The CCD Antenna—Improved, Ready-to-Use Construction Data

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Since we first described the controlled-current-distribution (CCD) antenna in 1978,[1] over a thousand copies of our data sheet have been requested by interested amateurs and professionals. Their questions and comments have given us an incentive to continue our experimentation with this unique antenna. The latest improvements in construction methods and performance are reflected in this update.

Background

The CCD antenna concept of the first author has been undergoing continual refinement at his antenna test range since 1959. Antenna experimentation was a natural by-product of our careers as Federal Communications Commission engineers. Harry was Chief of Engineering, Renewal and Transfer Div of the Broadcast Bureau, serving at the Washington, DC, office for over 34 years. Needless to say, the unusual properties of the CCD design have held our interest since those early days.

At the heart of a full-wave CCD antenna is a string of series-resonant circuits which result from pairing each capacitor with an inductor (wire section) having equal reactance but opposite polarity at the operating frequency. The net result is a very low impedance to the flow of RF through the radiator. This idea is implicit in Harry A. Mills' US Patent 3,564,551.

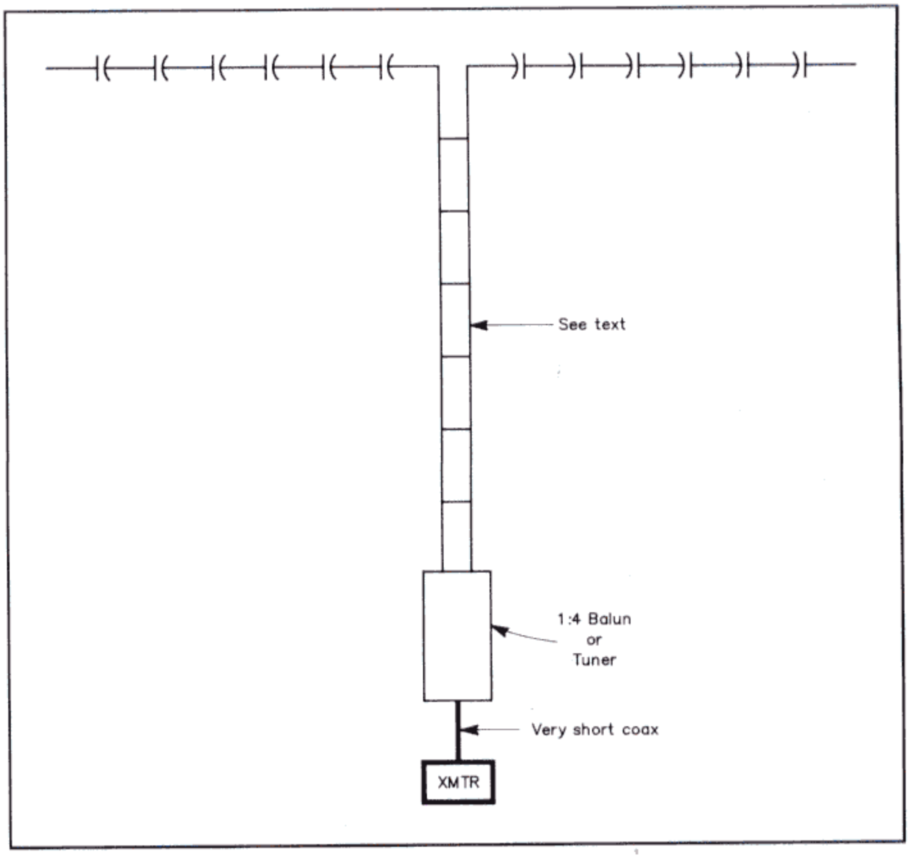

Fig 1—The basic CCD antenna system.

General Considerations

The recommended arrangement for a basic CCD system is shown in Fig 1. A 1:4 balun is connected to the transceiver through the shortest possible length of coax. Using a balun in this manner results in wider bandwidth and improved balance. (The impedance of the CCD antenna closely matches the characteristic impedance of space—376.7 Ω.[8])

Ladder-type 450-Ω feed line is suitable for legal-limit power. For low-power operation (less than 300 watts), foam-type 300-Ω ribbon cable is adequate and provides an easier, neater installation. The line length is not critical in either case, but trimming it to any multiple of an electrical half-wavelength greatly improves the convenience of using a noise bridge *at the operating position*. This may reduce the need for repeated trips to the antenna.

Fig 2 compares the performance of two vertical CCDs against a conventional quarter-wave vertical standard. These field-intensity patterns were measured at 146 MHz on the W4FD range. Note the 12° vertical-plane main lobe from the CCDs—with *no* radials required!

Component Considerations

There are two types of capacitors that have been found to offer the best performance in CCD applications. Silvered mica

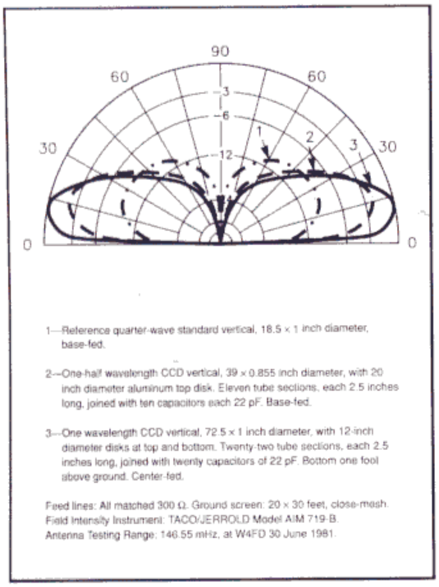

Fig 2—Measured radiation patterns of vertical 2-meter CCDs compared to a ¼-λ reference. Note the 12° main lobe of the full-wave CCD.

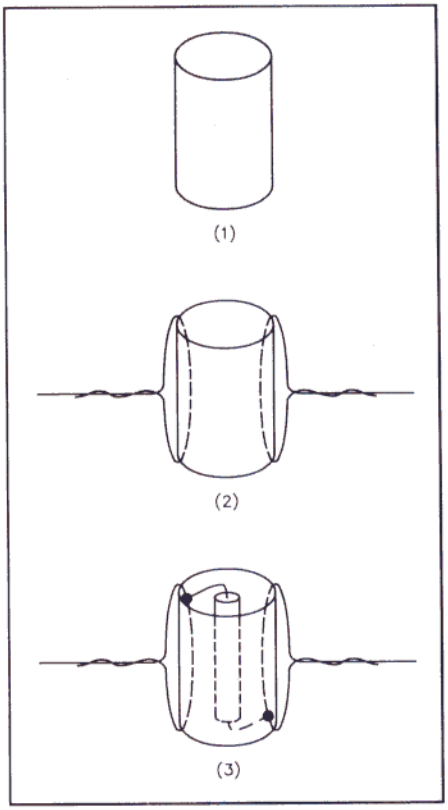

Fig 3—Capacitor/protector assembly in three easy steps. (1) Select a plastic water pipe diameter that is just large enough to accept the capacitor. Cut the pipe lengths ¼ inch longer than the capacitor to hold an adequate amount of silicone sealer. A pipe cutter or hacksaw is suggested. (2) Select the proper wire section length from Table 1, allowing enough for twists. Sand or scrape the wire ends in preparation for soldering. Loop the wire ends through pipes, making sure that the section lengths are exactly as shown in Table 1 for the desired band. The length of the wire section is measured between pipe centers as shown in Fig 4. Twist the ends securely. (3) Finally, solder the capacitors as shown. Do not apply the silicone sealer until after you've tested the CCD at a convenient height of 5 feet above ground.

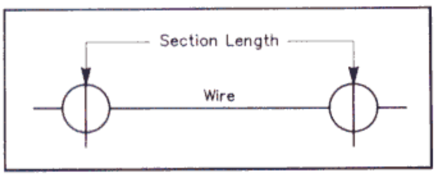

Fig 4—Measure the length of a wire section between the pipe centers.

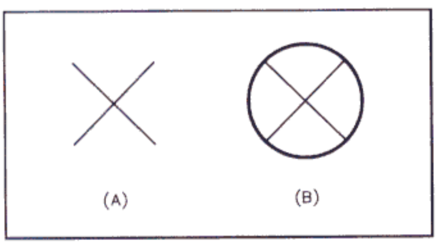

Fig 5—Two examples of simple end loads or hats that can be used if required. (A) Two stiff wires (such as brass welding rod) are soldered at their crossing points. Make two assemblies and solder one to each end of the CCD. (B) This design is similar to the crossed wires, but adds a rim for additional capacitive loading. The total end-load diameters can be found in Table 1.

Table 1
Capacitor Sizes, Wire Sections and End Loads

End-Load Diameter	*Band (Meters)*	*Length (Feet)*	*Section (Inches)*	*Sections (Number)*	*Capacitor (pF)*	*Capacitors (Number)*
—	160	560	140	48	1560	46
18°	80	280	70	48	780	46
12°	40	140	35	48	390	46
—	30	97	24.36	48	270	46
9°	20	70	17.5	48	195	46
—	15	46.5	11.5	48	130	46
—	10	35	8.75	48	97	46

Note: Loads for other bands may be extrapolated from the values shown. (Capacitive load diameter increases current flow in end sections.)

capacitors have low loss, high Q, and are ruggedly constructed. The 300-V, 5% types are sold for as little as five cents each in quantities of 100.[7] Polystyrene capacitors are very stable, and offer high Q and very low loss. Regardless of which capacitor you choose, beware of those with fragile leads. Also be sure to check the tolerance of each capacitor (it must not exceed 5%). Try to locate an accurate instrument for your measurements. Club or school instruments are often available for testing in their labs.

Twelve-gauge wire was used to obtain the specifications in Table 1. Stranded wire with a tough plastic jacket will reduce precipitation static. Enameled solid copper is also a good choice. Avoid copper-clad wire since it often rusts through the coating and exposes the steel core, a poor conductor of RF.

Setting Resonance

A correctly built CCD antenna for 80 meters, for example, will cover 3.5 to 4.0 MHz with a usable SWR and using *no* tuner. Because of the capacitor action, bandwidth is not symmetrical at each side of resonance. Resonance should be set at 25 kHz above the low end of any band by removing (or adding) equal numbers of capacitor sections at both antenna ends. If only partial band coverage is desired, set the resonance to 25 kHz above the lower limit of the band segment you intend to use.

Recent CCD Successes

Excellent CCD performance on 160 meters has been reported by N4VL, W4FD and W9ALU. All have worked numerous VKs and ZLs on this challenging band. Among the many amateurs who have reported excellent performance on other bands are KK4X, KT3E, KD4CE, KK4EJ, N4VMB, NX4B and the husband and wife team of Delbert AB4TH and Dortha N4SHE.

Acknowledgments

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9 Route 3, Box 654, West Jefferson, NC 28694

10 PO Box 6658, Beaverton, OR 97007.