Patch Antenna with the Same Substrate for GPS L1 and L2 Bands

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Abstract

There are two bands, L1 (1575 MHz) and L2 (1227 MHz), for different applications at GPS (global positional satellite). Usually, L1 (1575 MHz), L2 (1227 MHz) bands are for military and commercial applications respectively. In order to satisfy the requirements of specification, both dual bands RHCP (right hand circular polarization) patch antenna with the same substrate has been developed for GPS in this paper. The results from both simulation and measurement are in agreement. The measured impedance bandwidths for 10 dB return loss are 15 MHz at L2 band and 27 MHz at L1 band. The measured AR for both bands is smaller than 3 dB for angular coverage from zenith to 70 degrees. The measured gains are 4.68 dBic and 4.89 dBic at L2 and L1 respectively.

Keywords: GPS, patch antenna, L1, L2

1. Introduction

In general, patch antennas are attractive with CP (circular polarization) characteristic and compact size. Because of their low-profile and CP performance, patch antennas are general used for GPS application. In general, a corner-truncated square patch antenna with high dielectric ceramic substrate is used for GPS [1-5] applications. Such a compact RHCP antenna has low angle power pattern coverage, adequate impedance bandwidth, lower axial ratio, and lower cost in mass production. However, most of the relate designs, available in the open literatures, operate only at either L1 or L2 band. Very few designs can cover both L1 and L2 bands. GPS antennas cover both L1 and L2 bands are required for special applications.

This paper demonstrates a GPS antenna for dual bands with RHCP by using a single feed and two stacked patches. The compact dual bands, RHCP GPS antenna is a two corner-truncated stacked patches with same substrates. Based on the simulation modelling by Ansoft HFSS, the antenna is designed, fabricated, and measured. Detail of design and test results are presented and discussed in this paper.

2. Simulation with Dual Bands GPS Antenna

The geometry of the computer modelling dual bands GPS antenna is shown in Fig.1. The top and bottom square patches are overlap without an air gap layer. In order to excite two orthogonal near degenerate resonant modes for RHCP radiation, each square patch with size b1 and b2 has a pair of truncated corners with size c1 and c2 respectively. The probe is directly connected to the top patch through via a hole in the bottom patch. The substrates thickness for bottom and top are h1, h2, respectively. The size of square substrate is a. The relative permittivity of the substrate is 11.7 and loss tangent is 0.0005. The thickness, permittivity, and feed position d from edge of bottom patch will affect the impedance matching significantly. The dimensions of Fig.1 are with square substrate a (40 mm), feed position d (21.1mm), upper square patch b1 (27.2 mm), bottom square patch b2 (32.2mm), truncated corner of upper patch c1 (2mm), truncated corner of bottom patch c2 (2.3mm), thickness of upper patch h1 (2mm), and thickness of lower patch h2 (4mm). The simulated results were achieved by using the Ansoft HFSS. Green solid line as shown in Fig.2 is the simulated return

loss. It is obvious that the two resonance bands are at 1575 MHz (L1 band) and 1227 MHz (L2 band). Fig.3 is the simulated AR versus angular coverage for L1 and L2 bands. The AR is less than 3 dB from zenith to 70 degrees for L1 and L2 bands. Fig.4 is the three dimensional patterns for L1 and L2 bands. The gains are 5.2 dBic and 4.52 dBic at L1 and L2 respectively.

3. Hardware Implementation and Measurement

The dual bands RHCP GPS antenna has been implemented and measured. Fig.5 is the top view and side view of the antenna. The measured return loss is compared with that of simulation as shown in Fig.2. The results of return loss from simulation and measurement are in good agreement. Fig.6 shows the radiation gain patterns for L1 and L2 bands with mechanical rotated linear polarization transmit antenna. The gains are 4.89 dBic and 4.67 dBic at L1 and L2 bands. The results are quite similar between simulation and measurement. The summary results of impedance bandwidth, AR, and gain for L1 and L2 bands are shown in table 1. Form this table, the results of impedance bandwidth, AR, and gain for both simulation and measurement are in agreement.

4. Conclusion

A stacked patch GPS RHCP antenna for dual bands at 1575 MHz (L1 band) and 1227 MHz (L2 band) has been developed and implemented. The stacked antennas have the same dielectric material with 4 mm in thickness. Measured gains are 4.89 dBic and 4.67 dBic at L1 and L2 bands. The AR for both bands is smaller than 3 dB for angular coverage from zenith to 70 degrees. The impedance bandwidth with 10 dB return loss is 27 MHz and 15 MHz at L1 and L2 bands respectively. The results of measurement are agreed with that of simulation.

Acknowledgments

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		L2 (1227MHz)	L1 (1575MHz)
Impedance bandwidth (10 dB)	S	14MHz	27MHz
	M	15MHz	27MHz
Axial Ratio	S	2.97dB	0.57dB
	M	2.8dB	1.7dB
Peak Gain	S	4.52dBic	5.20dBic
	M	4.67dBic	4.89dBic

S: Simulation, M: Measurement

Table 1: Comparisons between simulation and measurement

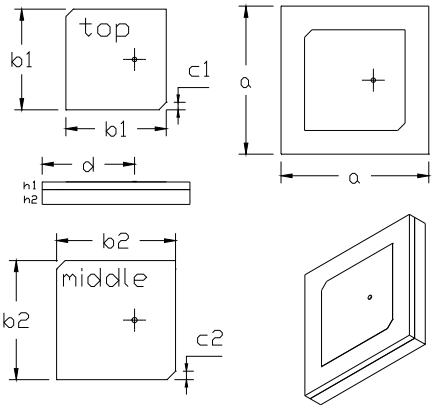


Fig.1 Simulated structure of GPS antenna

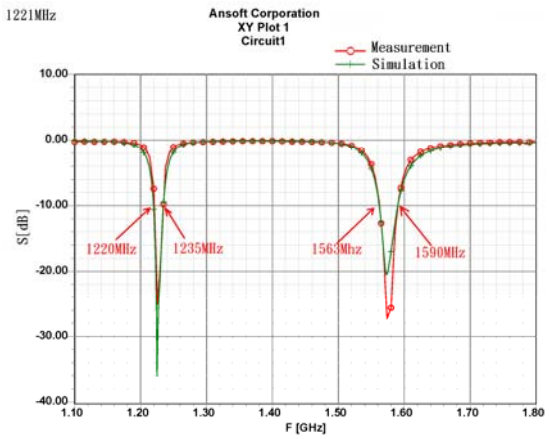
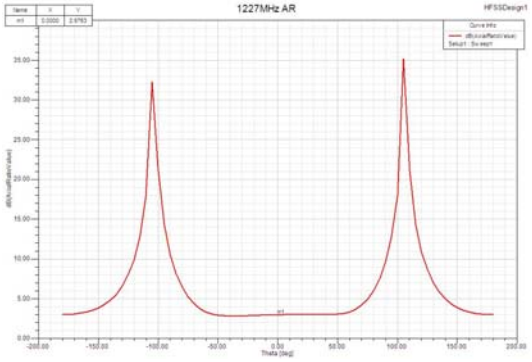
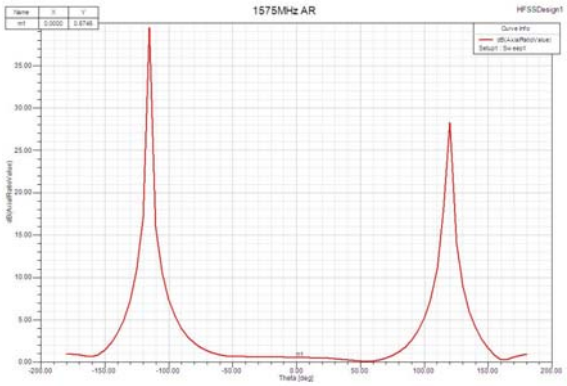


Fig.2 Return loss of simulation and measurement

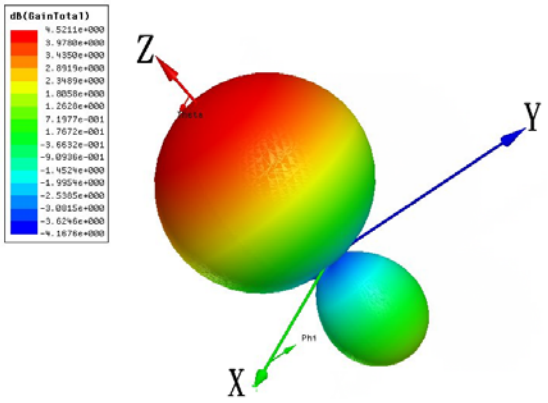


(a) 1227 MHz

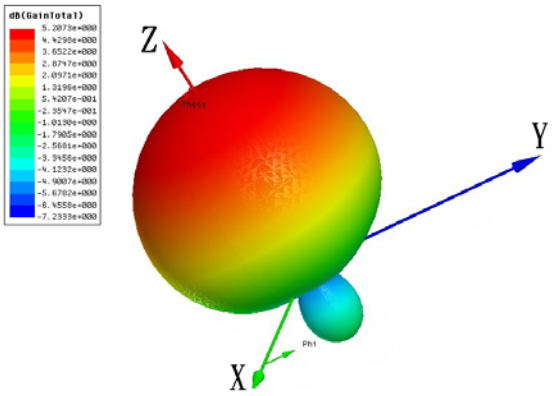


(b) 1575 GHz

Fig.3: Simulated axial ratio

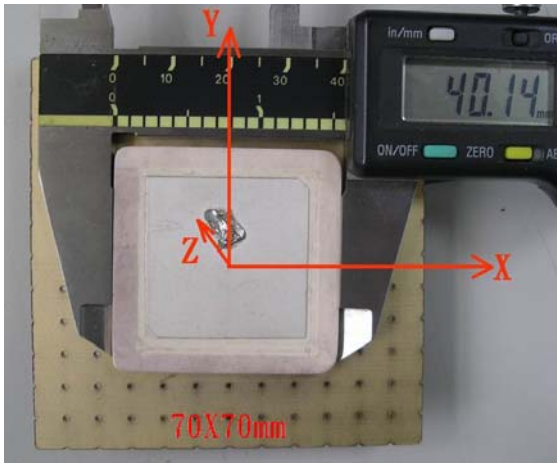


(a) Gain=4.52 dBic at 1227 MHz

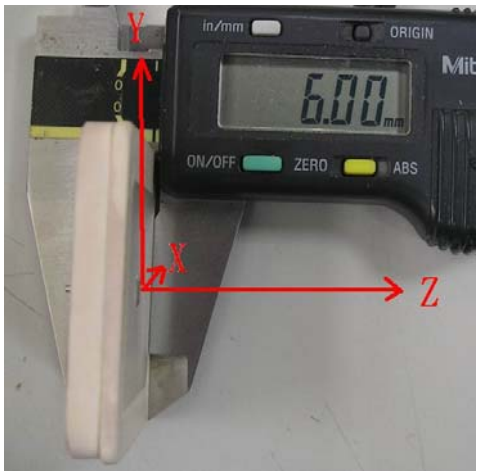


(b) Gain=5.20 dBic at 1575 MHz

Fig.4: Simulated 3D radiation patterns

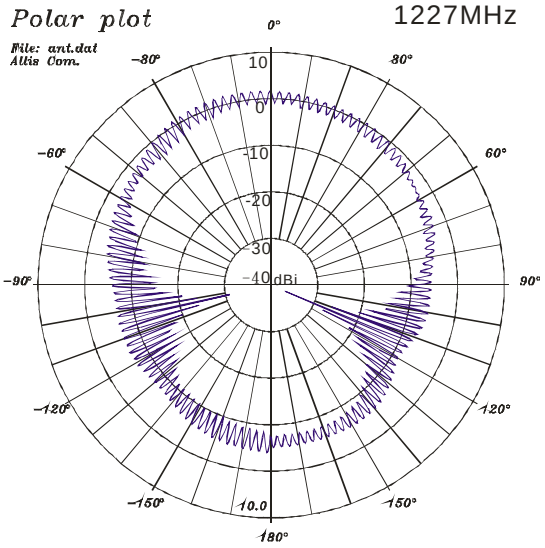


(a) Top view

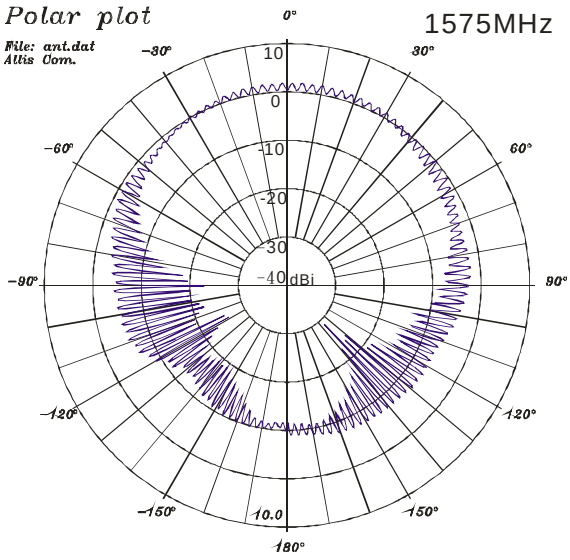


(b) Side view

Fig.5: Hardware of dual bands GPS antenna



(a) Gain=4.67dBic at 1227MHz



(b) Gain=4.89dBic at 1575MHz

Fig. 6 Measured radiation Patterns at L1 and L2 bands