Design of a GPS Antenna using a Coupled feed Structure

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***Abstract*—This paper proposes a microstrip patch antenna using a coupled feed structure with a parallel-L matching element. The proposed antenna is composed of radiating patch for resonating 1.575 GHz (GPS L1 band), feeding patch and a feeding network. In this structure, feeding patch is truncated and connected to a short-pin that is element of the feeding network for improving circular polarization (CP) bandwidth. The feeding network contains a feed-pin and short-pin whose position determine resonance point and matching bandwidth. The proposed antenna is optimized by a genetic algorithm in conjunction with the FEKO EM simulator. The results prove that the proposed antenna has a high radiation gain and a broad CP characteristics.**

Keywords- GPS antennas; Coupled feed structure

I. INTRODUCTION

Global positioning system (GPS) antennas have been widely used in various applications to obtain location information from satellites. Since satellite signals are transmitted through the ionospheric layer, GPS antennas are often designed to provide circular polarization (CP) characteristics to minimize the ionospheric loss. To achieve the CP characteristics, there have been a lot of effort using microstrip patch antennas [1]-[3]. Corner truncation [1] and slot insertion [2] have been suitable candidates; however, these approaches are often confronted with the performance degradation of GPS receivers because of their narrow CP bandwidth and high sensitivity in fabrication. Although the CP bandwidth can be improved by adopting an external hybrid chip coupler, this approach increases the complexity and the fabrication cost because of an additional circuit for the chip coupler [3].

In this paper, we propose a design of a microstrip patch antenna using a coupled feed structure with a parallel-L matching element to improve the CP bandwidth. The proposed antenna consists of a radiating patch and a feeding patch, and the radiating patch is electromagnetically coupled with the feeding patch. The feeding patch is connected to the ground through a short-pin that operates as an L-matching network to broaden the CP bandwidth of the antenna. To demonstrate the suitability of the proposed antenna, it is fabricated and mounted on a 5.5-inch circular ground platform, and its performance is measured in a full anechoic chamber. The results show that the antenna is suitable for use in GPS applications with a radiation gain of 5.2 dBic and a CP bandwidth of 24 MHz.

II. ANTENNA GEOMETRY

Fig. 1 shows the geometry of the proposed antenna structure that consists of a feeding patch and a radiating patch resonating at 1.575 GHz. In this structure, the feeding patch is fed by a feed-pin representing a coaxial cable, and its two corners are truncated with W_3 to obtain CP characteristics. To improve the CP bandwidth, the feeding patch is connected to the ground by a short-pin that operates as a parallel-L matching network. Then, the radiating patch is electromagnetically coupled with the feeding patch, and the coupling strength is adjusted by the width of the radiating patch (W_1) and the thicknesses of the first and the second substrate layers (H_1 and H_2) having high relative dielectric constant of ε_r = 10.0 and dielectric loss of tanδ = 0.0035 (Model: CER10 from Taconic). The position of the feed-pin is (X_1, Y_1), that of the short-pin is (X_2, Y_2), and widths of the feeding patch and the ground are W_2 and W_4, respectively. To more improve the antenna performance, we used a genetic algorithm (GA) in conjunction with the FKEO EM simulator.

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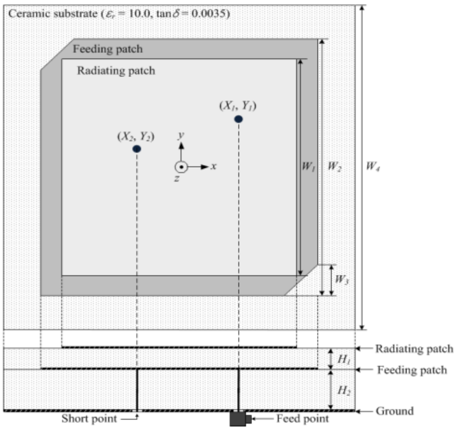

Figure 1. Geometry of the proposed antenna.

III. SIMULATION RESULTS

Fig. 2 shows the reflection coefficients of the proposed antenna, whose matching bandwidth is 150 MHz with a reflection coefficient of -13.2 dB at 1.575 GHz. Fig. 3 presents the bore-sight gain of the antenna, which is shown in the right hand circular polarization (RHCP) gain. The antenna has high radiation gain of 5.2 dBic at 1.575 GHz, and the measurement shows a good agreement with the simulation. Fig. 4 shows the axial ratio of the proposed antenna. Although the antenna exhibits a slight frequency shift of about 15 MHz in the measurement, its axial ratio is still lower than 3 dB in the GPS L1 band.

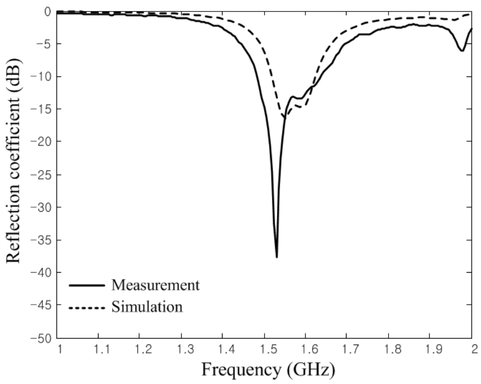

Figure 2. Reflection coefficients of the proposed antenna.

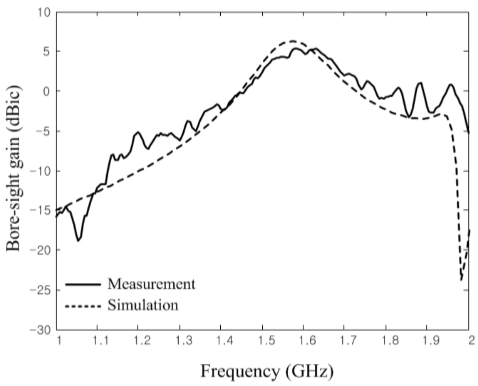

Figure 3. Bore-sight gain of the proposed antenna.

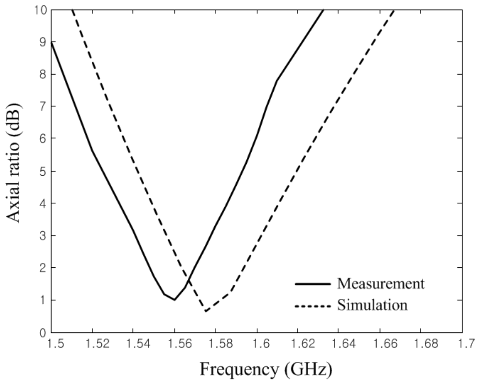

Figure 4. Axial ratio of the proposed antenna.

IV. CONCLUSION

We proposed a GPS antenna design using a coupled feed structure with a parallel-L matching element to improve the CP bandwidth. In this structure, a feeding patch was truncated and connected to the short-pin, and the radiating patch was electromagnetically coupled with the feeding patch. To verify the performance and demonstrate the suitability of the antenna, we fabricated the antenna structure on the high dielectric ceramic substrate and measured the antenna performances in a full anechoic chamber. The results demonstrated that the proposed antenna is suitable for use as GPS receivers with high radiation gain and a broad CP bandwidth.

ACKNOWLEDGMENT

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