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Capacitive Disc Fed GPS Antenna Operating at L Band

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Abstract*: *A rectangular antenna, to work in the operating frequency of L band is designed with capacitive disc fed for GPS application. The antenna gain aimed to have 2dBi. The capacitive disc is utilized for the increment of impedance bandwidth. It is designed using CADFEKO 7.0 and obtained the output with improved bandwidth and good return loss. Moreover, much improved reflection coefficient of the proposed antenna is obtained and it has been analyzed. With reference to simulation results, reflection coefficient at 1.13 GHz is attained as -34.18 dB with bandwidth of 140 MHz and at 1.34 GHz is -26.13 dB with the bandwidth of 230 MHz.

Keywords* : *GPS, Capacitive Disc, L Band.

I. INTRODUCTION

The market for GPS based applications is booming with navigation systems deployed in to vehicles, across the world [1].

A. Global Positioning Systems (GPS):

GPS Satellites transmits RF signals to trigger the GPS receivers for finding the location, time and speed of the users. RF signals which are transmitted from GPS transmitters contains ranging signals. The ranging signals having navigation message in it are used to calculate the distance. The distance calculations are mainly based on two GPS codes: 1. Coarse/Acquisition code or C/A, 2. P-code.

B. GPS Antenna:

The GPS antenna works from L1 to L6 bands. But only some of the bands used for civilian applications. The bands for civilian applications are L1, L2 and L5. The other bands L3, L4 are used for military. Primarily Dome, Blade, Helical, Choke-Ring Design and Patch antennas were used with right hand circularly polarized to match the incoming signals. However, each one had their own drawbacks in covering the L bands.

There were few reconfigurable arrangements proposed by researchers to achieve the multiband functionality. Multiband reconfigurable antenna for GPS and RFID was proposed by N.M. Sahar [1]. Reconfigurable wideband antenna was designed by H.F. Abu Tarboush et.al.[2]. Multiband Reconfigurable slot configuration with switchable operation was proposed by L. Pazin et.al.[3]. Polarization reconfigurable antenna with dual band for WLAN is proposed by Pei-Yuan Qin et.al. [4]. Concentric annular ring is used to achieve triple-frequency by X.L. Bao et.al. [5]. Meander-line loaded dual band antenna design with spiral resonators was proposed by F.Paredes, et.al.[6]. Dual band RFID tag antenna with AMC ground plane has been proposed by Kim Dongho et.al [7]. Li.R. L. et al. designed tri-band planner patch for WLAN/WiMAX application [8]. L.Yoonjae et.al. designed an antenna which works in tri-bands L1 (1.5GHz), L2 (1.2GHz) & L5 (1.1 GHz) with reduced back lobes [9].

C. Capacitive Disc Fed Antenna:

To analyze a probe fed wideband antenna, keep the resonating patch followed by probe fed capacitive disc patch on a dense substrate. The probe fed capacitive patch adds capacitance to input impedance and deletes out inductance. There are two issues in stacked configurations of capacitive disc fed antennas:1. It is costlier and 2. Need additional layer. Therefore, there is a great demand for the researchers to develop the alternative tactics to overcome the above stated issues. G.M. Ridgers et.al. have proposed an alternative approach in 2005, in which they have kept a capacitor patch next to resonant patch [10]. By varying dimensions of the capacitive disc patch and the suitable gap amongst the radiating and capacitive disc patch they have exactly achieved the input impedance matching. The main benefit of this arrangement is that capacitor and resonant patch kept next to each other in a same plane which in turn minimize the number of layers that are mandatory. Hence in this paper, single layer capacitive disc fed patch design is proposed and analyzed for GPS multiband. Similarly, single feed stacked antenna for tri-band GPS application was designed by Falade et.al. Few other methods like Frequency Reconfigurable [11 & 13] and Focused Antenna Arrays [12] were also found interesting to achieve the multiband.

II. DESIGN PARAMETERS

The proposed capacitive fed patch and radiating patch is designed on FR4 substrate with the measurement of 78.81mm× 78.81mm in size and relative dielectric constant εr = 4.7. The construction of patch antenna consists of a rectangular patch and as shown in the figure 1 and 2. W is the width and L is the length of patch. There is a gap between the rectangular and feed pin of about feed spacing of 3.082mm. The feed disc has diameter (Dd) of about of 12.43mm and it has a feed pin which has diameter (Df) of about 1.221mm.

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There are top and bottom substrates which have height of 29.31mm and 1.221mm respectively. Bottom substrate relative permittivity (ε_b) is one and the top substrate relative permittivity (ε_t) is 4.7 with bottom substrate tangential loss (tanδ) equal to zero. The summary of the parameters was given in Table 1.

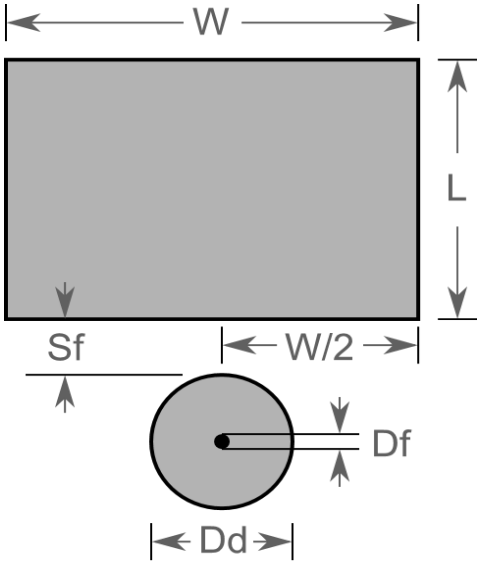


Fig.1 Capacitive disc fed and radiating patch (Top View)

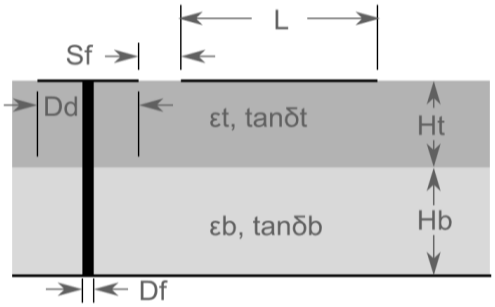


Fig.2 Capacitive disc fed antenna (Side view)

Table **I**: Optimized Antenna Parameters

DESCRPTION	**VALUES (mm)**
Feed-disc diameter (Dd)	12.43
Feed pin diameter (Df)	1.221
Feed spacing (Sf)	3.802
Patch length (L)	78.81
Patch width (W)	78.81
Bottom substrate height (Hb)	29.31
Top substrate height (Ht)	1.221
Device X-dimension	78.81
Device Y-dimension	95.04
Device Z-dimension	30.53

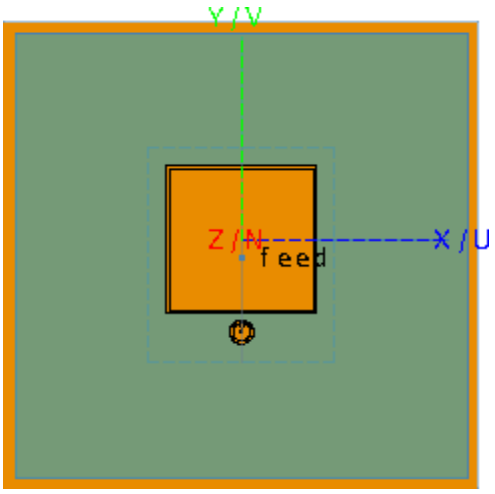


Fig.3 Designed antenna (Top view)

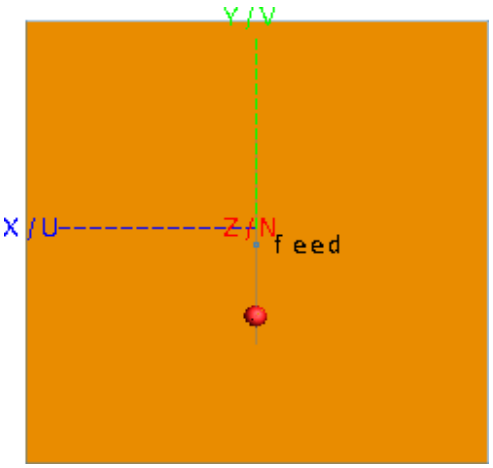


Fig.4 Designed antenna (Bottom view)

The final design of the patch antenna's top and bottom view were shown in figure.3 and 4 respectively. Finite round plane is considered for this antenna. The operational frequency will be tuned by adjusting the electrical length of the antenna. Thus, L, (length of patch element) is adjusted equally at each aspect and therefore the breadth of dipole (W) is constant to vary the frequency response.

III. RESULTS AND DISCUSSION

A. Reflection Co-Efficient Vs. Frequency

The below diagram gives the resulting reflection coefficient characteristics of the designed antenna structure. The antenna shows the reflection co-efficient of -34.18dB @ 1.13GHz and -26.13dB @ 1.34GHz (Refer Fig 5) and Impedance obtained was (50.44+i0.34) Ω (Refer Fig 6).

B. Antenna Gain

The gain of the antenna is increased by introducing slots. Highest possible radiation at a particular angle of direction is considered to be antenna's gain and shown in fig.7.

The gain observed from this plot is 3.5 dBi at Phi equal to 90 degree. The designed antenna is fabricated on double sided FR4 sheet by using Eleven Lab Precision Machine. Fabricated antenna's top and bottom view is shown in fig.8.

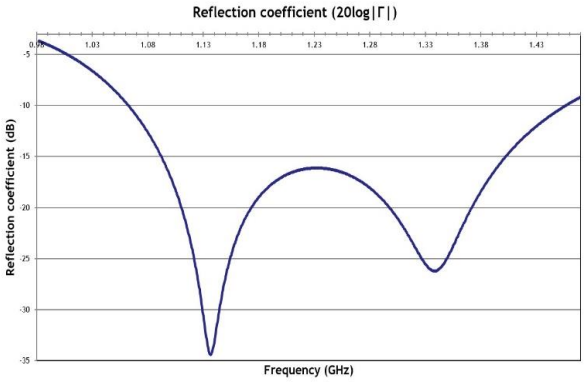


Fig 5 Reflection co-efficient

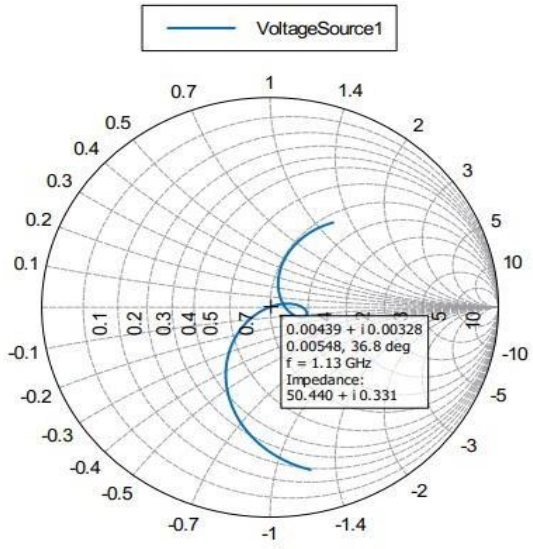


Fig 6 Impedance of the proposed antenna

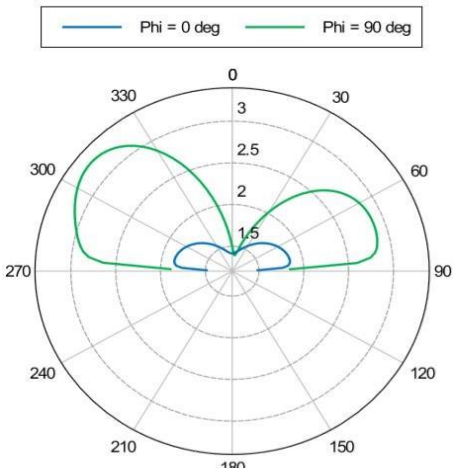
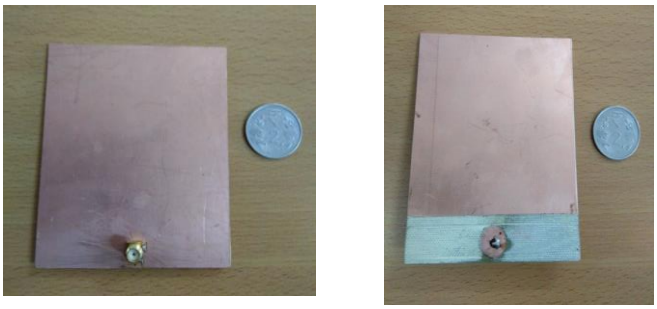


Fig 7 Gain of the antenna

IV. CONCLUSION

The design of disc fed GPS antenna is achieved by modeling in CADFEKO 7.0, where reflection characteristic of the same has been analyzed. The obtained reflection



a b

Fig 8 a. Bottom & b. Top View of GPS Antenna

coefficient at 1.13 GHz is -34.18 dB with 140 MHz bandwidth and at 1.34 GHz is -26.13 dB with the 230 MHz bandwidth. At both frequencies the designed antenna has very good impedance match especially at 1.13GHz, it has 50Ω matching.

Future works: The capacitive fed GPS antenna is operating in L3 & L5 bands. However, in future it is a need to find the appropriate dimension of the capacitive disc and the suitable gap amongst the radiating and capacitive disc patch to make the designed antenna to work in other two bands i.e.L1 and L2.

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