New Design of Multilayer Wideband GNSS Antenna with Dual Layer Strip Lines Fed

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***Abstract* - A compact circularly polarized shorted annular stacked patch antenna has been proposed for global navigation satellite system (GNSS) in this paper. The antenna has been designed to operate for the satellite navigation frequencies including GPS, GLONASS, Galileo and Compass (1100MHz-1600MHz). Dual layer strip lines which being composed of one broadband 180° hybrid and two wideband 90° hybrids are introduced as feeding network. As a result, the antenna has a 50.8% 10-dB return loss bandwidth from 1.1GHz to 1.85GHz, and 45.5% 3-dB axial ratio bandwidth from 1.07GHz to 1.7 GHz, respectively. The designed antenna occupies a compact size of 70mm×70mm×28.5mm. In this paper, shorted annular stacked patch is introduced to obtain stable gain bandwidth, broad beamwidth characteristics and good axial ratio at low elevation. The final antenna provides very good circularly polarized radiation for GNSS.**

***Index Terms* —GNSS, circularly polarized antenna, wideband.**

1. Introduction

As global navigation satellite system (GNSS) developing, the requests for multi-system navigation ability increase. To fulfill the need, The antennas should have characteristics of wideband, stable gain bandwidth, broad beamwidth, low cross-polarization at low elevation and compact size. Quadrifilar helical antenna has exciting radiation characteristics of broad beamwidth [1-2]. However, its inherent disadvantages of big size and narrow bandwidths limit its applications. Several patch antennas have been reported in recent years for dual-band GPS operation[3-4]. The advantages of these antennas are simple fabrication. However, the bandwidth is too narrow to cover all the frequencies of four GNSSs. Several wideband antennas have been proposed in the literature [5-6] for GNSS application. However, few of them can obtain broad beam width and good axial ratio at low elevation, which are useful to suppressing multipath interferences.

In this paper, a novel dual layer strip lines fed shorted annular stacked patch antenna design for GNSS application has been presented, which can be used in all four satellite navigation services. In the next section, the antenna configuration and design principle are described. The measured results of the antenna depicted in results and discussion parts, followed by a brief conclusion.

2. Antenna Configuration and Design

Fig.1 presents the structure of the proposed shorted annular stacked patch antenna. The antenna design includes five layers. The upper annular patch is printed on the top of the first substrate layer and the lower annular patch is printed on the back, furthermore, the upper and lower patch are shorted by the metal wall. The second substrate layer acts as the support and isolates the lower patch and L-probe. In this design, four L-probes are introduced to excite the annular ring and transform the input impedance. The L-probes includes four square metal strips, which are printed on the top of the third substrate and the posts, which go through the substrate and are connected to the broadband 90° hybrid port. The dimensions of the probes and the distances between strips and annular patch affect the coupling effect. The fourth layer and the fifth layer are the substrate layer of the strip lines feeding network. The feeding network is composed of one broadband 180° and two wideband 90° hybrids, they are connected trough via holes. In this case, the feeding network can provide good 90° phase differences between two adjacent ports. The structure of the feeding network can be seen in Fig.2.

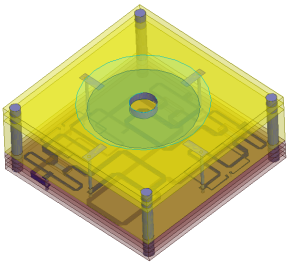
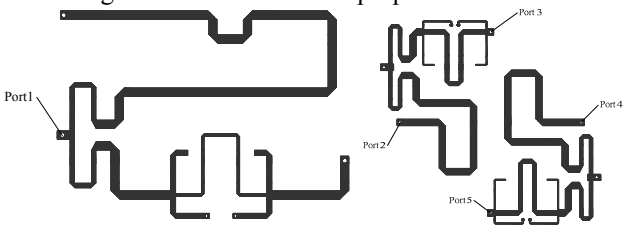


Fig.1 The structure of the proposed antenna



(a) Broadband 180° hybrid (b) Broadband 90° hybrid
Fig.2 The construction of the feeding network

3. Results and Discussion

Fig.3 shows the photo of the fabricated antenna. The overall size of the antenna is 70mm×70mm×28.5mm. The measured VSWR collected from Agilent E8363B network analyzer along with simulated results using HFSS are presented in Fig.4. It can be observed that the impedance bandwidth for VSWR<2 is 50.8%, ranging from 1.1 to 1.85 GHz. From Fig.5, the 3-dB AR bandwidth of the proposed antenna is 45.5% from 1.07 to 1.7 GHz. As can be seen in the figure, the impedance and AR bandwidths are sufficient to cover GNSS frequencies. The radiation performances were measured in an anechoic chamber. Two Archimedean spiral antennas were used to measure right-hand circular polarization and left-hand circular polarization radiation, respectively. The measured AR patterns in the X-Z and Y-Z planes at 1.4 GHz are presented in Fig.6. As seen, the elevation angles for AR<5dB are -115°-90° at X-Z plane and -45°-110° at Y-Z plane respectively at 1.4 GHz. The asymmetry of the AR patterns is mainly due to machine and measurement errors. Fig.7 shows the measured radiation patterns in the X-Z and Y-Z planes at 1.4 GHz. Broad pattern coverage and high gain at low elevation angles (more than -5 dBi at elevation angles>10°) is achieved.

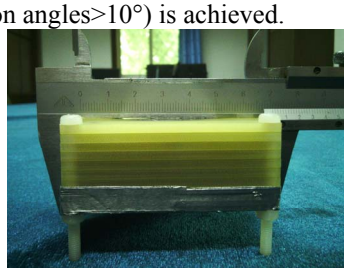


Fig.3 The photo of the proposed antenna

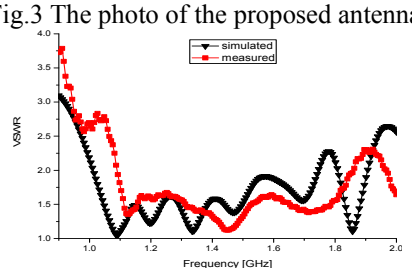


Fig.4 Simulated and measured VSWR

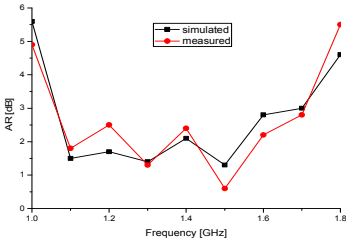


Fig.5 Simulated and measured AR

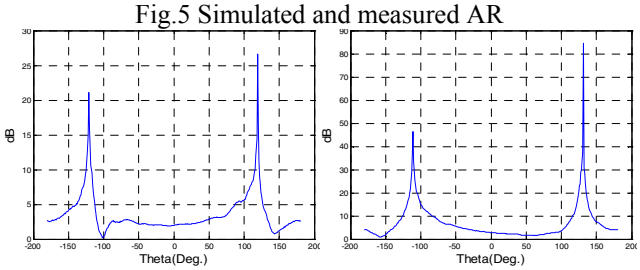


Fig.6 Measured AR patterns at 1.4GHz

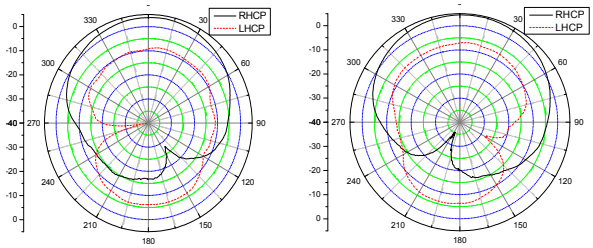


Fig.7 Measured radiation patterns at 1.4GHz

4. Conclusion

In this paper, a novel compact circularly polarized shorted annular stacked patch antenna has been designed and fabricated for GNSS application. Dual layer strip lines feeding structure are introduced in this design to compact the overall antenna size. Using the proposed structure, the antenna exhibits an effective bandwidth of 42.9% from 1.1 to 1.7 GHz for VSWR<2 and AR<3dB. Moreover, the proposed antenna not only has a compact size of 70mm×70mm×28.5mm, but also can provide stable gain bandwidth, broad beamwidth characteristics and good axial ratio at low elevation. Measured parameters show good agreement with the modeling and conform that such antennas can be successful used for GNSS applications.

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