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5G BAND ANTENNA WITH DEFECTIVE GROUND STRUCTURE

Dr G Kameswari[1] , P Janardhana Reddy[2] , G Gowthami[3] , G Keerthi[4] , A Ajay Kumar[5] ,

A Durga Vara Prasad[6]

[1] Associate Professor , Dept of ECE , NBKR Institute of Science and Technology

[2]Research Scholar , Dept of ECE , J N T U Anantapuramu

[3,4,5,6] B.Tech Student Dept of ECE , NBKR Institute of Science and Technology

Abstract:

In this paper we had designed a multiple band antenna with the dimensions of substrate length was 24mm and width was 20mm and height was 1.26mm on FR4 substrate .the operating bands of the antenna were 6.32 to 6.67 GHz and 8.93 to 10 GHz . these two bands are useful for the Telecommunications, Radar Systems, Scientific Research, Industrial & Medical applications and Satellite Systems.

Key Words : Multiple Bands , FR4 Substrate .

Introduction:

In the last decade of wireless communication field have abrupt changes for compact size wireless devices demand has been arise due to ease of fabrication of multiple IC within smaller space. Today we also introduced the 5G wireless communication system that operated higher bandwidth spectrum. On account of this, designers are paying more concentration on compact broadband antenna, micro-strip patch antenna has attracted the designers matter of its compact size, low profile, low cost and high reliability. However major disadvantage of micro-strip patch antenna is narrow bandwidth, low gain and directivity. Defective Ground Structure (DGS) contemplated by researchers due to some uncommon electromagnetic properties those are extremely hard to discover in nature. Therefore, the radiated beam of the basic antenna will be more directive with narrow beam width, when EM wave propagates in the ground substrate. To fetch the advantages provided by the DGS we are trying to modify the ground substrate and patch to make the antenna should operate at different bands with low return loss and high directive gain.

A quad-element reconfigurable radiation pattern Multiple Input Multiple Output (MIMO) antenna is designed for WLAN and 5G applications suitable for indoor wireless communications. It consists of four radiating elements that operate over triband frequencies 2.4, 3.5, and 5.5 GHz[1]. The overall physical dimension of the proposed antenna is about 0.55 × 0.55λ0. In addition, an Acrylonitrile Butadiene Styrene (ABS) enclosure is designed. The measurement results show that the proposed antenna has an impedance bandwidth of 4.18%, 14.13%, and 28.5% at the said frequencies respectively [2], A slotted patch MIMO antenna to enhance isolation and gain. The MIMO antenna configuration includes two radiators integrated with an array of Frequency Selective Surfaces (FSSs). The proposed MIMO antenna possesses dimensions of 65 mm (width) × 45 mm (length) × 1.6 mm (height). The FSS unit cells exhibit excellent stability across various polarization incidence angles and operate within the frequency range of 7 to 9 GHz. The FSS loaded antenna offers a bandwidth ranging from 8.0 to 8.55 GHz, with a peak gain of 6.5 dB and isolation exceeding −20 dB among the MIMO elements [3], a 4-port MIMO antenna for 5G mid-band application resonating from 4.5–5.1 GHz. The first design involves a single-element microstrip patch antenna with a diamond shaped slots and partial ground structure of size 30 × 43 × 1.6 mm3. Using this single element antenna as reference, a 4 port MIMO antenna is presented which operates at 4.9 GHz resonance frequency. The proposed 4 port MIMO antenna is designed and fabricated over a commercially available low-cost FR-4 substrate having a relative dielectric permittivity of 4.4 and thickness of 1.6 mm. the proposed antenna is an excellent candidate for deployment in 5G networks [4], a flexible 2-port MIMO antenna with dual band-notched properties is designed and built for wireless body area network applications. Two UWB slot antenna components are arranged in parallel with linked ground. The measured operating bandwidth can reach 3.0–15.7 GHz, with blocking bands of 5.0–6.5 and 7.0–7.9 GHz. Port isolation (S21) is better than 20dB. This antenna has fine radiation properties, high isolation, and flexibility, according to the bending and flat antenna tests. It has a promising future for wearable Internet of Things applications [5], Multiple Input Multiple Output (MIMO) antenna is using limited spectrum and high capacity, operators have successfully adopted multisector MIMO deployment and achieved a 70% increase in capacity without increasing spectrum. MIMO realizes efficiency in mobility with the increase in capacity of links and several sub-bandwidths using polarization diversity providing better cyber security[6], for nonionizing radiation assessment to reduce the Specific Absorption Rate (SAR) in the IEEE SAM phantom using a MIMO antenna. The traditional copper material MIMO is designed with mode characteristics and validated for 2.4 GHz in this experiment. The MIMO antenna, when placed near SAM phantom and SAR, is estimated. Copper-based antennas are replaced by nanomaterial-based antennas, such as graphene, multi-walled carbon nanotube (MWCNT), and single walled carbon nanotube (SWCNT), to study SAR behavior. SAR is reduced using nanomaterial-based antenna in which SWCNT significantly reduces SAR up to 66 percent using Altair’s Feldberechnung f¨ur K¨orper mit beliebiger Oberfl¨ache (FEKO) [7].

In this paper we had modified the surface area and ground to get a multiple operating bands .

Antenna Modelling:

Fig1 shows the basic patch antenna, the parametric dimensions of the ground and patch of the designed antenna was in the table 1.

Table 1:

Parameter	Value(mm)
L1	24
L2	1
W1	16
W2	1
S1	2

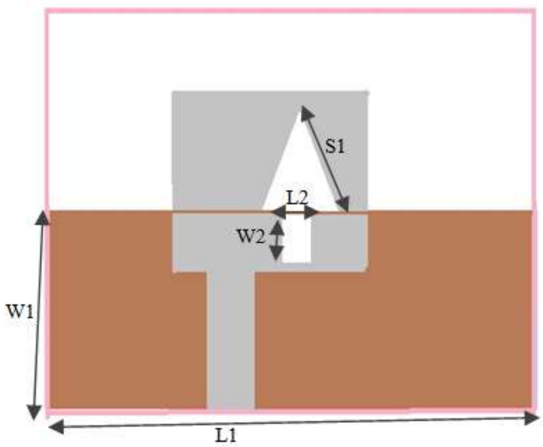

Fig .1 The reflection coefficient of antenna was illustrated in fig 2.

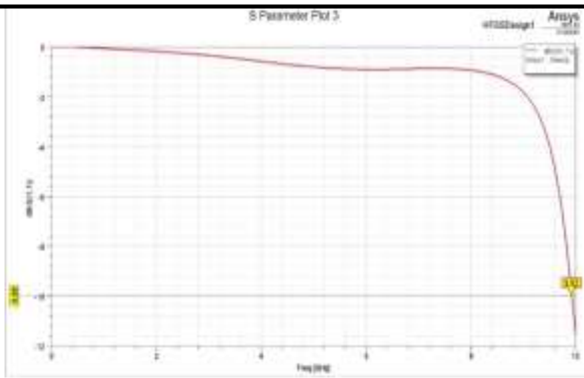

Fig 2: S11 parameter for antenna shown in figure 1

To improve the performance of the antenna had modified the surface area of the basic antenna as like in the fig 3.

Table 2: parametric dimensions of the antenna shown in fig 3

Parameter	**Value(mm)**
L1	8
L2	4
L3	4
W1	10
W2	6
W3	2
R1	2

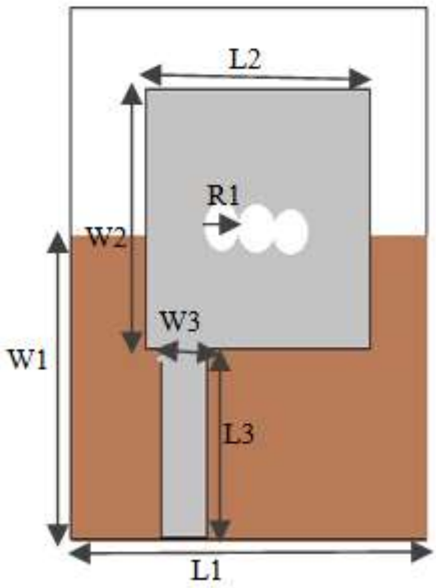

Fig 3: The s11 parameter for the modified antenna was in fig 4.

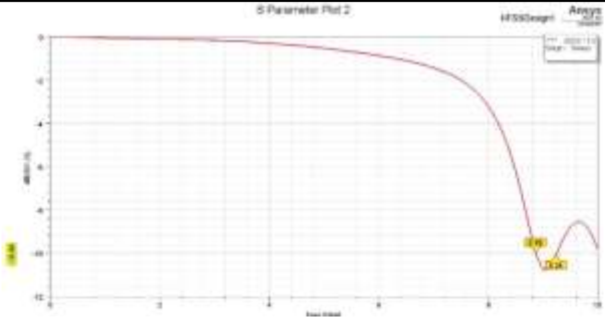

Fig 4: The s11 parameter for the antenna shown in figue 3

We had further modified the surface area of the antenna as like in the mentioned fig 5.

Table 3: parametric dimensions of the antenna shown in figure 5 .

Parameter	Value(mm)
L1	24
L2	1
W1	16
W2	6
R1	2

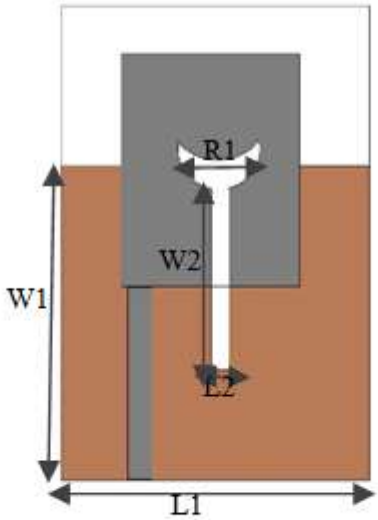

Fig 5: Further modified the surface area of the antenna

The s11 parameter of the designed antenna was in fig 5.

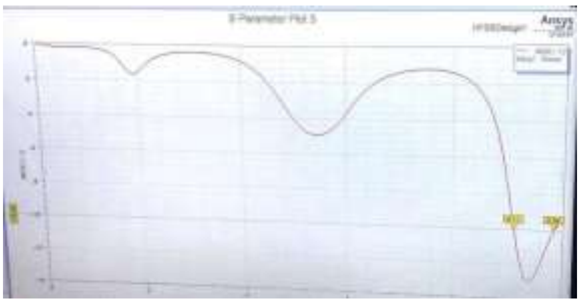

Fig 6: The s11 parameter of the designed antenna in figure 5

From the above antenna, we had observed that bandwidth was increasing with the modification on surface area. With this observation we had modified further to work the antenna at multiple bands .

Table 4: parametric dimensions of the antenna shown in figure 7 .

Parameter	Value(mm)	Parameter	Value(mm)
L1	10	W1	8
L2	4	W2	6
L3	2	W3	4
L4	6	W4	2

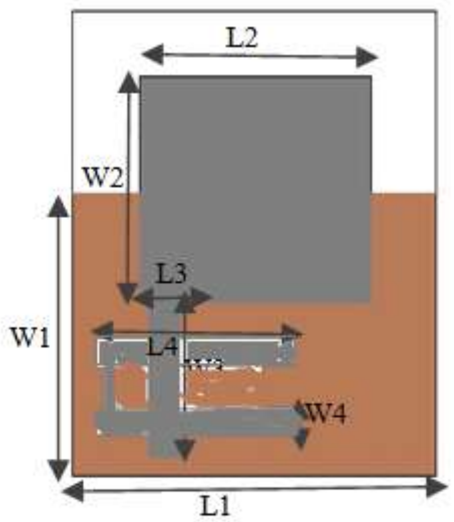

Fig 7: L2

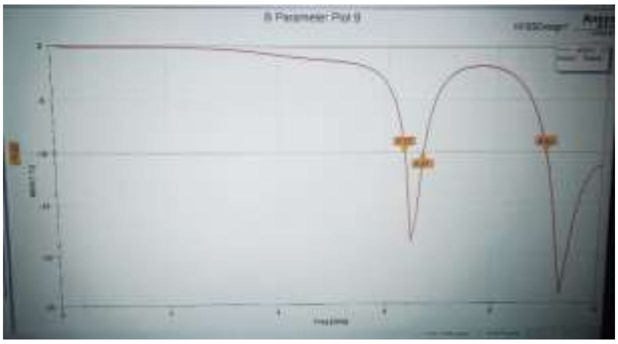

Fig 8: The s11 parameter for the modified antenna

To get ultra wide band and decrease reflected energy we had modified surface of the radiating patch further.

Table 5: The dimensions of the surface area of the ground

Parameter	Value(mm)
L1	24
L2	1
W1	16
W2	6
R1	6

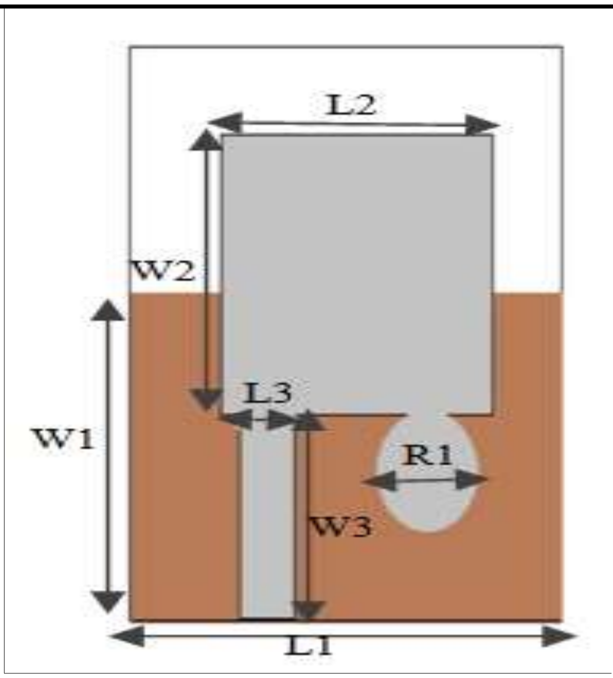

Fig 9: Further modified the ground substrate

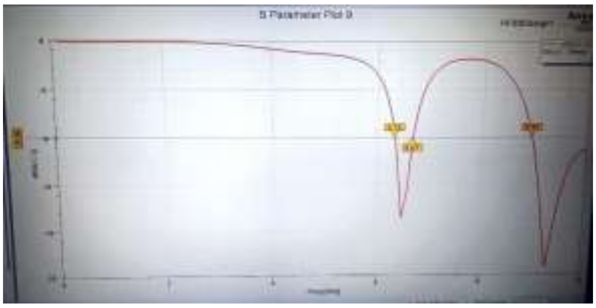

Fig 10: The s11 parameter for the modified antenna

The design of the proposed antenna was showed in the figure. and we can observe the operating bands of the antenna were 6.32 to 6.67 GHz and 8.93 to 10 GHz. This bands have the applications of Telecommunications, Radar Systems, Scientific Research, Industrial & Medical applications and Satellite Systems.

Conclusion:

The integration of a defective ground structure presents a promising avenue for enhancing the performance of 5G band antennas. By strategically manipulating the electromagnetic properties of the ground plane, the proposed design achieves multiple operating bands i.e 6.32 to 6.67 GHz and 8.93 to 10 GHz.

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