ISSN 2320-9984

Volume 3 Issue 4 | December 2015 ISSN: 2320-9984 (Online)

International Journal of Modern Engineering & Management Research

Website: www.ijmemr.org

Dual-Band Microstrip Antenna with Defected Ground Structure (DGS)

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Abstract—*In this manuscript, a microstrip feeding rectangular MPA using DGS structure into ground plane is presented. In the absence of slot a conventional rectangular MPA is also considered for confirming the validity of designed antenna. This conventional antenna design found to resonateon7.0611 GHz frequency at-23.70dB return loss. When introducing an S-shape DGS structure into the ground plane, and then the frequency shift of 7.0611 GHz to 7.1361 GHz is observed. The main involvement of this antenna design is the dual-band responses. Further, the end result confirms that the designed Dual-band DGS antenna has return loss at -16.0659dBon7.1361 GHz, and -18.1572dB on9.1538GHz.*

Keywords:— *Dual-band Antenna, Microstrip Patch Antenna (MPA), DGS (Defected ground structure).*

1. INTRODUCTION

In Wireless Communication the predominant growth, forces the researchers to design a low profile, small in size and low cost antenna for multi-frequency operation. Telecommunication technology is only one technical field which has great concern in many applications like military, professional and civil sphere. Due to commercial increment of multifarious electrical devices, antenna devices of recent communication have to be capable to receive and transmit electromagnetic waves in different frequency bands associated with different communication services [1]. The performance parameter of the single band MP A only works properly at the design frequency. Now we turn our attention on dual-band microstrip antenna meant for dual -frequency operation. To achieve dual-band response several strategies have been developed. In [2], this paper presents an S-shape loaded dual-band microstrip antenna designed for wireless & WLAN applications. In [3], a multi-band microstrip antenna was presented with a defects ground structure which is conventionally conformal and appropriate for WLAN applications. In [4],this paper mainly focuses on the basic concept and characteristics of DGS structure. DGS structure is basically formed in periodic/non-periodic configuration defect etched into ground plane. A rectangular MPA with slots on patch and DGS structure into ground plane level was introduced. Without slot sand DGS the MPA found to resonate on 5.22GHz and by introducing slots and DGS frequency shift of 5.22 GHz to 1.56 GHz was observed[5]. In [6],microstrip antenna using periodic cross strip-line gaps as DGS structure is created. The suitable comparison between the outcome of conventional antenna and DGS antenna has been present. In [7], a compact multi-band MPA using DGS was introduced. The design for the MPA consist an H-shaped slot on top of the patch along with DGS structure of U and L shape into ground plane level. In[8], MPA with I-shape DGS is introduce for improved bandwidth of 118% compared to conventional design. This antenna design also confirms additional improvement in parameters like Gain, return loss & radiating patch size.

2. ANTENNACONFIGURATION

In this manuscript, MPA (Microstrip Patch Antenna) is design and analyzed with the help of ANSOFT HFSS software [9]. For explicit comparison, it is essential to propose a conventional MPA as a reference. This conventional antenna designed on Rogers RT/Duroid (5880)dielectric material of1.6 mm thickness having ε_r (relative permittivity) of 2.2and design frequency of 7.2 GHz. In Figure 1 front view of reference conventional MPA is present. Mathematical calculation of width & length of MPA is simply given in [10] and Table1 explains the appropriated et ail about the parameter dimension of designed antenna. This conventional antenna operates at 7.0611 GHz frequency of single band with 192.2 MHz bandwidth.

Table-1 Common Design Specification for Both Antennas

S.N.	Specification	Dimensions
1	Ground Plane	Wg=30 mm, Lg=30mm
2	Substrate	Ws = 30mm Ls = 30mmhs =1.6mm
3	Rectangular Patch	Wp = 12.67mm Lp = 9.29mm
4	Permittivity of sub-strate material	2.2

In Figure 2 the front view of DGS MPA configuration is present. In which the patch is considered as without slot and an S-shape DGS structure is etched into ground plane level for defecting the ground. This S-shape DGS is integrated in the center of ground plane. This geometry, force the current to split in different paths and we observed dual-band frequency response. Design specification of DGS antenna without defects is similar to conventional antenna as given in table1.

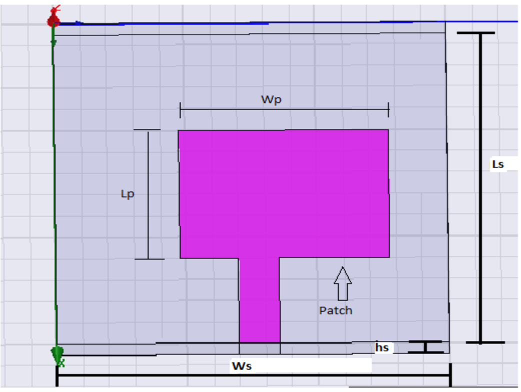

Figure 1 Conventional MPA (Microstrip patchAntenna)

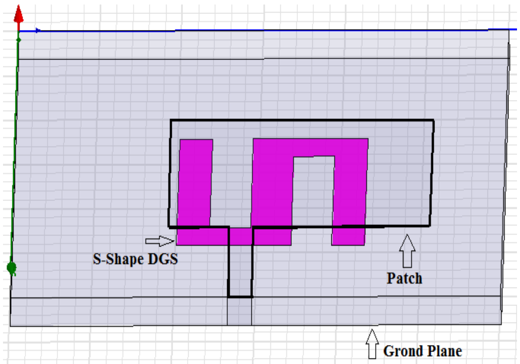

Figure 2 S-shape DGS MPA (Microstrip patch Antenna)

3. RESULTS AND DISCUSSION

The outcome shown here is simulated on HFSS software to determine the characteristic parameter of design antenna like VSWR, return loss & impedance bandwidth.

Return loss and Impedance Bandwidth

The graphs offigure 3 confirm a relative comparison between the conventional antenna & the S-shape DGS antenna. Graph 3(a) indicates that the conventional antenna is resonating on frequency of7.0611 GHz with -23.7098 dB return loss for single band with the bandwidth of 192.2 MHz while the graph 3(b) indicate that the resonating frequency of DGS MPA is shifted down from7.0611 GHZ to 7.1361GHz due to increase in the capacitance of slots incorporated in ground plane. The graph 3(b) also specifies that the designed DGS MPA is resonating on dual frequency these means that we get the dual-band response due to suitable DGS into ground plane level. Our antenna design shows two resonating frequency with satisfactory impedance bandwidth concluded in table 2. So from the graphs and table 2 it is confirm that our proposed S-shape DGS antenna have satisfactory bandwidth and sufficient return loss. So this antenna design can cover many applications for wireless communication.

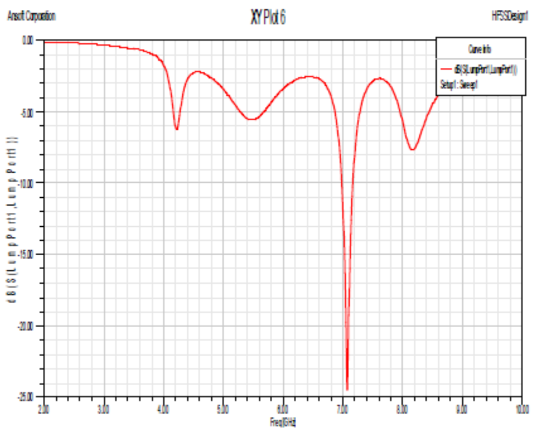

Figure 3(a) Return loss (S11) vs. Frequency

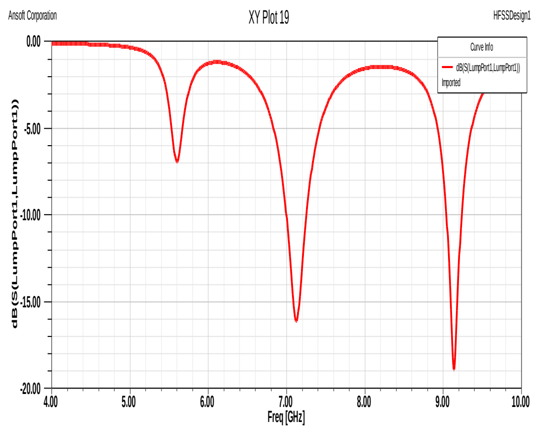

Figure 3(b) Return loss (S11) vs. Frequency

A. VSWR

One more necessary parameter to measure how well matched the antenna to transmission line is known as Voltage Standing Wave Ratio. Figure 4(a) &4(b)show the VSWR of conventional antenna and S-shape DGS antenna respectively. VSWR<2 indicated by the graphs and normally this is adequate margin.

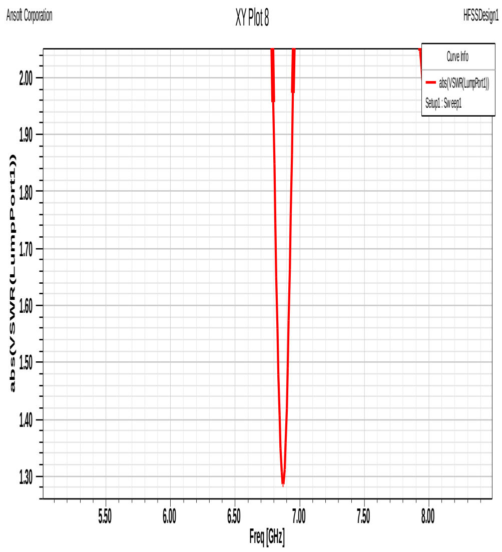

Figure 4(a) VSWR vs. Frequency

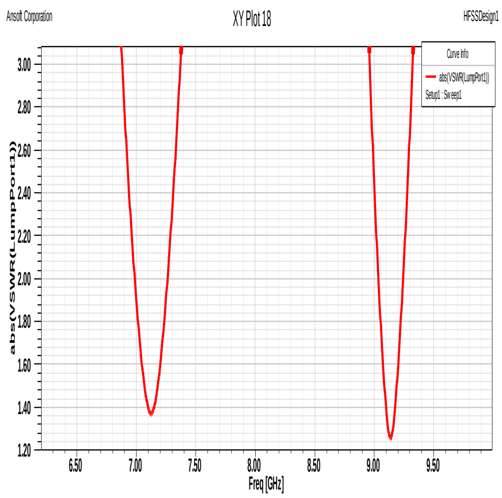

Figure 4(b) VSWR vs. Frequency

B. Radition Pattern

The E-plane & H-plane is defined as the Electric Field & the Magnetic Field Vector respectively with the directions of maximum radiations. Principle E-Plane is X-Z plane Elevation with φ (azimuth angle). While the Principle H- plane is X-Y plane Azimuth with θ (elevation angle). In graphs of figure 5 &figure 6 shows the 2-D E-Plane & H-Plane radiation patterns respectively at different operating frequencies.

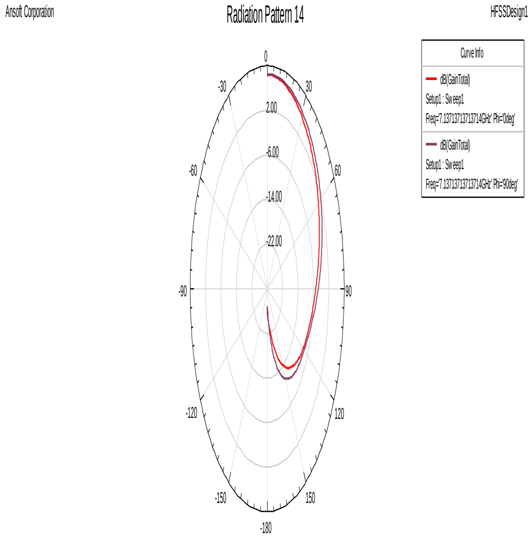

Figure 5(a) 2-DRadiation Pattern for E-Plane at7.1361GHz

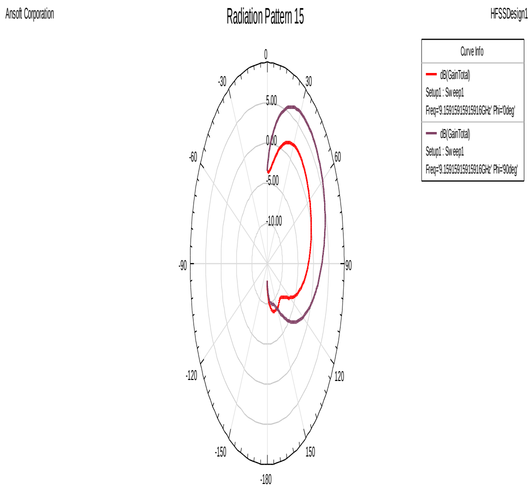

Figure 5(a) 2-DRadiation Pattern for E-Plane at9.1538GHz

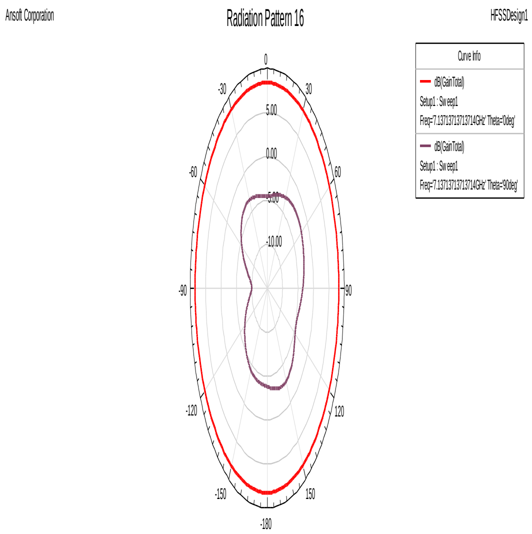

Figure 6(a) 2-D Radiation Pattern for H-Plane at 7.1361GHz

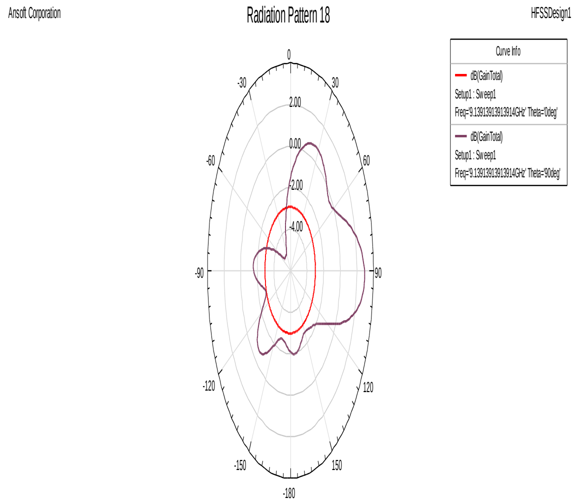

Figure 6(b) 2-D Radiation Pattern for H-Plane at9.1538GHz

The graphs of figure 7 indicate the3-D radiation pattern for different frequencies in the band.

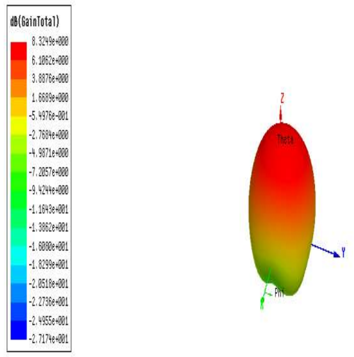

Figure 7(a) 3-D Radiation Pattern at 7.1361GHz

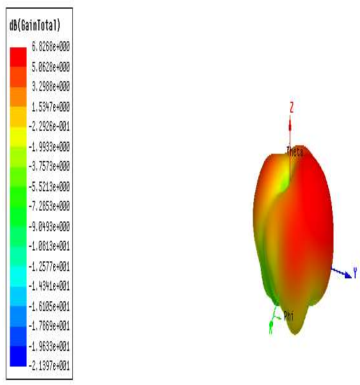

Figure 7(b) 3-D Radiation Pattern at 9.1538GHz

Table 2 Conclude the Obtain Simulation Results of Considered Antennas.

S.N.	Parameters	Conventional Antenna	S-Shaped DGS Antenna
1.	ResonatingFre-quency(GHz)	f_1 = 7.0611	f_1 = 7.1361 f_2 =9.1538
2.	Bandwidth (MHz)	$BW1$ =192.2	$BW1$ = 254.4 $BW2$ =177.5
3.	Return loss (dB)	-23.70 at f_1	-16.0659 at f_1 -18.157 at f_2
4.	VSWR	1.1468	1.261
5.	Gain	1.5386	6.826

4. CONCLUSION

Technique for the dual-band operation of microstrip antenna is investigated with DGS (defected ground structure). The DGS is produced by the S-shape structure incorporated into ground plane level. Projected antenna offers dual-band response at a satisfactory return loss & ample impedance bandwidth. This antenna is suitable for F and mobile communications.

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