a "California" phased array?*

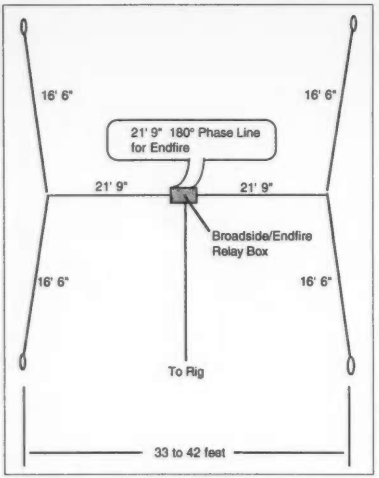


*Fig. 2. Dimensions of W7DE's setup.*

Array was designed around the palm trees as supports, and the dipoles are separated by approximately 40 feet, other available supports and spacings can be utilized (H-plane patterns for the California Phased Array, depending upon your final spacing, can be found in *The ARRL Antenna Book*). Some alternate physical configurations are illustrated in **Fig. 3**.

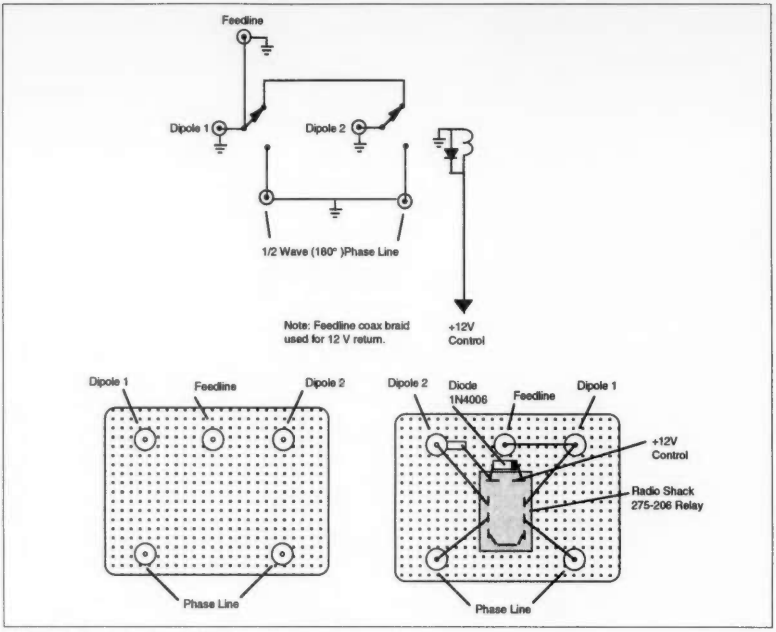


*Fig. 4. Remote control box for electronic rotation.*

Details for the relay assembly that switches the additional half-wave phasing line in and out (to rotate the array electronically) are shown in **Fig. 4**. The relay and BNC connectors were assembled in a small metal enclosure. The shield of the coax feedline is used for the DC return when energizing the relay coil.

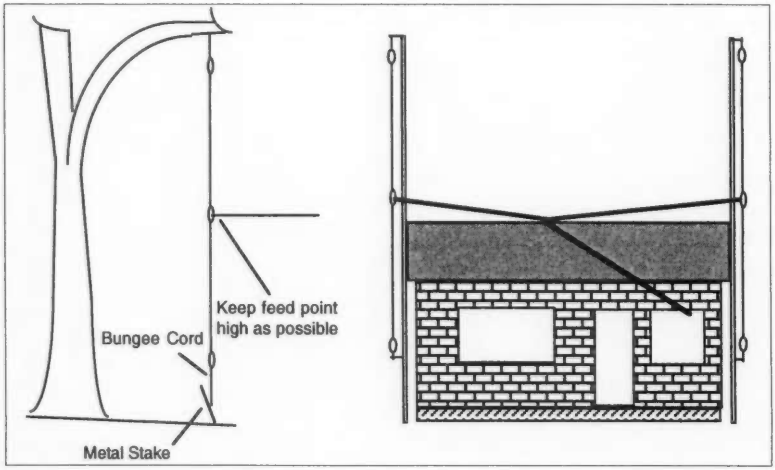


*Fig. 3. Alternate configurations.*

The initial checkout of the antenna was performed on the broadside configuration. I measured each dipole individually and found it to be flat across the band and about 47 ohms. When I connected the phasing lines of the antennas together, I fully expected to see something around a 2:1 SWR (about 23 ohms); instead, I found virtually no SWR and 47 ohms across the entire 20-meter band. I even changed the battery in the little MFJ SWR analyzer, and still got the same measurements. Here's why: If an array of two identical elements is fed in phase or 180° out of phase, both elements have the same feedpoint impedance. With these arrays, feeding the elements through equal lengths of feedline (in phase) or lengths differing by 180°

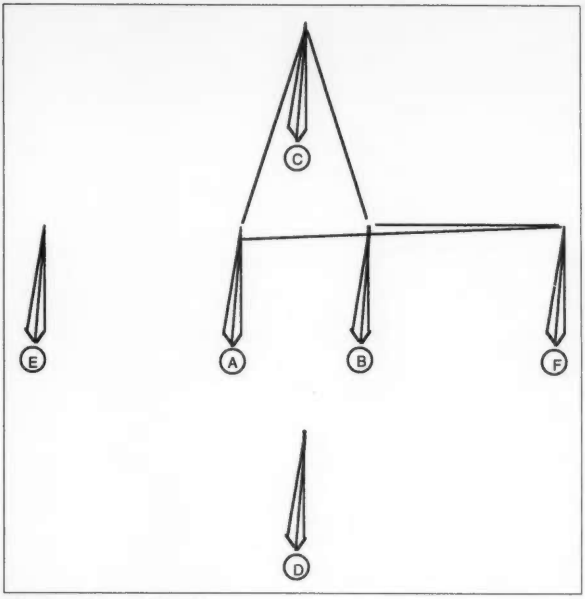


*Fig. 5. Gain and directivity.*

(out of phase) will lead to the correct current and phase match, regardless of the what the line length is.

The California Phased Array can deliver an honest 3 dB gain, and here's a simple explanation of how it does (see **Fig. 5**).

•Broadside (in phase) phasing: Antennas (A) and (B) are identical vertical dipoles separated by one half-wavelength and fed in phase. Receiving stations (C) and (D) are equally distant from antennas (A) and (B). The signals from (A) and (B) will, therefore, reach antennas (C) and (D) at the same time, in phase, and will add. However, receiving stations (E) and (F) will receive the radiated signals from antennas (A) and (B) 180° out of phase because the signal from the transmitting antenna that is farther away by one half-wavelength will arrive at the receiving antenna 180° out of phase, subtract and cancel out.

•Endfire (180° out of phase) phasing: The antennas are the same as above, but this time antennas (A) and (B) are fed 180° out of phase. In this case, since receiving stations (C) and (D) are equally distant from antennas (A) and (B), the signals will reach antennas (C) and (D) at the same time, but since the radiated signals are 180° out of phase, they will subtract and cancel out. However, in the case of receiving stations (E) and (F), the signal from one transmitting antenna is farther away by one half-wavelength and it will arrive at the receiving antenna 180° later than the closer one. This will put the signals back in phase and the signals will add.

**It's so simple**

There you have it: Gain and directivity with a simple wire antenna system—and all you need to rotate it electronically is a simple relay to switch an additional phasing line in and out.

The only thing critical about this antenna system is to be as precise as possible when preparing the dipoles and the feedlines. If a metal tower is used for support, the proximity of the tower will affect the characteristics of the dipole and distort the radiation pattern to some degree, but who knows? It may even improve performance. The original California Phased Array used RG-58U, because it's light and I never run over 100 watts. For high power usage RG-8 must be used.

Upon completion of the antenna system, I conducted its maiden test. While running 50 watts SSB, within a 35-minute period (I did a little rag-chewing) my first contacts included W1AW (CT) and KH6/W7GMH in Hawaii. This certainly demonstrated that the two major lobes were doing what they were supposed to do in the broadside configuration. A second test (also in the broadside configuration) was performed during the California QSO Contest (5 October 1996) and within an hour and a half, I worked 12 states and Canada (once again, 50 watts SSB). On-the-air testing is still underway in the endfire configuration (which is north and south from my San Francisco-area QTH). I'm sure hearing a lot of Spanish-speaking stations, so I guess I'll have to brush up on my Spanish!