Design and Analysis of L Band Microstrip Patch Antenna for Global Navigation Satellite System

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Abstract : **In the recent year's antenna configuration shows up as a develop field of research. It truly isn't the reality on the grounds that as the innovation develops with new thoughts, fitting desires in the antenna configuration are continually coming up. In this paper L-band patch antenna stacked with scores and cut has been structured and mimicked utilizing CST studio device. Single frequency band operation is gotten from the proposed microstrip antenna. The structure was done utilizing air as the substrate and copper as antenna material. The planned antennas reverberate at 1.567GHz with return loss over - 12dB and VSWR 1.66. Such planned band is utilized in the satellite application for Global Navigation Satellite System (GNSS), non-geostationary circle (NGSO) and settled satellite administrations suppliers to work in different fragments of the L-band.**

***IndexTerms* - L-Band, CST, GNSS, VSWR, Return loss.**

I. INTRODUCTION

GNSS (Global Navigation Satellite System) is a satellite system that is utilized to pinpoint the geographic area of a client's beneficiary anyplace on the planet. Two GNSS systems are as of now in operation: the Assembled States' Global Situating System (GPS) and the Russian Federation's Global Circling Navigation Satellite System (GLONASS). An assortment of types of antenna can be utilized for transmitting to and accepting from satellites. The most widely recognized sort of satellite antenna is the allegorical reflector, anyway this isn't the main kind of antenna that can be utilized. The real sort of antenna will rely on what the general application and the necessities. The separations over which signals travel to a few satellites is extensive. Geostationary ones are a specific case. This implies way losses are high and as needs be flag levels are low. Notwithstanding this the power levels that can be transmitted by satellites are constrained by the way that all the power has be produced from sunlight based boards. Therefore the antennas that are utilized are frequently high increase directional assortments. The microstrip patch antenna is a standout amongst the most mainstream.

Figure 1: Antenna for satellite communication

A. SATELLITE FREQUENCY BANDS

Because of lower frequencies, L-Band is most effortless to execute for marine satellite settled systems. There isn't much L-Band bandwidth accessible. The higher you go in frequency, the more bandwidth is accessible, yet the hardware should be progressively complex.

L C Ku Ka

On the off chance that one could liken the expense and accessibility of L-Band space section to state, city land, C-Band may be suburbia, Ku band the wide open, and Ka-Band the prairies of the Wild West. Possibly somewhat harder to get to, yet a great deal of it accessible at a sensible cost.

L-Band (1-2 GHz) | C-Band (4-8 GHz) | Ku-Band (12-18 GHz) | Ka-Band (26.5-40 GHz)|

Being a generally low frequency, L-band is less demanding to process, requiring less complex and more affordable RF hardware, and because of a more extensive bar width, the pointing precision of the antenna does not need to be as exact as the higher bands.

Just a little part (1.3-1.7GHz) of L-Band is allotted to satellite interchanges on Inmarsat. Inmarsat utilizes L-band for their Armada Broadband, Inmarsat-B and C. The more seasoned Inmarsat An and B antennas were commonly 1 meter in distance across, be that as it may, with the dispatch of all the more incredible satellites and the utilization of steerable spot shafts, the new Armada broadband antennas are down to under 30cm (12 inches).

L-Band is likewise utilized for low earth circle satellites, military satellites, and earthbound remote associations like GSM cell phones. It is likewise utilized as a moderate frequency for satellite television where the Ku or Ka band signals are down-changed over to L-Band at the antenna LNB, to make it less demanding to transport from the antenna to the beneath deck, or indoor gear.

B. Utilization OF L and S BAND

L band - Global Situating System (GPS) transporters and furthermore satellite cell phones, for example, Iridium; Inmarsat giving interchanges adrift, land and air; WorldSpace satellite radio.

S-band (2– 4 GHz)- Climate radar, surface ship radar, and a few correspondences satellites, particularly those of NASA for correspondence with ISS and Space Transport. In May 2009, Inmarsat and Solaris versatile (a joint endeavor among Eutelsat and Astra) were granted each a 2×15 MHz segment of the S-band by the European Commission.

II. LITERATURE REVIEW

C B. Zhang, R. Li, L. Wu, H. Sun [1] this present a three-dimensional (3-D) printed metallic K-band (18-26.5 GHz) aloof front end for satellite correspondence. It is proposed to be utilized as a unit cell in a huge antenna exhibit. The proposed front end is made out of a two-organize 1 × 4 control divider, rectangular-to-roundabout waveguide decreases, and a direct four-component cone shaped antenna cluster, which are too unpredictable to be in any way created by a conventional machining process in an entire piece. Exploiting the 3-D printing innovation in acknowledging complex structures, this accomplish a very incorporated inactive module. A decent understanding is accomplished among reenactment and estimation. The proposed front end has impedance bandwidth 19-21 GHz, the greatest gain of 15.5 dBi at 21 GHz, and alluring radiation designs on both E-and H-planes. The impact of creation resilience like the surface harshness and dimensional resistance are watched and examined. Contrasted and generally created metallic microwave detached gadgets, the proposed work has a shorter turnaround time and a lower cost. Contrasted and dielectric 3-D printed microwave gadgets, it includes greater effortlessness regarding procedure and better physical strength. It opens up new conceivable outcomes for microwave gadget manufacture.

S. Kharche, G. S. Reddy, R. K. Gupta [2] A wide band circularly captivated assorted variety antenna comprising of firmly separated monopole radiators is proposed. Two tale, microstrip sustained printed monopoles are structured on a shared view plane. The ground plane which is unbalanced regarding the feed line alongside the planar monopole structure is utilized to accomplish roundabout polarization. The monopoles which are symmetric regarding the vertical pivot create symmetrically energized waves. A changed split ring resonator-like structure is planned on the ground plane to accomplish high port-to-port seclusion. The impedance bandwidth (Voltage Standing Wave Ratio <; 2) of the proposed antenna is 45.53% which covers the frequency band somewhere in the range of 1.73 and 2.75 GHz. Separation of >18 dB between the transmitting components is accomplished. The proposed antenna gives a hub ratio (AR <; 3 dB) bandwidth of 41.28% somewhere in the range of 1.73 and 2.63 GHz. The radiation designs are steady and the envelope relationship coefficient is <;0.005 over the working band. The proposed structure accomplishes effectiveness >70% and gain >2 dBic over the frequency band somewhere in the range of 1.73 and 2.63 GHz.

C. Mao, S. Gao, Y. Wang, Q. Chu [3] An epic technique for accomplishing a solitary feed circularly captivated (CP) microstrip antenna with both wide impedance bandwidth and hub ratio (AR) bandwidth is exhibited. The CP attributes are produced by utilizing a resonator to energize the two symmetrical methods of the patch by means of two coupling ways and the required 90° stage distinction is accomplished by utilizing the diverse requests of the two ways. The displayed technique, rather than ordinary strategies that control dividers and stage defer lines are typically required, not just fundamentally improves the bandwidths of the antenna yet additionally results in a conservative feed, diminished loss and high gain. In light of this strategy, a double band shared-opening CP exhibit antenna is actualized for C-/X-band satellite correspondences. The antenna gap incorporates a 2 × 2 exhibit at C-band and a 4 × 4 cluster at X-band. To suit the C-X-band components into a similar gap while accomplishing a decent detachment between them, the C-band roundabout patches are scratched at the four corners. The deliberate outcomes concur well with the recreations, appearing wide impedance bandwidth of 21% and 21.2% at C-band and X-band, individually. The C-band and X-band 3 dB AR bandwidths are 13.2% and 12.8%. The cluster additionally displays a high opening proficiency of over 55%, low sidelobe (C-band: - 12.5 dB and X-band: - 15 dB), and high gain (C-band: 14.5 dBic and X-band: 17.5 dBic).

S. Mener, R. Gillard [4] A tale Ka-band double band double circularly-spellbound antenna exhibit is introduced in this letter. A double band antenna with left-hand round polarization for the Ka-band downlink frequencies and right-hand roundabout polarization for the Ka-band uplink frequencies is acknowledged with smaller annular ring openings. By applying the consecutive turn system, a 2 × 2 subarray with great execution is gotten. This letter depicts the structure procedure and presents reproduction and estimation results.

Z. Yang, K. C. Browning [5] Reflector-based satellite correspondence (SatCom) terminals require high affectability to limit in general antenna measure, and in perspective of their effortlessness and high radiation proficiency, horn antennas are utilized solely as reflector encourages. As these terminals turn out to be increasingly unpredictable, littler and progressively minimal feeds that can be specifically coordinated with microstrip circuits are attractive. Standard microstrip antennas (MSAs) have unsatisfactorily low radiation proficiency for use as reflector nourishes. this demonstrate that the stacked shorted annular patch (SSAP) can be utilized as a substitution for horn sustains and accomplishes higher radiation and overflow efficiencies than ordinary patch antennas because of the nonattendance of dispersion systems and dielectric substrates. Utilizing a half-wavelength stacked patch as an executive understands an example that accomplishes high light productivity with standard explanatory reflector geometries. Reproduction and estimations demonstrate that the smaller SSAP might be the primary announced nonwaveguide feed antenna to accomplish affectability similar to that of an ordinary horn feed.

III. PROBLEM FORMULATION

From the above writing audit we can reason that the fundamental issue with the microstrip patch antenna is Thin bandwidth, bring down gain (6 dB), extensive ohmic loss in the feed structure of exhibit, polarization virtue is hard to accomplish, bring down power dealing with capacity and so on in the light of writing study we can figure an issue of lower bandwidth is one of the primary disadvantage.

IV. PROPOSED DESIGN

Microstrip antenna comprise of a thin (h<<λ0, where λ0 is the free-space wavelength and f0 is the working frequency) metallic strip (patch) set on a little division of a wavelength over a ground plane. The microstrip patch is planned so its example most extreme is typical to the patch (broadside radiator).

(i) Resonant frequency

The resonance frequency of a CMSA is obtained using the given formula [3].

$$f_o = \frac{K_{mn} c}{2\pi a_e \sqrt{\varepsilon_e}}$$

where K_{mn} is the m^{th} root of the derivative of the Bessel function of order n . For the fundamental TM_{11} mode, the value of K_{mn} is 1.84118. The a_e and ε_e are the effective radius and the effective dielectric constant of the CMSA, respectively. The fringing fields along the circumference of the given MSA are taken into account by replacing the patch radius a by the effective radius a_e.

$$a_e = a\left[1+\frac{2h}{\pi a \varepsilon_r}\left\{\ln\left(\frac{a}{2h}\right)+1.41\varepsilon_r+1.77+\frac{h}{a}(0.268\varepsilon_r+1.65)\right\}\right]^{\frac{1}{2}}$$

(ii) Actual radius of the Patch

Using above equations and taking the values of different parameters as follows,

K_{mn}=1.84118; $c=3\times10^{8}$ m/s;
ε_o= 8.86×10^{-12}F/m; ε_r=4.4;
h=1.6 mm; Frequency(f_o)=1.7GHz

and effective radius a_e followed by the value of the actual radius 'a' which come out to be 25.4 mm.

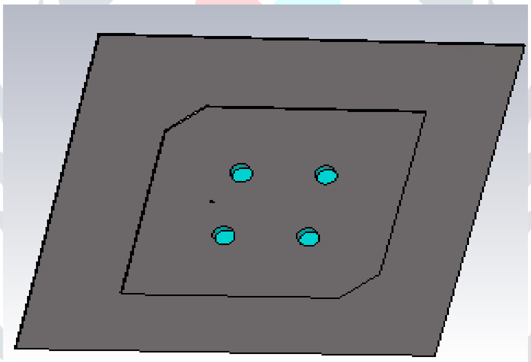

Figure 2: Top view of proposed antenna

Figure 2 is showing proposed design, here substrate material is Air and top and ground structure is made form pure copper material. Due to microstrip patch antenna its size is small then previous.

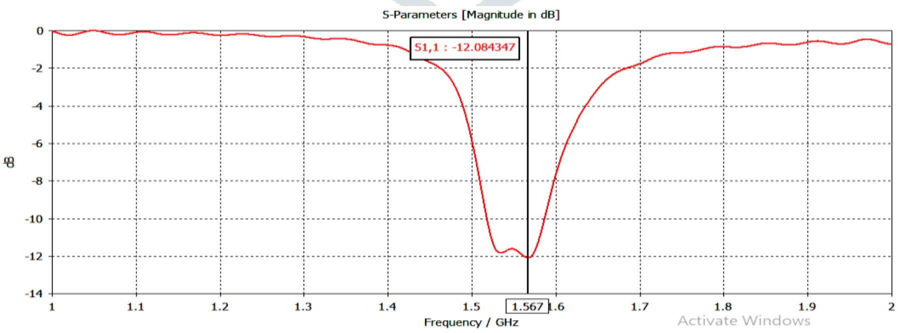

Figure 3: S 11 calculation

Figure 3 is showing return loss and s11 parameter, here 1.567GHz is resonant frequency.

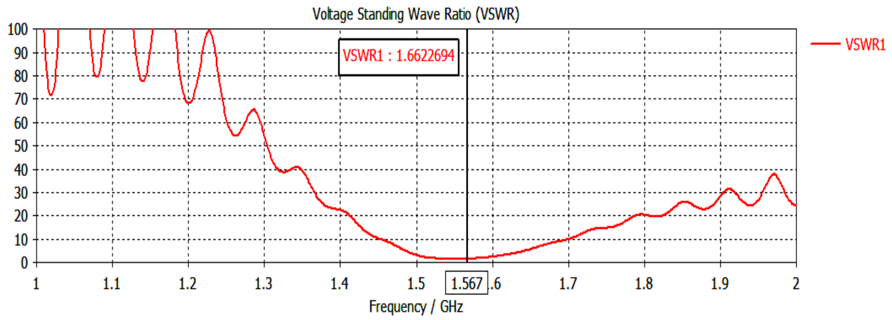

Figure 4: VSWR of proposed antenna

Figure 4 is showing voltage standing wave ratio its value should lie between 1 and 2 for better performance.

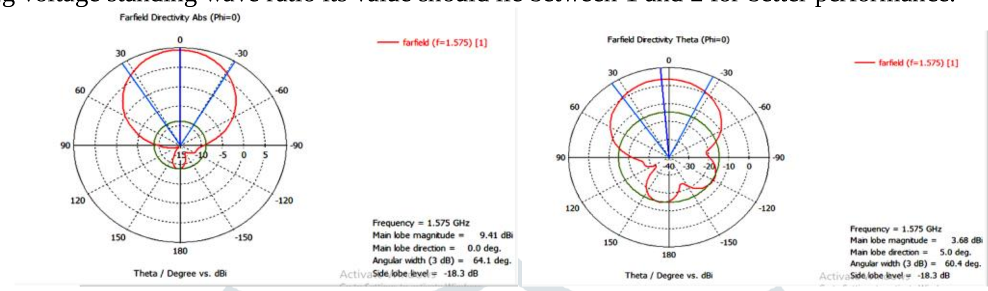

Figure 5: Far field of E and H

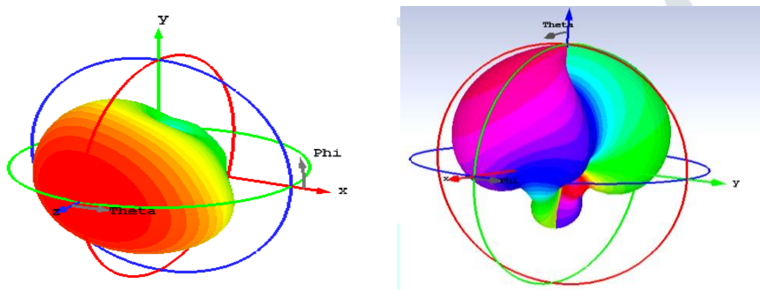

Figure 6: SAR calculation of antenna field

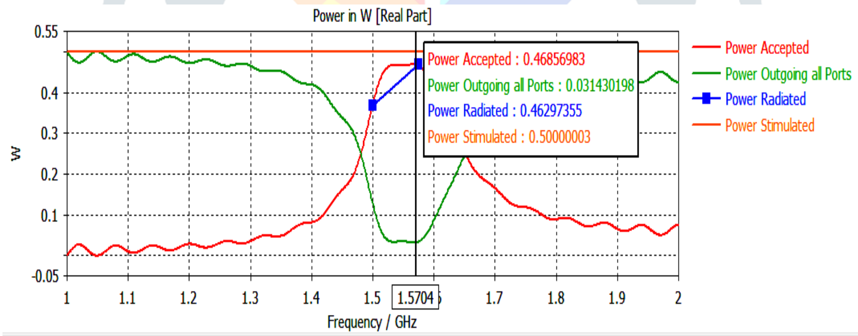

Figure 7: Power calculation of proposed antenna

Table I Design parameters for proposed frequency

Frequency(f_r)	1.7 GHz
Dielectric constant(ε_r)	4.4 /Air
Substrate Height(h)	1.6 mm
Line Impedance	50 Ω
Ground Plane	140 x 180 mm^2
Tangent Loss	0.06

Table II. Comparison of proposed design with previous work.

Parameter	Previous work	Proposed Work
Bandwidth	25MHz	70.2MHz
Return Loss	-11db	-12.08db
Resonant Frequency	1.35GHz	1.567GHz
VSWR	>1	1.662
No of Band	Single	Single
Application	GNSS	GNSS

V. CONCLUSION

In this work, we proposed a changed single frequency microstrip antenna which works productively in satellite correspondence. As aftereffects of proposed antenna was reproduced with fitting parameters for better working antenna. The cutting of rectangular opening brought about wide single band microstrip antenna for GNSS applications. The last outcomes fulfill every one of the parameters of an effective antenna. The structured antenna works productively under all conditions with great return loss and appropriate impedance coordinating. Frequency extend from 1-7 GHz utilized in remote correspondence can be accomplished by utilizing planned antenna. Further streamlining should likewise be possible with various dielectric substrate and in addition on geometry.

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