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A Low Cost Omnidirectional Wideband GPS Antenna

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Abstract

Micro strip antenna is a very promising solution for the applications where space and cost is a constraint and robustness is desirable. This paper presents such a micro strip antenna for GPS application, covering both the bands of GPS. The antenna has been fabricated with the help of general purpose one sided low cost PCB which is easily available in labs and aluminum foil has been used as radiating patch. The substrate of PCB is Bakelite which has dielectric constant 4.1. The radiation pattern and frequency response measurements of the antenna have been taken in lab. The results show the antenna is omnidirectional and simultaneously covers both bands of GPS i.e. 1227 MHz and 1575 MHz.

1. Introduction

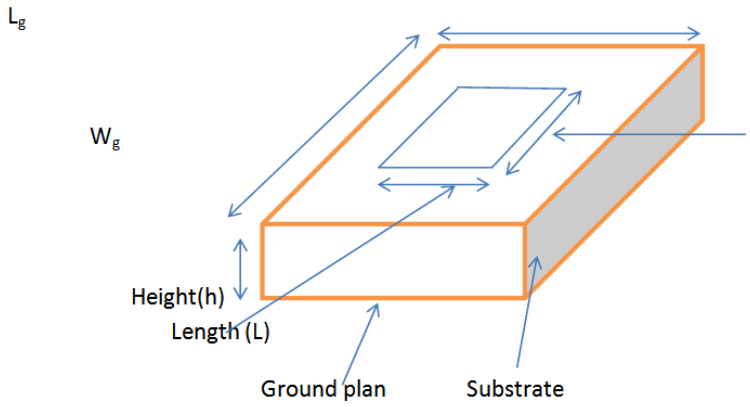
Micro strip Patch antenna are popular for use in wireless application due to their low profile structure [1-5]. Therefore they are extremely compatible for embedded antenna in handheld wireless devices such as cellular phones, pagers etc [6-7]. This paper presents an antenna which covers both of GPS bands and simultaneously has very good relation characteristics. The method and for antenna fabricated are low cost general purpose material which are easily available. Aluminum foil single side general purpose PCB have been used for antenna fabrication. Few point has been calculated using transmission line model. The antenna is feed with coaxial cable. Excellent performance of antenna in terms of bandwidth gain and radiation pattern has been achieved.

2. Design & Structure

Structure of micro strip antenna is shown in fig. 1

In a micro strip antenna width and length is depend on the frequency at which antenna is fabricated. The essential parameters for the design of a rectangular Micro strip Patch Antenna are[7]:

- Frequency of operation (fo): The resonant frequency of the antenna must be selected Appropriately.
- Dielectric constant of the substrate (εr): The dielectric material selected for my design is Bakelite which has a dielectric constant of 4.1.



- Width $(W) = \frac{c}{2f\sqrt{(\epsilon+1)/2}}$

Substituting c = 3e8 m/s,ε=4.1,f=1.227Ghz or 1227Mhz and height (h) = 1.615mm.

W=76.6555536mm

- Calculation of Effective dielectric constant (ϵ_{reff}):-

$\epsilon_{reff} = (\varepsilon+1)/2 + (\varepsilon-1)/2[1+12h/W]^{-1/2}$

$\epsilon_{reff} = 3.787216204$

- Calculation of the Effective length (Leff):-

$L_{eff} = c/2f\sqrt{\epsilon_{reff}}$

$L_{eff} = 62.818367mm$

- Calculation of the length extension (ΔL):-

$\Delta L = 0.412h(\epsilon_{reff} + 0.3)(W/h + 0.264)/(\epsilon_{reff} - 0.258)(W/h + 0.8)$

$\Delta L = 0.762025127mm$

- Calculation of actual length of patch (L)

$$L = L_{eff} - 2\,\Delta L$$

$$L = 61.29431675\text{mm}$$

3. Ground plane dimension:-

Length of ground plane :-

$$L\,g = 6h + L \text{ mm}$$

$$L\,g = 70.98431675\text{mm}$$

Width of ground plane:-

$$W_g = 6h + W \text{ mm}$$

$$Wg = 86.3455536\text{mm.}$$

Feeding point:-For feeding point first the input impedance is calculated with the help of input impedance formula[7]. The feeding point is calculated for 50 Ω value. Now drill the PCB at the feeding point location in lab.

Input Impedance at adage of antenna is

$$R_{in} = 191.3746093\ \Omega.$$

$$Y_o = 20.17944188 \text{ mm.}$$

It is fabricated at single side PCB. The ground plane of PCB is copper and substrate is Bakelite which has dielectric constant 4.1. With a calculated dimension general purpose Aluminum foil is fixed to the PCB substrate. A coaxial cable is connected at the feeding point Y_0 at the PCB.

Figure2: (Front view of the GPS antenna) **Figure 3**: (Rear view of the GPS antenna)

The front view of fabricated antenna is shown in fig. 2 . For fabrication we used general purpose Aluminum foil. The substrate is Bakelite has dielectric constant 4.1.The rear view is shown in fig.3. The ground plane material is copper.

4. Result and Discussion

Various measurement of antenna has been perform in the antenna lab of the department. All the measurement are taken at far field distance calculated by

$X = 2D^2/\lambda$

Where D=largest dimension of antenna,

and λ = wavelength of electromagnetic wave for which the antenna has been designed .

The power versus frequency curve is shown in fig4.It can be observed that the antenna is giving good performance from 900Mhz to 1600Mhz covering both the bands of GPS application . The radiation pattern of antenna is shown in fig.5. The pattern shows that the antenna is having omnidirectional radiation property which is desirable for most of handheld modern equipment.

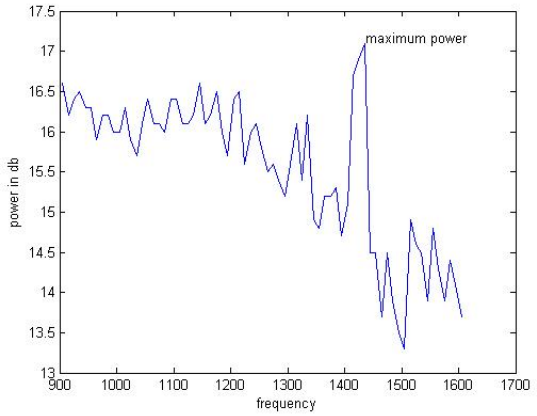


Fig. 4: Graph between power and frequency

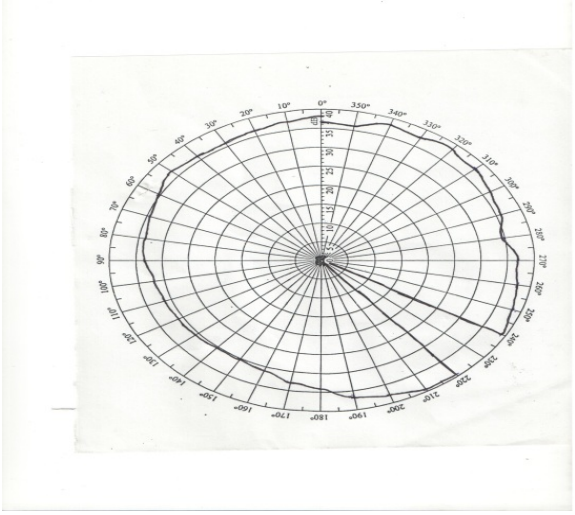


Fig. 5: polar plot of the GPS antenna.

5. Conclusion

A low cost omnidirectional antenna has been fabricated for GPS application. Low cost easily available general purpose materials have been used for the fabrication of antenna because of which the overall cost of antenna becomes quite low. The measurements results show that the antenna is wideband covering both the bands of GPS. The radiation pattern of the antenna is omnidirectional which is a desirable property for most of hand held wireless equipment's. In future, work can done to design and fabricate an antenna which covers more number of application bands while keeping the cost of overall antenna still low.

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