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A Miniaturized Square Shaped Microstrip Antenna with L-shaped Slot for 5G, 4G and Other Applications

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Abstract - *The miniaturized square shape microstrip antenna with L-shaped slot for 5G, 4G and other applications is proposed in this paper. A square shaped patch having dimension of 9×9 mm² is attached to a feed line of 7.85 mm long. The s-parameter, gain, polarization gain, VSWR and radiation pattern are calculated at various operating frequencies. A wide band frequency range of 3.76 to 3.94 GHz and 4.91 to 5.54 GHz is achieved with resonant frequency of 3.853 GHz and 5.3 GHz respectively. The gain maximum achieved is around 4.09 dB. Various operating frequencies like 3.8 GHz, 4.9 GHz and 5.1 GHz are included in the observed frequency range. Many parameters which consists of gain and surface current are studied at these frequencies. This design is useful in various applications like 5G, 4G, Wi-Fi, Wi-MAX, WLAN.*

Key Words: DGS, Octagon, Star Shaped, circular polarization, wideband.

I. INTRODUCTION

A miniaturized square shaped microstrip antenna with L- shaped slot in ground plane is proposed using FR-4 substrate [1]. The configured antenna is light and is very cheap and easy to handle due to its miniaturized size. The dielectric constant of FR_4 is 4.3 which is quite high so, it is best suitable for various microwave applications.

In this design, L-shape slot is introduced, which disturbs the ground plane current distribution. This changes the line capacitance and inductance. L-shape slot also increases the directional radiation of antenna. Microstrip antennas are available in various designs like T-shape, H-shape, circular shape and so on. As the size and directivity of these antennas are the big advantage, it is used in various industries.

II. PROPOSED DESIGN

A. Antenna design

In Fig. 1a, front view of the proposed square shaped antenna with L-shape ground slot is depicted. Substrate used is FR4 lossy with thickness of 1.6 mm. This shaped is responsible for high directivity. Then a micro-strip feed line with edge feeding is used which is provided from the bottom end and have a length of about 7.85 mm and is 3 mm in width.

The substrate is 25mm×25mm dimension and has dielectric constant of 4.3. In Fig. 1b, ground plane of antenna is portrayed. L-shape slot in ground is embedded.

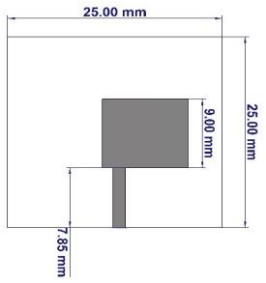

Fig.1a. Patch plane of proposed antenna.

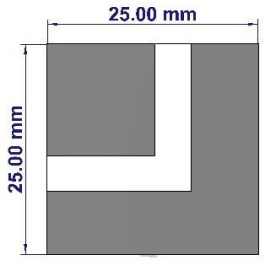

Fig.1b. Ground plane of proposed antenna

The dimension table of the proposed antenna is shown below.

Table -1:

DIMENSIONS OF THE PROPOSED ANTENNA (UNIT: mm)

Parameters		Measurement
Substrate thickness	(*t*)	1.6
Substrate length	(*l*)	25
Substrate width	(*w*)	25
Ground width	(*w1*)	25
Ground length	(*l1*)	25
Ground thickness	(*t1*)	0.035
Square patch length	(*l2*)	9
Feed line length	(*l3*)	7.85
L-Defect length	(*l4*)	17.5
L-Defect width	(*d*)	12.75

III. SIMULATION RESULTS & DISCUSSIONS

The proposed antenna possesses a dimension of 25×25×1.6 mm^3 is designed and optimized using Computer Simulation Technology (CST) tool. S-parameters, radiation pattern, surface current, gain and polarization measurements are shown.

A. Discussion on results

In Fig.3a, S11 parameter results are depicted which shows a wideband frequency range of 3.76 to 3.94 GHz and 4.91 to 5.54 GHz. So, from the S11 results we can see that resonant frequency is 3.853 GHz and 5.3 GHz. Moreover, we can observe that the operating frequencies of 3.8 GHz is for Wi-MAX, 4.9 GHz for Personal Area Network (PAN) and WLAN, 5.1 GHz for 5G communication.

Moreover, the frequency has in depth isolation and return loss. The efficiency is above 90% overall.

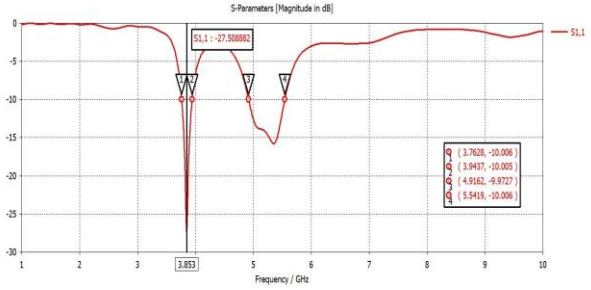

Fig.3a. S-parameters results.

Then, at this resonance of 3.853 GHz a VSWR of 1.08 is also achieved shown in Fig.3b. VSWR is ideally 1 and maximum it can be 2. This ideal behavior states that the input and output voltage is same. So, low losses and directivity is high.

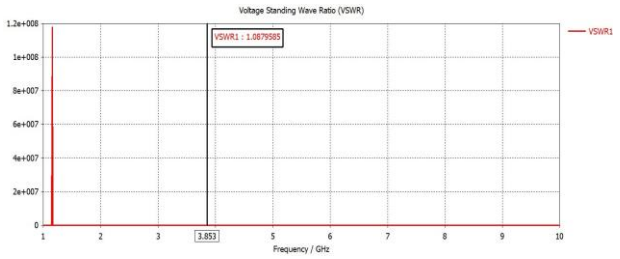

Fig.3b. VSWR at 3.853 GHz frequency.

The radiation pattern are shown in Fig.3c for 3.853 GHz frequency at constant theta and constant phi.

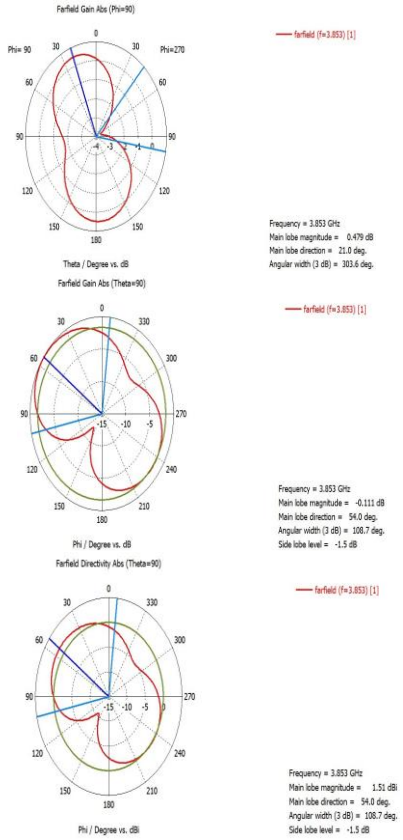

Fig.3c. Radiation patterns at 3.853 GHz.

The surface current at the resonance frequency of 3.8538 GHz is depicted in the Fig.3d. The density of surface current is more at the sides of feed line. Maximum is around 200 A/m.

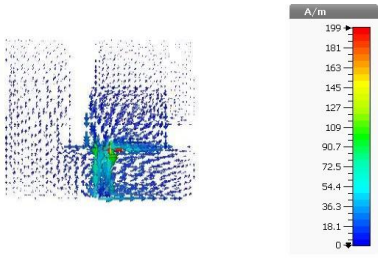

Fig.3d. Surface current at 3.853 GHz frequency.

The gain at 3.5 GHz frequency is about 1 dB and gain of about 4.05 dBi is achieved at 5.1 GHz frequency which is portrayed in Fig.3e. The surface area covered by the gain can be clearly seen and it shows that most of the part which was necessary for propagation in one direction is covered.

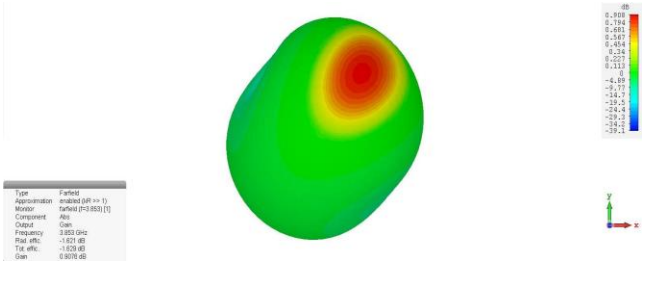

Fig.3e. Gain at 3.853 GHz.

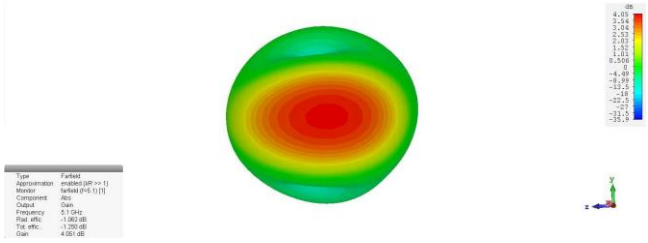

Fig.4. Gain at 5.1 GHz frequency.

The gain is bit higher in 5.1 GHz, 5.3 GHz which is 4.05 db and a bit lower at 5.5 GHz shown in Fig.5 and Fig.6.

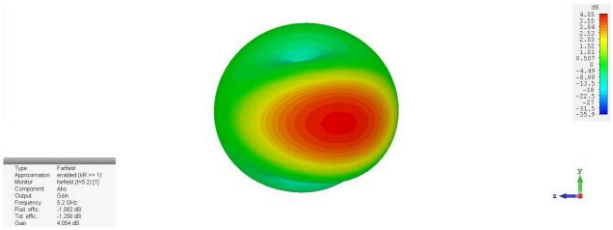

Fig.5. Gain at 5.3 GHz broadband frequency.

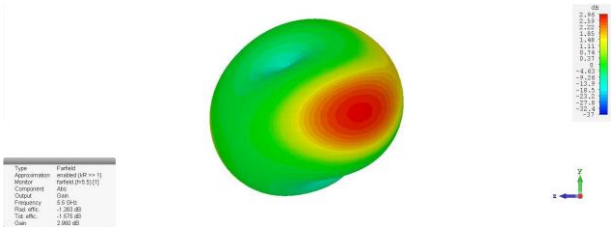

Fig.6. Gain at 5.5 GHz broadband frequency.

IV. CONCLUSIONS

We can conclude that the frequency range of the proposed design is from of 3.76 to 3.94 GHz and 4.91 to 5.54 GHz with resonance at 3.853 and 5.3 GHz. Due to L shaped slot implementation isolation is achieved as the current get trapped around. The design is acceptable for the applications like WLAN, PAN, 5G, Wi-MAX and others.

Moreover, this frequency band can be varied if L shape dimensions get changed. The band range is mostly dependent on L slot dimensions and other parameters like feed line position, shape of patch. This antenna design is simple, compact, easy to design and implement & practically efficient too.

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