Low Profile Disk and Sleeve loaded Monopole Antennas

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Abstract:

Two models of low profile compact disk and sleeve loaded monopole antennas are investigated for broadband applications in the VHF/UHF range. Parametric studies of these configurations are performed by Method-of-Moments simulations. Optimized performance (impedance and pattern bandwidths) of these antennas is presented and compared with that of existing designs of similar size.

Introduction:

Low profile monopole broadband antennas operating in the VHF and UHF range are required in several commercial and military applications. Goubau [1] has introduced the design of a small multi-element disk loaded monopole antenna with 3:1 vswr over a frequency bandwidth of about 2:1 (450-910MHz). The geometry of this antenna is shown in Fig.1. The height and diameter of this antenna are 43mm and 123mm respectively. Friedman [2] presented a single disk loaded monopole antenna (with a biconical center post as shown in Fig.2) whose size and performance are comparable to those of Goubau's antenna. Modifications to the Goubau's antenna have also been reported by Foltz's group [3-5]. The sleeve loaded monopole antenna is a conventional monopole with the outer conductor of the coaxial feed line extended over the ground plane. It has been experimentally shown by Wong and King [6] that sleeve loaded meander monopole antennas can provide low height and broad band performance (about 3:1 bandwidth).

The objective of the present work is to investigate a low profile disk loaded monopole antenna with sleeve and post loading. Two antenna models are optimized through systematic electromagnetic analyses, which are carried out using the software tool FEKO [7], for broadband operation.

Analysis and Design:

A disk loaded monopole antenna is the starting point for this study. The dimensions of the antenna height and disk diameter are fixed to be the same as those of Friedman's antenna, i.e. the height of the monopole is 65mm and the loading disk diameter is 184mm. The radius of the monopole wire element is 2mm. The computed input impedance of this disk loaded monopole antenna is shown in Fig.3. The radiation resistance is less than 10Ω and the resonant frequency is around 220MHz.

An open conducting sleeve, connected to the ground plane and encircling the monopole element certain distance along its axis, is introduced for increasing the bandwidth. An annular metallic disc is further attached to the top portion of the sleeve. The resonances from the sleeve and the annular disc are adjusted by modifying their geometrical parameters (sleeve radius and height, and annular disc radius). Finally, a pair of metallic posts, connected between the ground plane and the top disc, function as tuning devices which help to realize a slowly varying driving point impedance. The geometry of this model is shown in Fig.4. The sleeve parameters (radius and height), the annular disc

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radius and the position of outer posts are optimized to realize a 2:1 bandwidth of VSWR 3:1. The calculated VSWR of this configuration is shown in Fig.5.

In the second antenna model, a thick cylinder is fed at the base by a coaxial connecter instead of a thin monopole (as in the previous configuration). A conducting sleeve around this thick cylinder and two outer metallic posts (connected to the top disc) constitute this antenna model. The geometry is shown in Fig.6 and the computed VSWR of the optimized version is presented in Fig.7. The operating frequency bandwidth (VSWR 3:1) of this design is 350-1300MHz which is significantly more than the antenna #1. The radiation patterns are also observed to be relatively stable with varying frequency. More details of these results will be discussed at the Symposium.

Conclusion:

Two configurations of disc and sleeve loaded monopole antennas are introduced and their predicted performance is presented. These geometries are simpler in construction and their bandwidth characteristics are better compared to the recently reported designs.

References:

[1] G.Goubau, "Multi-element monopole antennas," Proc. ECOM-ARO Workshop on Electrically Small Antennas, Fort Monmouth, NJ, May 1976, pp. 63-67.

[2] C.H.Friedman, IEEE Trans. Antennas and Propagation, Vol. 33, pp. 1142-1148, Oct.1985.

[3] H.Foltz, et al., IEEE Trans. Antennas and Propagation, Vol. 46, pp. 1894-1896, Dec.1998.

[4] H.Foltz, et al., 2002 IEEE Antennas and Propagation Symposium Digest, Vol. 1, pp. 576-579, San Antonio, June 2002.

[5] L.Cobos, et al., 2004 IEEE Antennas and Propagation Symposium Digest, Vol. 3, pp. 3051-3054, Monterey, June 2004.

[6] J.L. Wong and H.E. King, IEEE Trans. Antennas and Propagation, Vol. 34, pp. 716-717, May 1986.

[7] FEKO Suite 4.1, EM Software and Systems (www.feko.info), 2003.

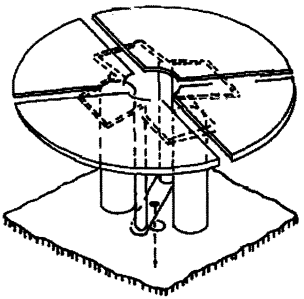

Figure 1 Goubau multi-element antenna [1]

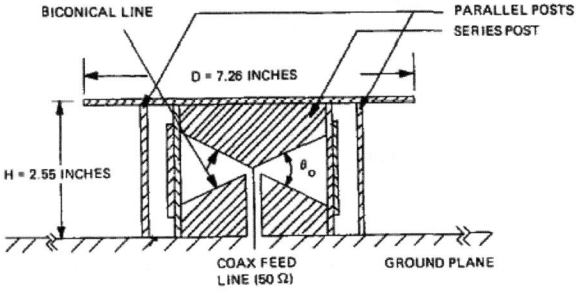

Figure 2 Modified disk loaded monopole antenna [2]

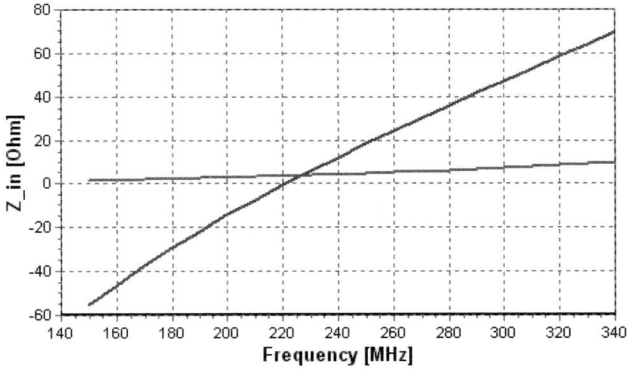

Figure 3 Computed input impedance of a disk loaded monopole antenna (monopole ht. 65mm, disc diameter – 184mm)

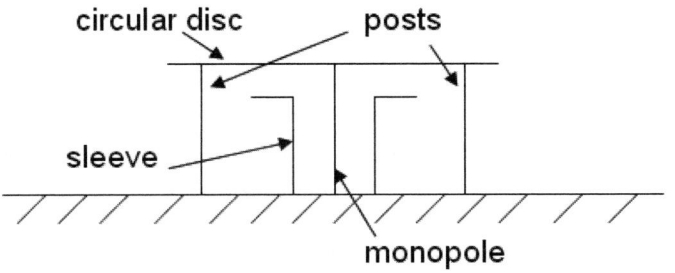

Figure 4 Disk and sleeve loaded monopole antenna model #1

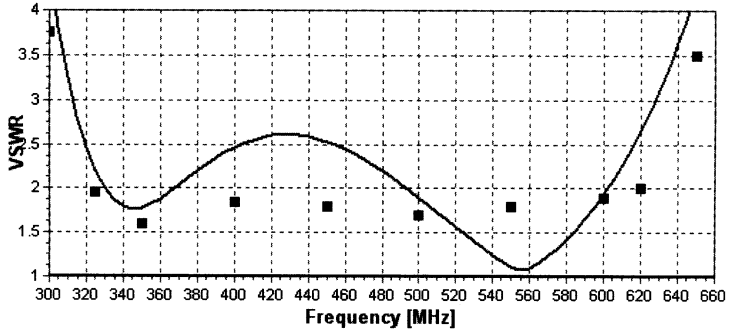

Figure 5 Computed VSWR of optimized Design of antenna model #1 (solid line) and measured VSWR of Friedman's antenna (■)

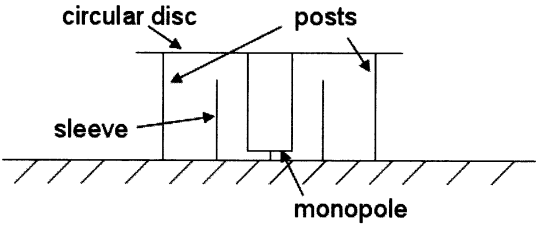

Figure 6 Disk and sleeve loaded monopole antenna model #2

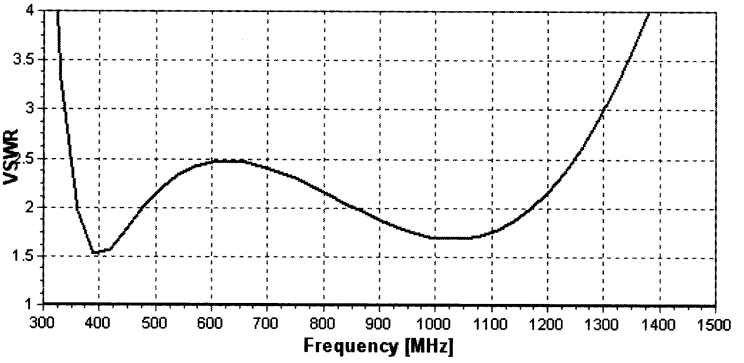

Figure 7 Computed VSWR of optimized design of antenna model #2