ULTRA WIDEBAND DOUBLE DISCON ANTENNA SHOWING 30:1 BANDWIDTH

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This paper proposes an improved discon antenna (double discone antenna). The double discone antenna consists of two discon antennas having two different dimension. One small discon antenna covers high frequency bandwidth, the other big discon antenna does low frequency range, and their feeding directions are opposite with each other. The proto type was made for the verification of agreement with the calculated results. The measured VSWR is less than 2.5 from 282*MHz* to 8.93 *GHz*, which is 30:1 bandwidth. This is much better performance than any same-size-discone antenna.

1. Introduction

A discon antenna is a modified shape of biconical antenna showing wide frequency bandwidth, and the biconical antenna can show good performance in low frequency band only if the height is long enough. But the biconical antenna's bandwidth is limited in high frequency region because of physical supporting problem and feeding structure realization. A broadband omni-directional antenna having bandwidth of 0.5*GHz* to 18*GHz* was researched using biconical antenna [1], however, the problem is the structural dimension of the biconical antenna because the height should be about 600*mm* (1/2 wavelength). As the operating frequency is lower as the realization is more difficult. The discone antenna has a merit which can reduce the dimension to a half length of the biconical antenna (about 1/4 wavelength). The general discone antenna, having a real finite monocone, has just 10:1 frequency bandwidth ratio, since the finite cone causes reflected current from the base of the cone.

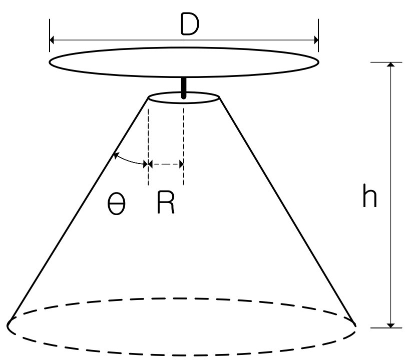


Fig.1 actual discon antenna

The bandwidth limitation is due to the finite cone length for the lower frequency limit and due to the top portion cut side radius R of the cone for the upper frequency limit [2][3]. The disk can be another impedance variation factor, but it is not critical one if the disk size D is large enough [4]. This paper investigates the design and realization of a new type discone antenna (double discone antenna) showing ultra-wideband frequency feature and remaining the overall dimension.

2. The structure of proposed antenna and its optimization

In Fig.1, the upper part of the actual discone antenna's conical skirt should be cut to fix coaxial adapter's position for feeding. In addition, the radius of the conical skirt upper cut, which is R, is inversely proportional to operating frequency bandwidth. So, we consider the other discone antenna, having the higher frequency band. Then, the two antennas are assembled upside down at full stretch of the radius R.

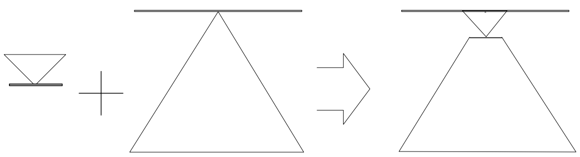


Fig.2 Assembly of Two discone antenna

The proposed antenna shown in Fig.2 consists of two different dimensional discone antennas. The big discone antenna was designed to cover from

300MHz to 3GHz, and the small discone antenna's skirt angle and height were optimized by computer simulation to cover frequency band over 3*GHz*. The big discone-dimension is that skirt's angle is 30˚, 230*mm* height (about 1/4 wave-length of 300*MHz*), and the disk radius is 145*mm*. For the small discone antenna part, the radius R, which becomes small discone antenna's disk radius, is fixed at 35*mm*. The other size is measured to find the best performance angle Φ and height h1. The prototype antenna's structure and dimension is shown in Fig.3.

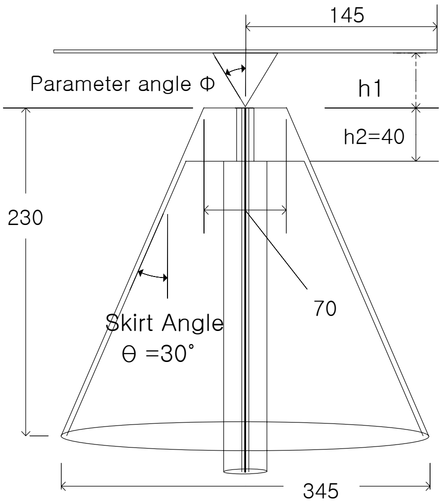


Fig.3 The proposed antenna, Prototype and dimensions [unit: *mm*]

Simulation and measurement parameters are the reversed small discone antenna's skirt angle Φ and height h1. The best fitted performance is at the angle of 50˚ and 25*mm* height. From the computer simulation result, we made the prototype antenna as seen in Fig. 3. The small discone skirt and large disk are fastened by a nut. The excitation is achieved by 50Ω coaxial line and an UHF jack adaptor. The geometric dimension is 260*mm* height, 172.5*mm* lower cone radius, 30˚ lower cone angle, 50˚ small discone skirt angle, and 145*mm* disk radius.

3. The comparisons between the calculated and measured results

The measurement of the prototype antenna is done using microwave network analyzer, HP8510D, in an anechoic chamber. Fig.4 shows the measured and simulated results of VSWR. The VSWR and radiation patterns were calculated with CST MWS. As seen in Fig.4, the resonant points are not exactly correspondent to calculated result's ones, but the overall pattern is similar to the one. The discrepancy between the measured and the calculated results is due to mechanical inaccuracies and the feed-problem from a UHF jack which was not precisely considered in the simulation.

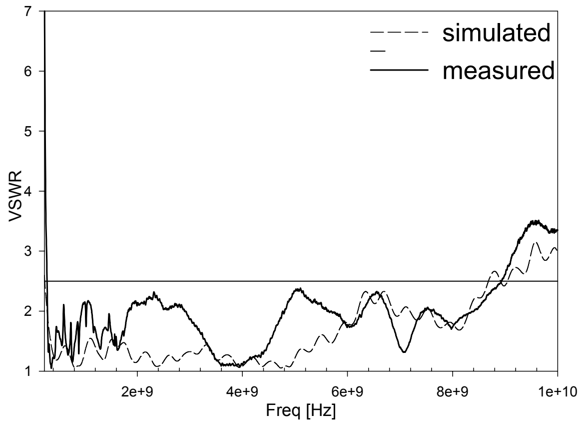
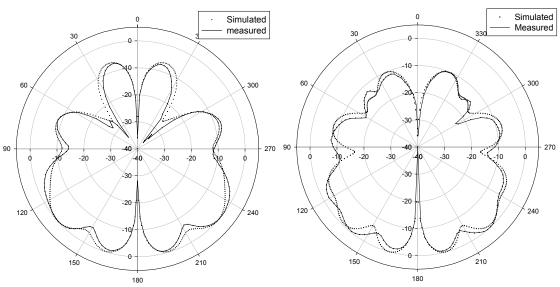
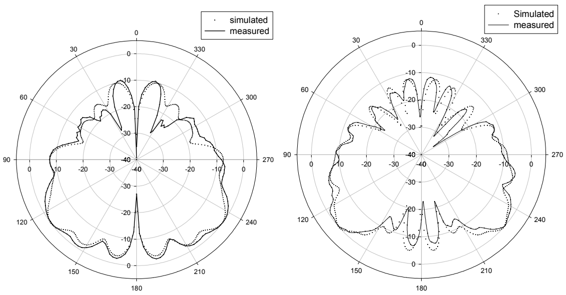


Fig.4 Measured result and calculated result

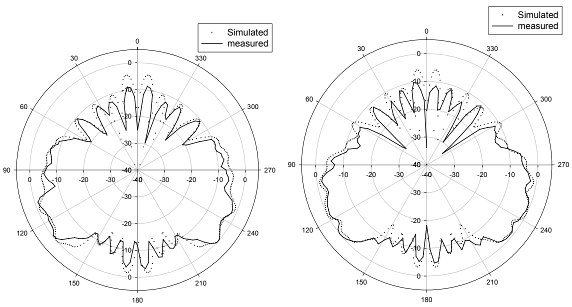
This antenna shows 30:1 bandwidth ratio, starting from 282*MHz* to 8.93*GHz*. The measured and the simulated radiation patterns are shown in Fig.5, which is the patterns of elevation angle at 1.7*GHz*, 2*GH,* 2.5*GHz*, 4*GHz*, 5*GHz*, and 5.8*GHz*. This antenna radiates the maximum power in the direction from 100˚ to 140˚. The radiation pattern measurement was achieved by the 3-antenna technique, using 2 standard horn antennas and the prototype antenna. The simulated gain are 5.572 *dBi* at 1.7 *GHz*, 5.675 *dBi* at 2.0 *GHz*, 6.218 *dBi* at 2.5 *GHz,* 5.585 *dBi* at 4.0*GHz*, 4.014 *dBi* at 5.0*GHz*, and 6.349 *dBi* at 5.8 *GHz*. The maximum measured gains are 4.76 *dBi* at 1.7 *GHz*, 3.9 *dBi* at 2.0 *GHz*, 4.58 *dBi* at 2.5 *GHz,* 7.18 *dBi* at 4.0*GHz*, 3.256 *dBi* at 5.0*GHz*, and 6.62 *dBi* at 5.8 *GHz*. The all gain error is within ±0.5 *dBi*.



(a) (b)



(c) (d)



(e) (f)

Fig.5 Elevation radiation pattern (a) 1.7 *GHz* and (b) 2 *GHz* (c) 2.5*GHz* (d) 4*GHz* (e) 5*GHz* (f) 5.8*GHz*

4. Conclusion

This paper demonstrates the double discone antenna, which is reversely assembled for two different dimensional discone antennas. This structure results into omni-directional radiation pattern, 30:1 bandwidth, and relatively small dimensions. The performances were validated by the measurement of the proto type. In our next paper we will suggest a solution on a fixing problem between the top disk and the lower discone skirt.

Acknowledgements

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References

[1] J. J. Nail, "Designing Discone Antennas", Jounal of Electronics, pp.167-169, August 1953.

[2] Taylor, R. M., "A broadband omnidirectional antenna", Antennas and Propagation Society International Symposium, AP-S. Digest, Vol. 2, pp. 1294-1297, June 1994.

[3] Constantine A. Balanis, Antenna Theory: analysis and design, USA, pp. 442-463, 1997.

[4] Gang Liu and craig. A. Grimes, "Spherical-coordinate FDTD analysis of conical antennas mounted above finte graound planes", Microwave and Optical Technology Letters, Vol. 23, No. 2, pp. 78-82, October 1999.