Modified cavity-backed 4-arm Spiral Antenna for GPS

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***Abstract* - In this paper, a modified cavity-backed spiral GPS antenna is proposed. The presented antenna consists of a modified four-arm Archimedean spiral, an absorber and a cavity which is fed by ut-47 cables. In order to confirm the broadband characteristic, S-parameter result at 1-2GHz is calculated. The gain for mode 1 and mode 2 of the antenna at 1.575GHz, is 0.9dB and -8.7dB respectively. The axial ratio is below 1.25dB between the range of ±45°, which validates circular polarization characteristic. Moreover, the performance of the proposed antenna is verified through the current distribution also.**

***Index Terms* — Spiral antenna, cavity-backed, GPS Antenna, Archimedean spiral antenna, Log spiral antenna.**

I. Introduction

The frequency independent antennas are known for maintaining a certain parameters constant over a wide band of Impedance, Radiation Patterns, bias characteristics and Gain. The spiral antenna, one of the frequency independent antennas, was designed by V. H. Rumsey for the first time in 1957 and some researches for geometry applied to the spiral antennas have been going on ever since [1-2]. If the spiral antenna satisfied self-complementary structure, the broadband characteristic should be obtained because the characteristic impedance is frequency independent [3]. There are some types of spiral antenna like Archimedean, Log, Hybrid spiral antennas and they are mainly used for direction finding.

In this paper, Archimedean cavity-backed spiral antenna operating at 1.575GHz for GPS is presented. The width of each arm is different and the distance between arms is narrowed as the arm goes radialy outwards, which makes the proposed antenna look like Log spiral antenna utilizing coupling effect. The designed antenna consists of 4-arm patterns connected to ut-47 cable and is fed by the phase contrast signal to each arm [4-5]. The gain of the proposed antenna is improved because of the single directivity obtained by attaching Cavity at the back side of the Spiral antenna. An absorber is applied in the Cavity. The proposed antenna is simulated by means of EM tool, Microwave studio of CST.

II. Antenna Geometry

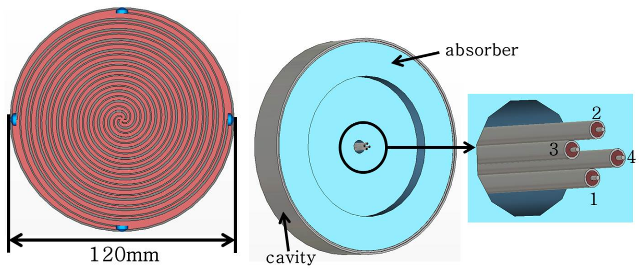

Fig. 1. The geometry and dimensions of the proposed spiral antenna design.

Figure 1 shows the geometry of the proposed antenna which is comprised of a thin metal 4-arm and a lossy substrate Teflon (with ε_r=2.1, thickness=0.8mm). As shown in Fig. 1, the inside of the Cavity is filled with absorber and position of the ut-47 cable is the center of the hole. The height of the Cavity is 30mm.

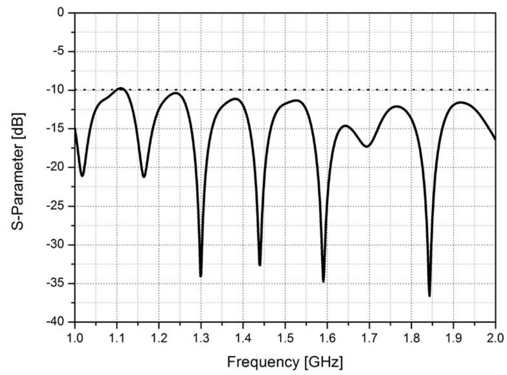

Fig. 2. S-parameter of the 4-arm spiral antenna.

Figure 2 illustrate the simulated S-parameter results of the proposed spiral antenna. The S-parameter is shown only for the range of 1 to 2GHz. The results signify that the antenna exhibits the broadband characteristic with return loss under -10dB and VSWR less than 2.

TABLE I
PHASE AT EACH PORT

	Port1	Port2	Port3	Port4
mode1	0 [deg.]	180 [deg.]	0 [deg.]	180 [deg.]
mode2	180 [deg.]	180 [deg.]	0 [deg.]	0 [deg.]

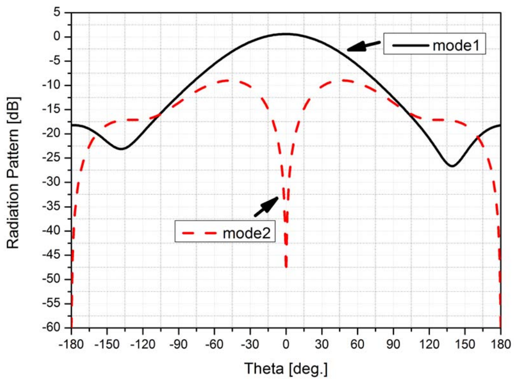

Fig. 3. Radiation patterns at each mode.

Figure 3 represents the simulated radiation patterns for each mode. Here, the mode indicates each port feeding different phase and the phase values are given in table 1. In Figure 3, the gain for the modes 1 and 2 of the antenna is 0.9dB and -8.7dB respectively.

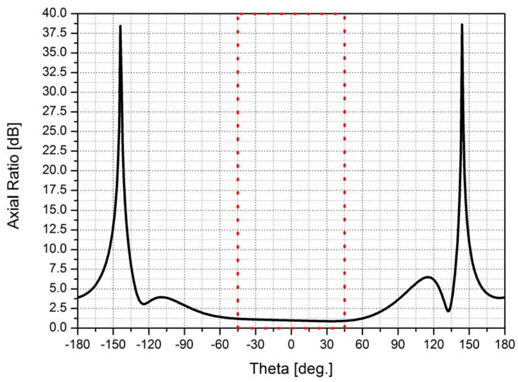

Fig. 4. Axial ratio at 1.575GHz.

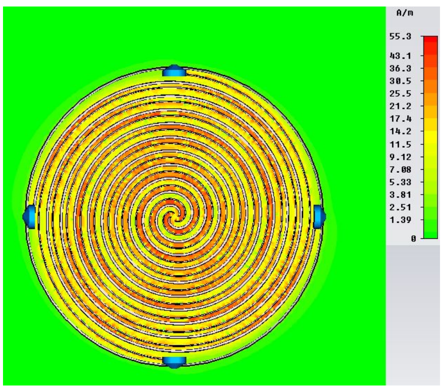

Fig. 5. H-field distribution at 1.575GHz.

Figure 4 shows simulated axial ratio at the center frequency of the GPS, 1.575GHz. The result of the axial ratio was highly satisfactory because it is below 1.25dB at a range of ±45°, which validates circular polarization characteristic. Usually, the value desired for such direction-finder antenna is 2dB.

In Figure 5, the H-field distribution at 1.575GHz is shown. The high and low density regions are shown with red and green colors respectively. As a result, the H-field is distributed uniformly along every arm.

III. Conclusion

In this paper, we have proposed a cavity-backed spiral antenna for GPS. The proposed antenna displays stable axial ratio by using Archimedean spiral pattern and is operated as Log spiral pattern by tuning the distance between arms to maintain a higher and stable gain. From the simulated return loss, the broadband characteristic is verified, the characteristic of circularly polarized antenna is demonstrated from the axial ratio results at GPS frequency and radiation pattern corresponding to each mode. Therefore, the maximized coupling effect from the discussed H-field distribution, should also be confirmed.

Acknowledgment

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References

[1] V. H. Rumsey, "Frequency independent antenna," *IRE National Convention Record.*, vol. 5, pp. 114-118, 1966.

[2] W. L. Curtis, "Spiral antenna," *IRE Trans. Antennas Propagat.*, vol. 8, pp. 298-306, 1960.

[3] J. Dyson, "The equiangular spiral antenna," *IRE Trans. Antennas Propagat.*, vol. 7, pp. 181-187, 1959.

[4] N. A. Stutzke, D. S. Filipovic, "Four-arm 2nd- mode slot spiral antenna with simple single-port feed," *IEEE Antennas and Wireless Propagat. Lett.,* vol. 4, pp. 213-216, 2005.

[5] R. G. Corzine, J. A. Mosko, "Four-Arm Spiral antennas," *Norwood, Ma: Artech House.,* 1990.