Report #6

Corner reflector antennas and a transmitter dipole with the split-type balun

Content

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1. Corner reflector antenna

The corner-reflector antenna is made up of two plane reflector panels and a dipole element. This arrangement prohibits radiation in the back and side directions and hence makes the antenna more directional [1]. The antenna is useful in obtaining gains of up to 12 dBi [1].

a. Reflector design

Fig 1 shows the geometry of the corner reflector antenna.

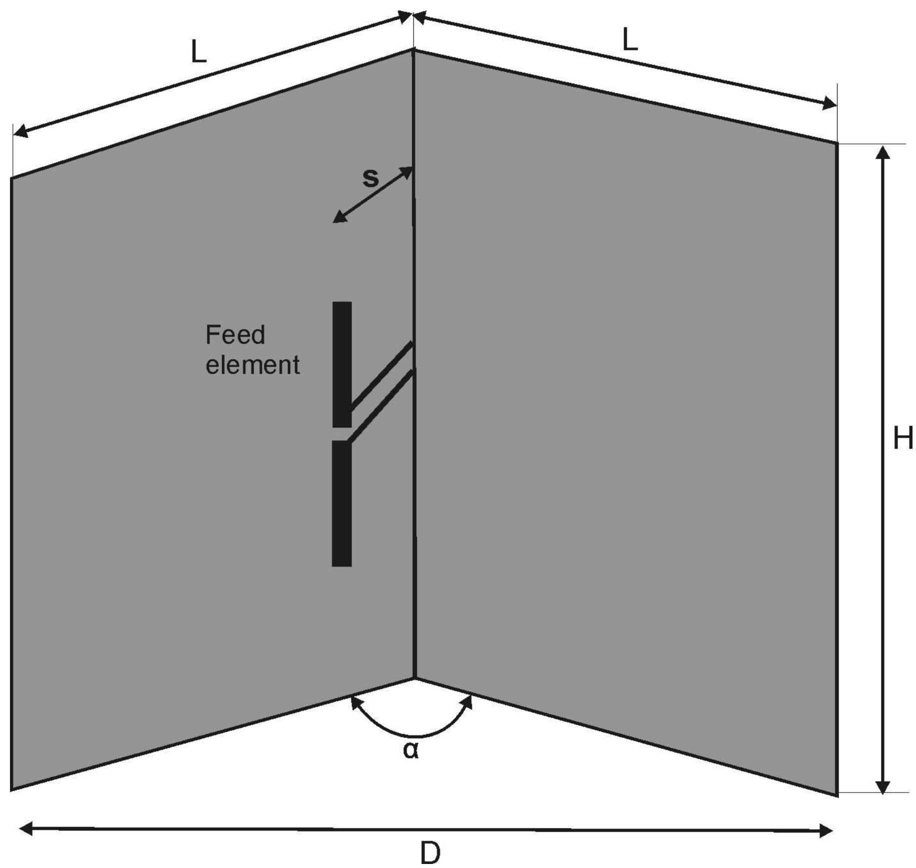


Fig 1. Design parameters for a corner reflector antenna

The feed element for the corner reflector is almost always a dipole or an array of collinear dipoles placed parallel to the vertex a distance s away, as shown in Fig. 1a (front view). To obtain a greater bandwidth the feed elements are thick cylindrical or biconical dipoles instead of thin wires. The aperture of the corner reflector (D) is usually made between one and two wavelengths $(\lambda < D < 2\lambda)$[1]. The feed-to-vertex distance (s) is usually taken to be between a third and two-thirds of the wavelength $(\lambda/3 < s < 2\lambda/3)$ [1]. For each reflector, there is an optimum feed-to-vertex spacing. If the spacing becomes too small, the radiation resistance decreases and becomes comparable to the loss resistance of the system which results in an inefficient antenna. For very large spacing, the system produces undesirable multi-lobes, and it loses its directional characteristics [2]. The length of the sides of the 90^o corner reflector is mostly taken to be twice the distance from the vertex to the feed $(L \approx 2s)$. The height (H) of the reflector is usually taken to be about 1.2 to 1.5 times greater than the total length of the feed element, in order to reduce radiation towards the back region from the ends.

b. Dipole-balun assembly

A dipole is a balanced antenna and cannot be directly fed with coaxial line [2]. Doing so causes the outer conductor to act as part of the antenna and a large amount of signal is radiated or received by the outer conductor. For casual reception this may not matter much, but the pattern of the antenna is destroyed and generally is no longer predictable.

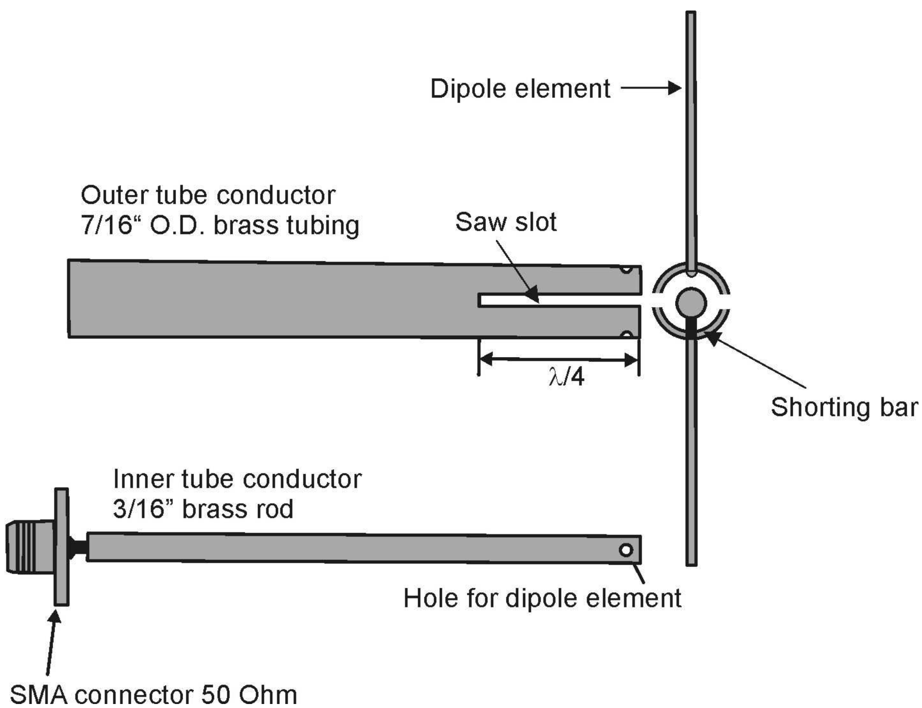


Fig.2. Dipole and split-balun assembly

In order to have a true dipole, balanced feed is a must. In order to derive a balanced feed for the dipole some sort of a transformer is necessary. This can be done in several ways. One way is to coil the coaxial line to form an inductor to isolate the end of the line from ground. Another is to use a ferrite bead to accomplish the same thing. These methods are not too practical at UHF but work well at lower frequencies (<200 MHz) [3].

One of the most common methods used at UHF is to split the outer conductor lengthwise for a quarter wavelength and connect the inner conductor to the end of one segment, and to one dipole element [2]. The other segment is connected to the opposite half of the dipole. This is known as a slot-feed or split-type balun [2]. Fig 2 shows the layout of the dipole and the split balun assembly.

2. Performance

Fig. 3 shows the three corner reflector antennas and a dipole antenna which were built and tested. For the present design (α=90^{o}) the best matching is obtained for $s = 0.55\lambda\,(15")$.

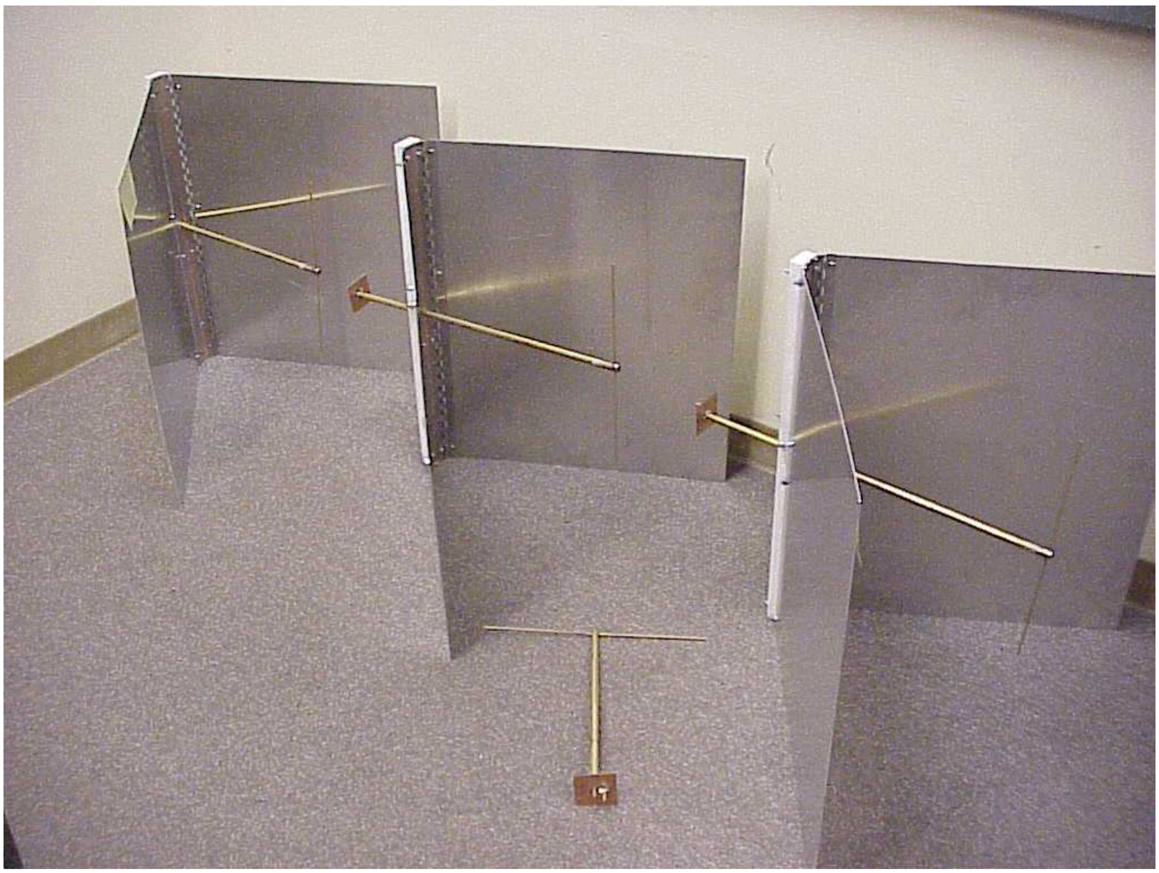
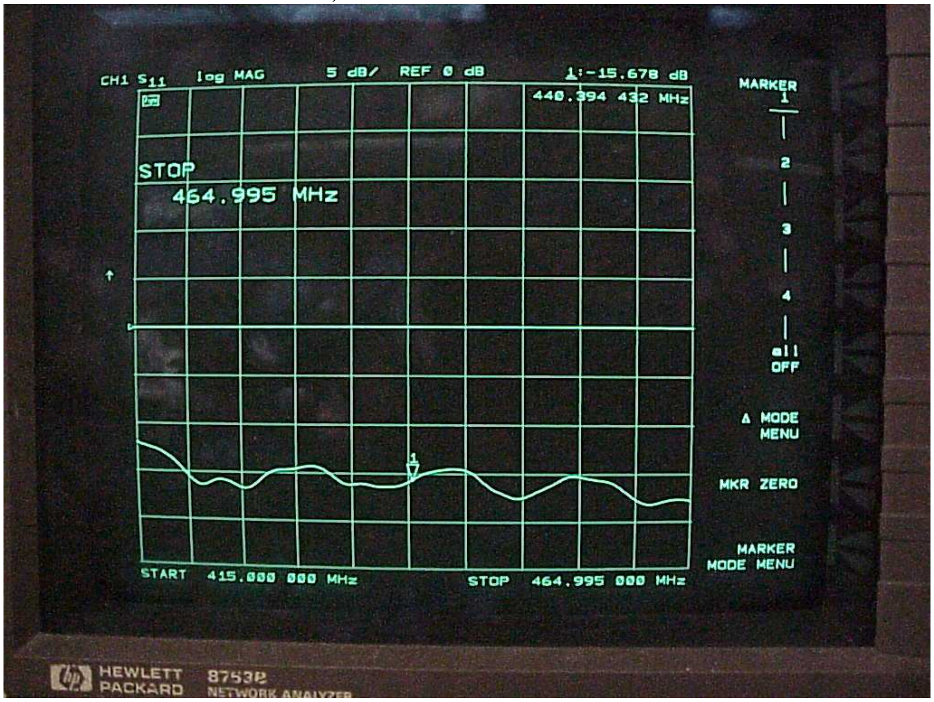


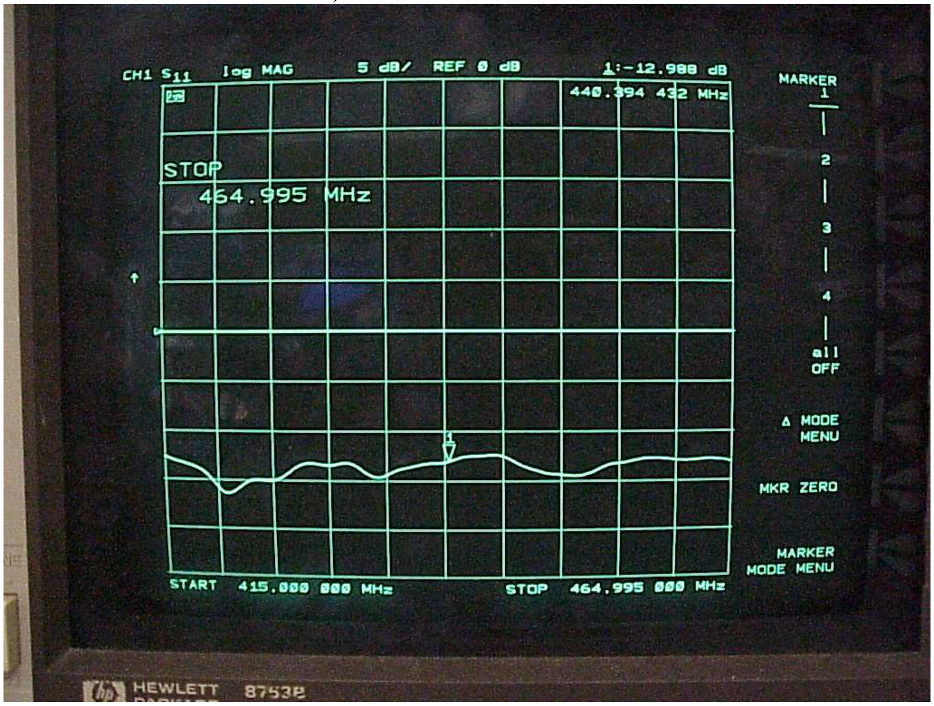
Fig.3. Three corner reflector antennas and a simple dipole antenna

This value is less than the limit of 0.66λ and hence should give us a smooth directional radiation pattern within the aperture, with no side lobes. However there was no way of confirming this, due the lack of antenna measurement facility. Fig 4 shows the return loss for all the four antenna elements. All the antennas have a return loss of about -12 to -15 dB over the required bandwidth of 415MHz to 465 MHz. Actually, they are more broadband than expected.

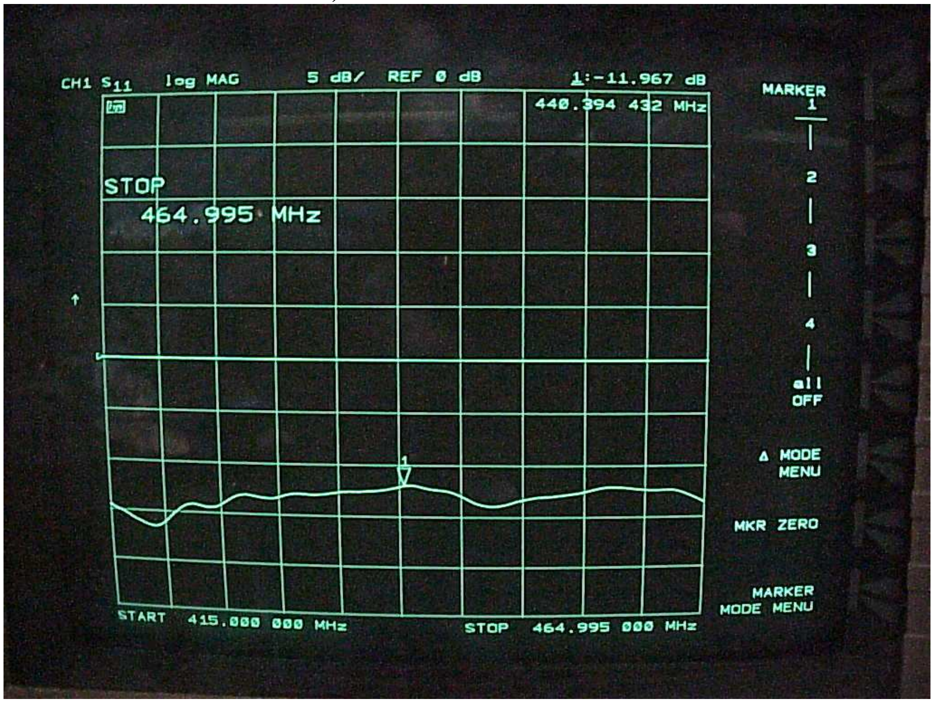
a) Reflector antenna #1



b) Reflector antenna #2



c) Reflector antenna #3



d) Simple dipole (transmitter)

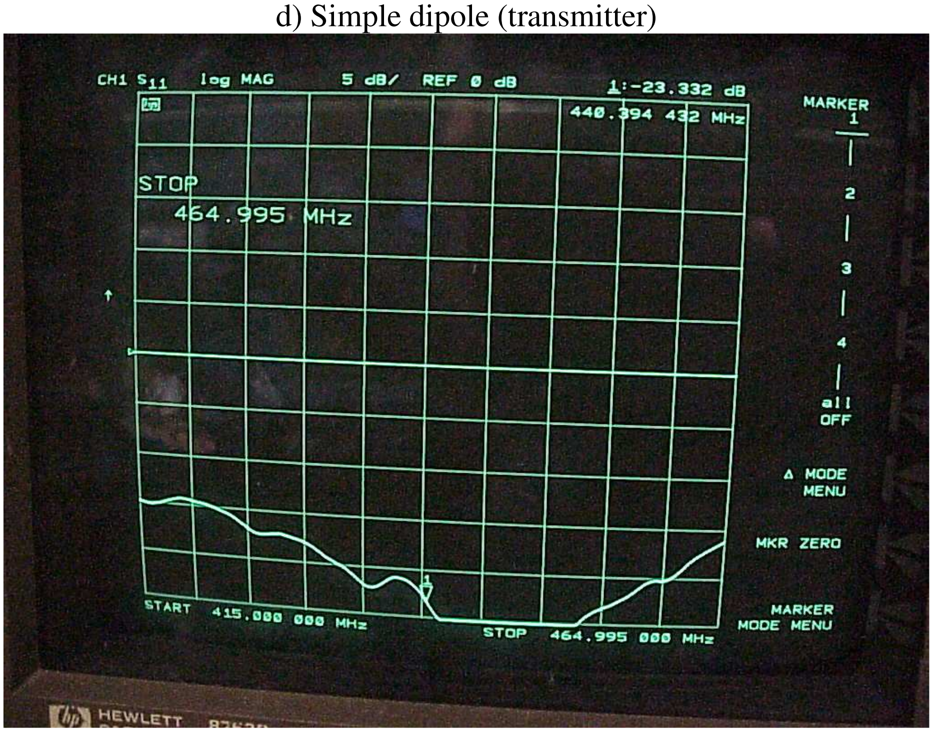


Fig.4. Return loss for the reflector antennas and simple dipole antenna

3. References

1. C.A. Balanis, "*Antenna Theory: Analysis and Design*", third edition, John Wiley & Sons, 2005, pp 883-884.

2. R.C. Johnson and H. Jasik, "*Antenna Engineering Handbook*", second edition, McGraw-Hill Book Company, 1984.

3. R.A. Burberry, "*VHF and UHF Antennas*", IEEE Electromagnetic Wave Series 35, Peter Peregrinus ltd., 1992, 113-114.