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Electrical Engineering

Elixir Elec. Engg. 70 (2014) 24276-24279

ISSN: 2229-712X

Multilayer L and Square slot Broadband antenna with Radom and effect of Ground Plane for S-C-Band application

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ARTICLE INFO

Article history:

Received: 26 December 2013;

Received in revised form:

10 May 2014;

Accepted: 20 May 2014;

Keywords

Broadband antenna,

L-Slot,

Radom,

Miniaturized antenna,

Square slot,

C-Band.

ABSTRACT

A Broadband multilayer antenna for C-Band applications is presented in this paper. The proposed antenna is composed of a FR-4 and air gap Dielectric material, two square slots, two L-Slot, and a Radom. By introducing the two parts, the impedance bandwidth of the antenna can be significantly enhanced. Analysis done with and without ground plane. Simulation results show that the proposed antenna can operate from 3.2GHz to 4.8 GHz with low VSWRs ≤ 2. Stable antenna gain (dB) is also achieved over the entire operating frequency band. Furthermore, the size of the proposed antenna is very compact, which is only at the centre of the operating frequency band.

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Introduction

A variety of broadband techniques have been developed using the three approaches categorized. It is known that the factors affecting the bandwidth of a microstrip patch antenna are primarily in the shape of the radiator, the feeding scheme, the substrate and the arrangements of radiation and parasitic elements. Essentially, the broad bandwidth of a microstrip patch antenna can be attributed to its low Q value and simultaneously well excited multiple resonances. If the antenna is considered as a high-Q filter, lowering the Q by reducing the energy around the radiator or increasing losses broadens the bandwidth at its resonance. Alternatively, by inserting a broad band impedance network between the antenna and the feeder, good matching over a broad frequency range can be attained. If two or more adjacent modes are well excited simultaneously, the bandwidth can be twice or more than that of the single resonance. microstrip patch antenna having a larger sphere suffers from a narrow bandwidth as the whole volume of the enclosing sphere is not utilized effectively .Therefore, a microstrip patch antenna can be considered as a high-Q circuit, so one way to alleviate the narrow bandwidth problem is to reduce the Q. Investigations have shown that the shape of a radiator affects the impedance bandwidth, even for the same maximum dimensions. However, bandwidth enhanced method of a low profile substrate integrated waveguide cavity is backed to slot antenna. Bandwidth enhancement is achieved by simultaneously exciting two hybrid modes in the SIW-backed cavity and merging them within the required frequency range. The gain and bandwidth are slightly improved to 6 dB and 6.3% respectively [2]. Discussed utilization of wearable textile materials for the development of microstrip antenna for wireless devices. A wearable antenna is meant to be a part of the clothing used for communication purposes, which includes tracking and navigation, mobile computing and public safety. In this paper they describe design and development of four rectangular patch antennas employing different varieties of cotton and polyester clothing for on-body wireless communications in the 2.45 GHz WLAN band. They determined impedance and radiation characteristics experimentally. The performance deterioration of a wearable antenna is analyzed under bent conditions too to check compatibility with wearable applications. The simulated and measured return loss plots obtained with polyester antenna. The theoretical values of resonant frequency and impedance bandwidth of this antenna are 2.34 GHz and 91.78 MHz respectively [3]. U. Chakraborty, S. Chatterjee, S.K. Choudhry and P.P. Sarkar [4], presented a single feed compact rectangular microstrip antenna. A triangular slot is introduced at the upper edge of the patch to reduce the resonant frequency. A small piece of triangular patch is added within the area of the triangular slot to improve the gain bandwidth performance of the antenna. The return loss and bandwidth are -27.36 dB and 160 MHz respectively for the proposed antenna and the structure is simulated on MOM based IE3D software. The dielectric substrate is FR4 Glass Epoxy.

E. Alboni and M. Cerretelli [5]. Presented a microstrip patch antenna for two substrates- FR-4 Glass Epoxy and Taconic TLC. The first simulation was done on 1.6mm thick FR4 substrate. To reduce patch dimension, 8 slits were introduced. In order to get circular polarization a double feed is used. Then to increase efficiency and gain, a low loss material Taconic TLC is used. They have achieved a gain of 3.8 dB and a bandwidth of 54 MHz with an efficiency of 47%. The improvement in the bandwidth is quite limited. [7] - [9].The shape of a radiator, which affects the operating modes, is critical for its radiation performance. Therefore, this technique is hardly employed in practical designs [23]. As an alternative, a thick substrate with low dielectric constant is good for improving the impedance bandwidth of these antenna [7]. This monotonically reduces the Q and broadens the bandwidth.

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Another important consideration is the increase in losses due to undesired surface waves, which lowers the radiation efficiency, excites spurious radiations, and degrades the radiation patterns. Investigations have shown that the impedance bandwidth monotonically increases with the substrate thickness while radiation efficiency rapidly decreases [7]. However, the achievable bandwidth will decrease when the thickness exceeds a certain value

Antenna Design And Configuration

The proposed design analysis with and without ground plane, analysis done by considering the effect of ground plane for enhancing bandwidth

Antenna Design With Ground Plane

The configuration of the proposed antenna is shown in Fig.1. The antenna is analyzed and optimized by IE3D™ software. The proposed antenna is composed of a FR-4 and air gap Dielectric material, two square slots, two L-Slot, and a Radom. The radiating arms are designed as two square slots and two L- slot to obtain compact size.

The dimensions of design at 4GHz are

Top layer dimension is

- L=17.78mm, W=20.32mm

Middle layer dimension is

- L=17.78mm, W=20.32mm with two L slot and two square **slot**

Bottom layer consists with and without ground plane,

in first geometry analysis proposed design with effect of ground plane of dimension Lg = 38.1mm, Wg = 35.56mm. In second design analysis proposed antenna without consideration of effect of ground plane. Radom is used for protection of radiation of antenna from atmospheric obstacle and radiation of other object. In fig 1 depicts Proposed Design Antenna with Ground Plane, in fig 2 depicts middle layer with slots.

Figure 1 Proposed Design Antenna with Ground Plane

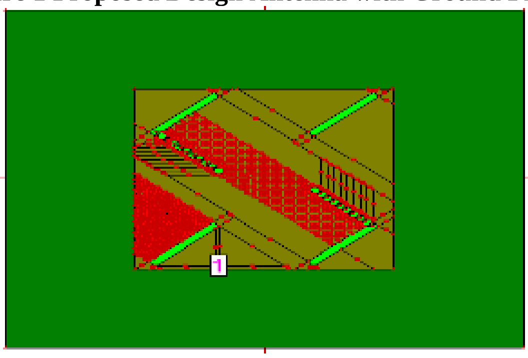

Figure 2 Middle layer with L-Slot and Square Slot

B. Antenna Design with Out Ground plane

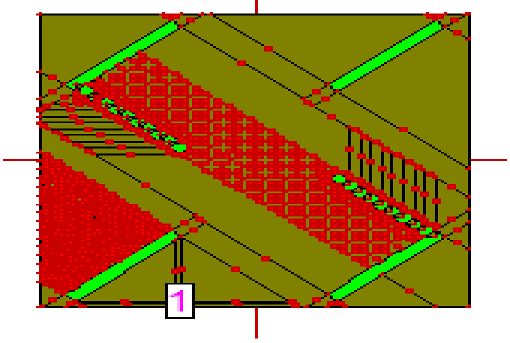

Figure 3 Antenna Design with Out Ground plane

In fig 3 depicts Antenna Design with Out Ground plane,

Results And Discussion

Proposed Antenna Design with Ground plane

Fig 4 depicts Return loss of proposed design with respect to frequency. Firstly designed conventional design on IE3D Simulator, after simulation we found that reflection at 4GHz is very high and VSWR is 5.212, this is a theoretical design with respect to centre frequency but with respect to standard system results cannot be useable. for effectively using at 4GHz we required good impedance matching, for providing good impedance matching we used stub matching technique of transmission line and found position of stub and length of stub, using resonance theory we found width of stub, After finding stub dimension, substitute stub on the edges of middle layer patch, optimization is completed by using appropriate dimensions of ground plane. From this optimization, we found return loss up to -36dB, and VSWR at 4GHz is 1.023. In stub matching technique we used L-Slot, square slot and appropriate dimension of ground plane. Achieved 40% impedance bandwidth from 3.2GHz to 4.8 GHz with low VSWRs ≤ 2. Fig 5 presents directivity of antenna with respect to frequency at 4GHz directivity is 5.5dBi, VSWR Shown in fig 6. Elevation and Azimuth Radiation pattern at 4GHz present in fig 7, fig 8, polarization of antenna demonstrate by axial ratio in fig 9,

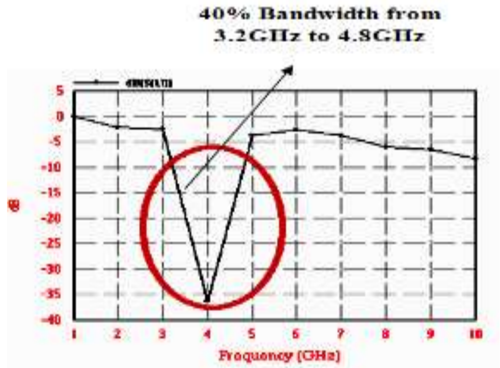

Figure 4 Return loss Vs Frequency

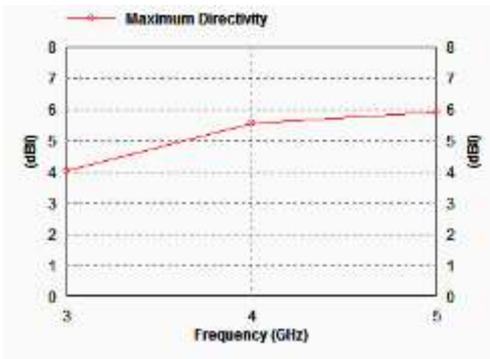

Figure 5 Directivity Vs Frequency

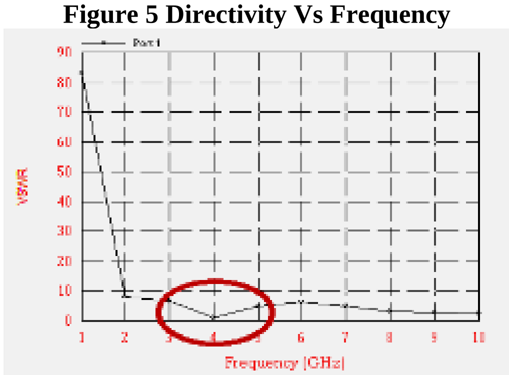

Figure 6 VSWR Vs Frequency

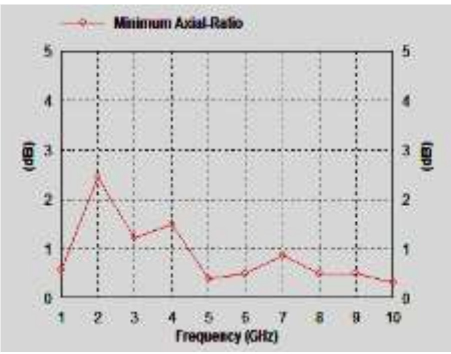

Figure 9 Axial Ratio Vs Frequency

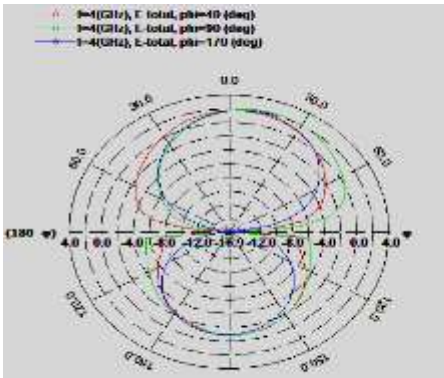

Figure 7 Elevation pattern at 4GHz

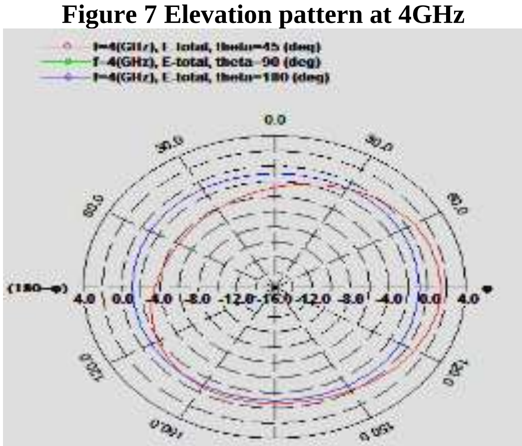

Figure 8 Elevation pattern at 4GHz

Antenna Design with Out Ground plane

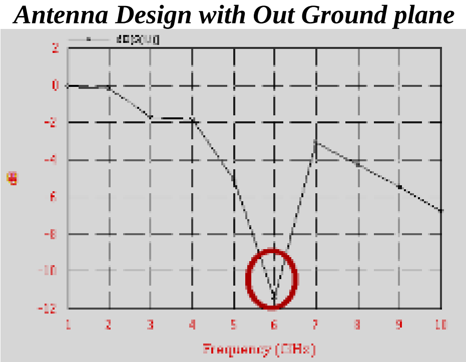

Figure 9 Return loss Vs Frequency of proposed design without ground plane

In fig3, depicts proposed design without ground plane, from fig 10 we concluded that ground plane is very effective part for eliminating of reflected signal and improve the bandwidth significantly. Fig 4 and fig 10 depicts effect of ground plane on bandwidth and return loss enhancement. The comparison results of both geometry with and without ground plane represented in Table-I. From conclusion we concluded ground plane significantly enhance bandwidth.

Table-I Results summary of proposed gemetries at 4GHz

Parameters	Proposed Design With ground plane	Proposed Design Without ground plane
Frequency	4(GHz)	4 (GHz)
Input Power	0.00999769 (W)	0.00999769 (W)
Radiated Power	0.000609773 (W)	0.00460558 (W)
Average Radiated Power	4.85242e-005 (W/s):	0.0003665 (W/s)
Radiation Efficiency	17.7815%	46.0664%
Antenna Efficiency	6.09773%	46.0558%
Directivity	7.13885 dBi	5.54785 dBi
3dB Beam Width	(57.9084, 107.099)	(64.2564, 96.7145) deg.
VSWR≤2 Impedance Bandwidth	40% at center frequency 4GHz	2% at center frequency 4GHz

Conclusion

A Broadband multilayer antenna for C-Band applications is presented in this paper. The proposed antenna is composed of a FR-4 and air gap dielectric material, two square slots, two L-Slot, and a Radom. For optimization of Bandwidth and return loss used stub matching method of transmission line. Analysis done with and without ground plane. From this analysis we concluded that appropriate dimensions of ground plane severely effect the VSWR≤2 impedance bandwidth and return loss, Simulation results show that the proposed antenna with ground can operate from 3.2GHz to 4.8 GHz with low VSWRs ≤ 2. By using ground plane we achieved 40% impedance bandwidth and -36dB, Return loss with 1.023 value of VSWR, Stable antenna gain (5.5dBi) is also achieved at 4GHz frequency. Furthermore, the size of the proposed antenna is very compact; the proposed antenna can be used for S-C-Band application. All results of proposed geometries proposed in Table-I.

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