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Design of Multiband Antenna for WLAN/WI-Max/IMT Application

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Abstract—Fast Growth in demand for Multiband Antenna makes it a special tool for communication. In this paper, the focus has been on showing Antenna Design Technique that wills greatly increases Mobile Communication Capacity and Flexibility. Therefore increase in Wireless communication system going to be Introduce worldwide the demand for wireless devices to support both old and new standard via single antenna becomes compulsory .The most immediate task for the new multiband antenna is to operate in both the new standard frequency band and the already established frequency bands. This is also a requirement on handheld devices to serve Cellular Bands and the new Multiband Microstrip Antenna that operates in Multi Frequency bands to Major Global Communication frequency bands including Bluetooth, Wireless LAN, and WiMax frequency band has been design. Main Objective in design a Microstrip Antenna with Defected Ground Structure (DGS) for Wireless communication. In its most basic form ,a multiband Microstrip Antenna consists of a DGS on one side of the Dielectric substrate and on other side a patch. The patch is generally mode of conducting material such as copper and can take any possible shape. The Multiband Antenna structure which can operate over a band starting from2.15GHZ to 5.77GHZ which covers the band Wireless LAN, WiMax, WiFi and Bluetooth is reported in this thesis. A Coaxial or Probe feed is to be used in this design. The feed point must be located on the pitch where input impedance is 50 Ohms for the resonate frequency. The dimensions of the path and the ground plane are 22x22mm2 and 33x33mm2.The result obtains the Antenna Exhibits Wideband charctestics with minimum loss. In this antenna is simulated i.e. ANSOFT-HFSS by the software High Frequency Structure Simulator (HFSS) is employed to analyze the prepared and simulated results on Return loss, Radiation Pattern and VSWR..

Keywords— WLAN, WI-Max, Defected Ground Structure, Microstrip Antenna, Cellular Bands

I. INTRODUCTION

Presently rapid growing of wireless communication, and is the fastest growing segment of the communication field. There are many government and commercial applications such as mobile radio, Satellite communication and Wireless communication where the weight, size, cost, performance, ease of installation are major constraints. The vision of the wireless communication supporting information exchange between people and devices is the communication frontier of the next few decades. This vision will allow multimedia communication from anywhere in the world. In the last few years, the development of wireless local area networks (WLAN) and WIMAX (Worldwide Interoperability for Microwave Access) represented one of the principal interests in the information and communication field. Also, in the today's environment, technology demands antennas which can operate on different wireless bands and should have different features like low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a chromatic spectrum of frequencies. This technological trend has much focused in the design of Microstrip patch antennas. With a simple geometry, patch antennas exhibits many advantages on other conventional antennas [1]:

- Capable of providing both linear and circular polarization.
- They are cheap to fabricate using modern day printed circuit board (PCB) technology.
- More Compatible with microwave and millimeter-wave integrated circuits (MMIC).
- Ability to observe to planar and non planar surfaces.

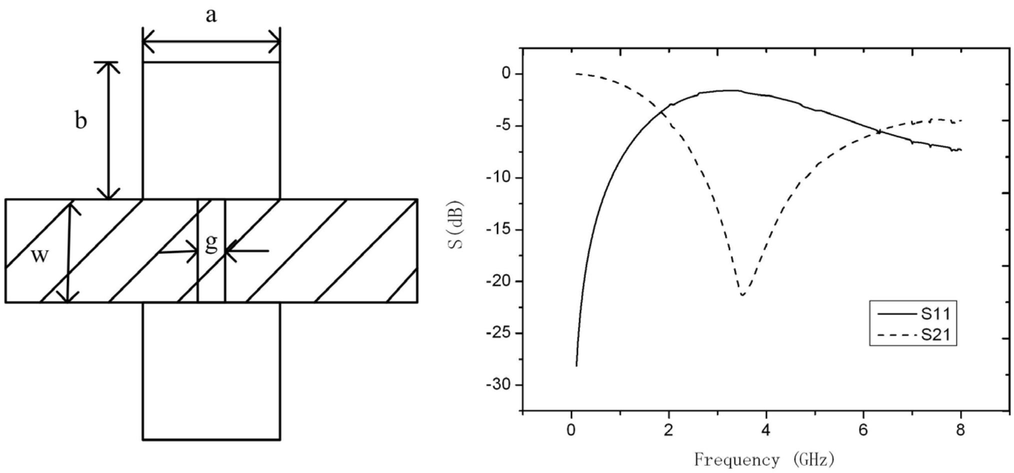
Microstrip antennas (MSA) have some good features written above. Due to these advantages, Microstrip antennas (MSA) are well suited for WLAN/Wi-MAX application systems. Microstrip antennas (MSA) have some disadvantages also like narrow bandwidth, low gain etc. Broad banding is the main problem, for solving this problem there are many broad-banding techniques available.

- Bandwidth can also be enhanced by using parasitic patches.
- By using stacking.
- By using U-slot within the patch.
- Microstrip patch, with inserted slots at one of the radiating edges etc.

Several compact and high performance components have been reported by using the generic structure called the defected ground structure (DGS) for the microstrip line [4]. DGS is analyzed in terms of its superior properties which enable the designers to easily realize many kind of microwave devices which are impossible to achieve with the standard applications. The scope of this thesis, the focus is on the rectangular shaped DGS and its characteristic properties. Likes improves gain, also reduces the reflection coefficient and good impedance match, slow wave and high impedance characteristics are utilized in the design of some microwave devices [5].

II. DEFECTED GROUND STRUCTURED SHAPES

DGS is an etched periodic or non-periodic cascaded configuration defect in ground of a planar transmission line (e.g., microstrip, coplanar and conductor backed coplanar wave guide) which disturbs the shield current distribution in the ground plane cause of the defect in the ground. This disturbance will change characteristics of a transmission line such as line capacitance and inductance. Therefor any defect etched in the ground plane of the microstrip can give rise to increasing effective capacitance and inductance [4]. The dumbbell DGS are composed of two a × b rectangular defected areas, g × w gaps and a narrow connecting slot wide etched areas in back side metallic ground plane as shown in Fig. 1(a). This is the first DGS Fig. 1(b) shows the S-parameters from an EM simulation of a dumbbell DGS. DGSs have the characteristics of stopband, slow-wave effect and high impedance matching



(a) (b)

Figure 1: The first DGS unit: (a) Dumbbell DGS unit (b) Simulated s-parameters for dumbbell DGS unit

It is very important when considering security issues of network, is wormhole attack, which is difficult to detect & can harm by directing important data to unauthorized nodes. [6] [7] [8] During the route discovery process, a wormhole can relay route request and response messages between distant nodes, creating the appearance of shorter routes to destinations. [9] [10] [11] Since the wormhole can be anywhere along a route, a source will have to detect its existence somewhere along the route when a node sets up the route (on-demand) [12].

III. EQUIVALENT STRUCTURE OF DGS

The basic element of DGS is a resonant gap or slot in the ground metal, placed directly under a transmission line and aligned for efficient coupling to the line. Figure 2 shows several resonant structures that may be used. Each one differs in occupied area, equivalent L-C ratio, coupling coefficient, higher-order responses, and other electrical parameters.

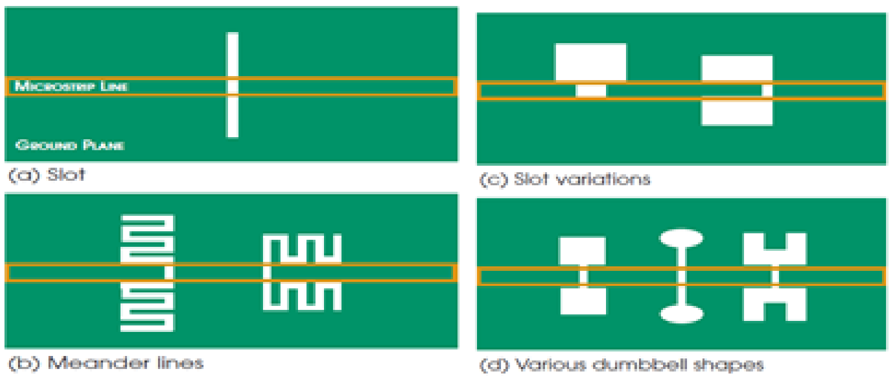


Figure 2: Some common configurations for DGS resonant structures

A user will select the structure that works best for the particular application. The equivalent circuit for a DGS is a parallel- tuned circuit in series with the transmission line to which it is coupled [25] (Figure 2.6). The input and output impedances are that of the line section, while the equivalent values of L, C and R are determined by the dimensions of the DGS.

IV. EXPERIMENTAION

Multiband microstrip patch antenna with DGS(Defected Ground Structure) and DMS(Defected Microstrip Structure) is designed with the coaxial feeding techniques for application at a frequency of 2.4GHz a comparison is made between various parameters like bandwidth, return loss, radiation pattern and voltage standing wave ratio been fetched.

The three essential parameters for the design of a rectangular Microstrip Patch Antenna are:

• **Frequency of operation (fr):** The resonant frequency of the antenna must be selected appropriately. The Mobile Communication Systems uses the frequency range from 900-5850 MHz. Hence the antenna designed must be able to operate in this frequency range.

Table 1: Various frequency range variation for different technologies

Wireless Applications		Frequency Band (MHz)	Bandwidth (MHz)
GSM	GSM 900	890-960	70
	GSM 1800	1710-1805	95
	GSM 1900	1850-1990	140
IMT		2300-2400	100
		2700-2900	200
		3400-4200	800
		4400-4900	500
WLAN standard		2400-2484	84
		5150-5350	200
Bluetooth		2400-2500	100
Wi-MAX standard		2500-2690	190
		2500-2690	290
		5250-5850	600

- **Dielectric constant of the substrate (Єr):** The dielectric material selected for my design is FR4_epoxy which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

- **Height of dielectric substrate (h):** For the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.6 mm..

DESIGNS WITH COAXIAL FEED WITHOUT DGS/DMS:

The geometry of proposed antenna which is coaxial fed for WLAN/WI-MAX/IMT/BLUETOOTH applications is depicted in figure 5.1. The dimensions of the designed antenna with coaxial feed are.

Table 2:- Dimension of the proposed multiband antenna

Ground size	33x33mm
Substrate size	33x33mm
Patch size	22x22mm
Feed size	.6mm

Design of Square Patch Microstrip Antenna for using HFSS structure Simulator Given some other specifications were,

- Dielectric constant (ε_r) = 4.4
- Frequency (f_r) = 2.4 GHz.
- Height (h) = 1/16 Inch = 1.6 mm.
- Velocity of light (c) = 3×10^8 ms-1.
- Loss Tangent (tan δ) = 0.001.

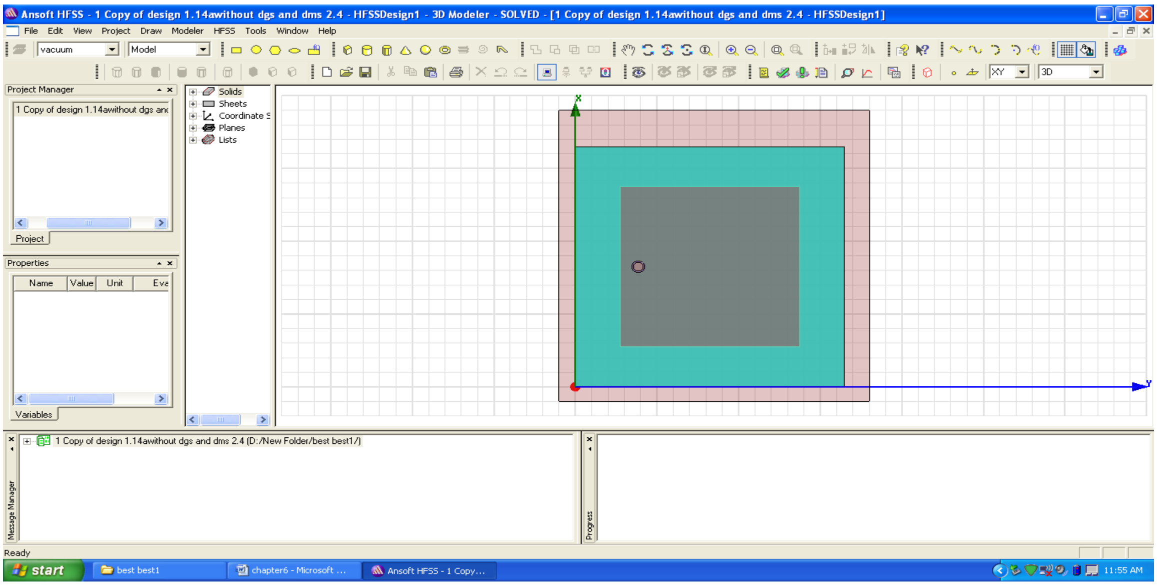


Figure 3: Geometry dimension of proposed antenna without DGS and DMS.

The return loss plot for the designed antenna at 10 dB bandwidth with coaxial feed is shown in figure 4 as below.

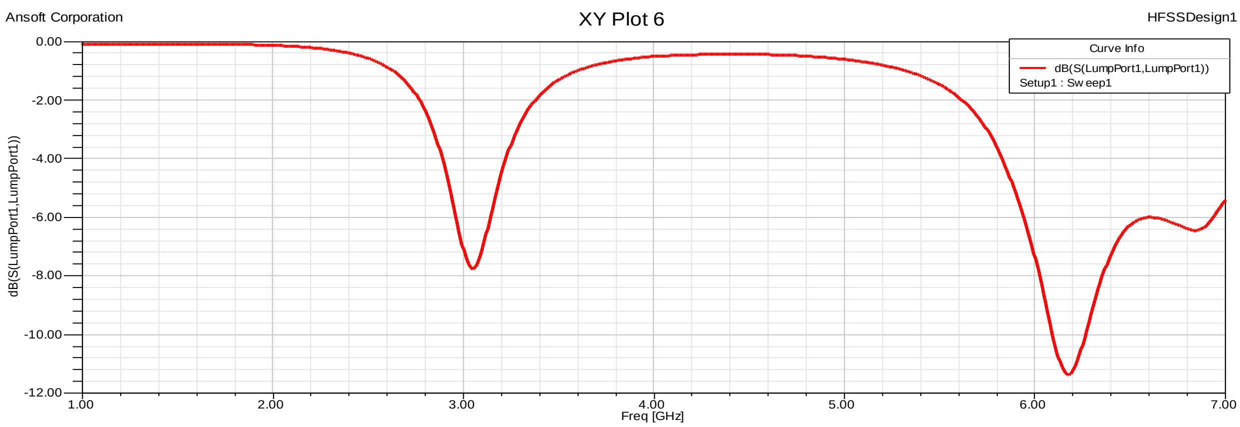


Figure 4: Simulated return loss [S11]

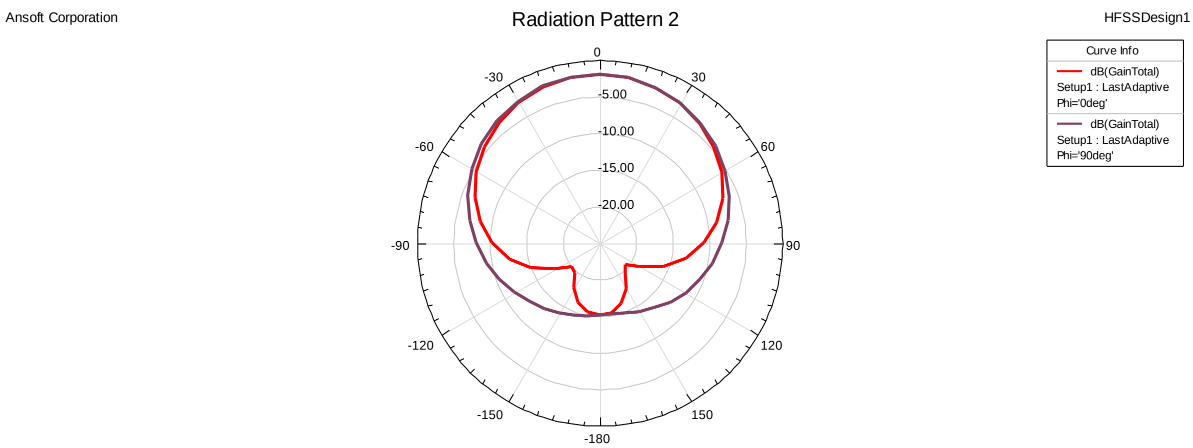


Figure 5: Radiation pattern plot

The VSWR (voltage standing wave ratio) plot for the design antenna (coaxial feed) without using DGS and DMS is shown in figure 6.The value of VSWR is shown in the table 3.

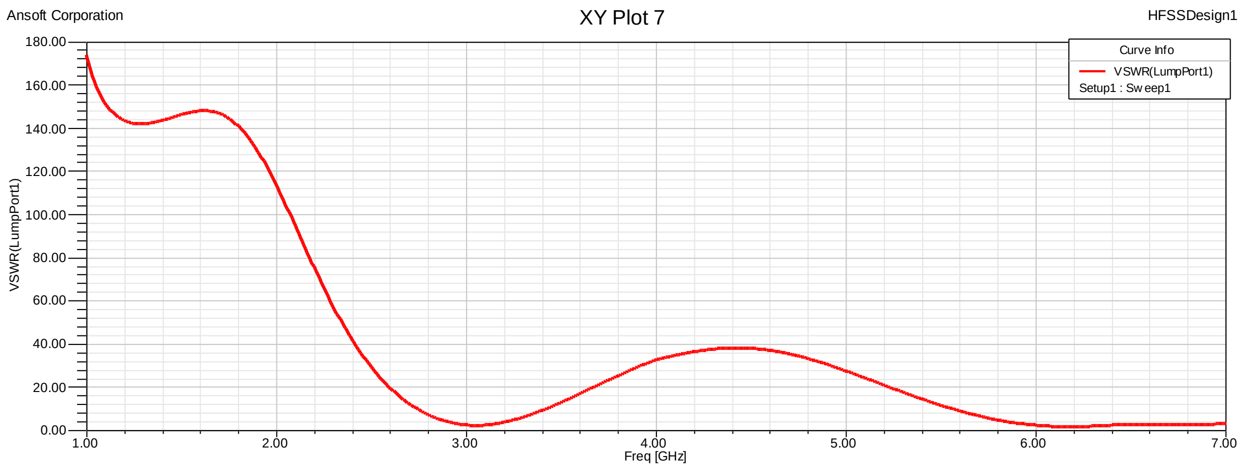


Figure 6:- VSWR Plot

Table 3: Summarized results of proposed antenna without DGS/DMS.

SR.NO	FREQUENCY (GHZ)	RETURNLOSS (DB)	BANDWIDTH (GHZ)	VSWR
1	6.1	-11.42	6.09 - 6.27	1.8

Comparison of return loss plot for each is shown by drawing all return loss plots on a single graph as shown below in figure 7. Hence, coaxial probe feed provides the largest bandwidth when we combine the DGS and DMS. The magnitude of the return loss [S11] at frequency 2.4GHz, 3.1GHz and 5.3 GHz is also less as compare with the other, which is shown in figure 7.

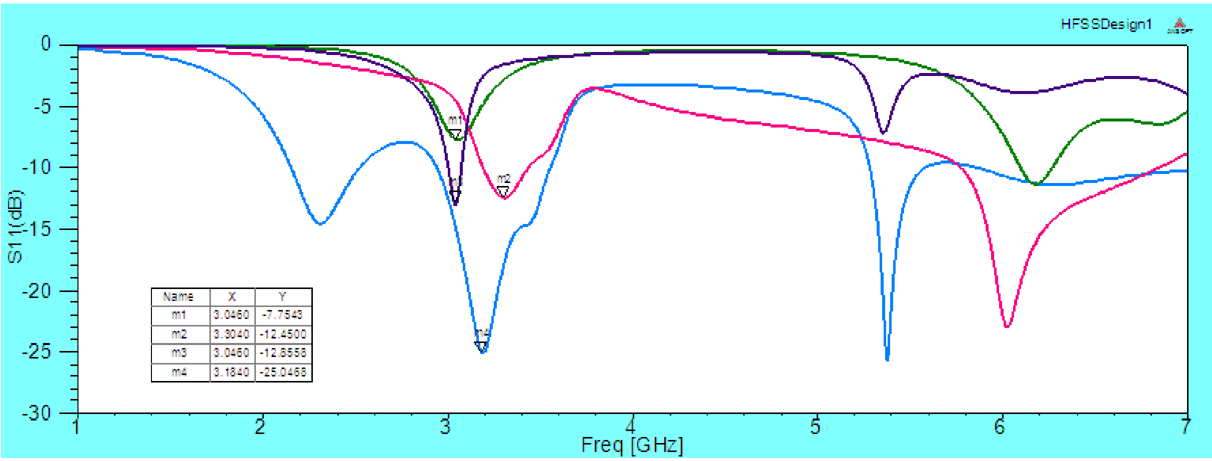


Figure 7: Simulated return loss [S11] after all the combination.

Table 4: Summarized results after all the combination

APPLICATIONS	FREQUENCY (GHZ)	RETURNLOSS (DB)	BANDWIDTH (GHZ)	VSWR
WITHOUT DGSAND DMS	6.1	-11.42	6.09-6.27	1.8
WITH DGS	3.3	-12.41	3.19-3.42	1.62
	6.0	-22.96	5.77-6.83	1.15
WITH DMS	3.3	-12.41	3.19-3.42	1.62
	6.0	-22.96	5.77-6.83	1.15
WITH DGS AND DMS	2.3	-14.41	2.15-2.51	1.46
	3.1	-25.11	2.94-3.55	1.23
	5.3	-25.78	5.28-5.77	1.1

V. CONCLUSION

There has been rapid growth of increasing demand for multi-band antennas. In particular, the focus has been on antenna design technique that will greatly increase mobile communication capacity and flexibility. Therefor increase in wireless communications systems going to be introduced worldwide the demand for wireless devices to support both old and new standards via a single antenna becomes compulsory. The most immediate task for the new multiband antennas is to operate in both the new standards frequency bands and the already established frequency bands. There is also a requirement on handheld devices to serve cellular bands and new communication technologies (e.g. WLAN, Wi-Fi, Bluetooth, Wi-Max). In this, a new square multiband microstrip antenna that operates in multi frequency bands to major global communications frequency bands including, Bluetooth ,wireless LAN ,Wi-max frequency band has been design.

Hence, it has been shown that microstrip antenna can be analyzed both theoretically and experimentally through simulations and fed by coaxial feeding techniques. The square microstrip patch antenna can have multiple resonant frequency i.e. we can design a single microstrip patch antenna for multiple bands. Also, the feeding point selection i.e. proper matching of feed and patch is very important for having desirable features.

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