International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 6, September-October 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

A Review on Recent DGS Techniques on Multiband Microstrip Patch Antenna for Wireless Applications

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ABSTRACT

In this paper, showing review multiband microstrip patch antennas based on many different design techniques & operating principles along with its properties & configurations. Multiband antennas have become attractive due to their inherent feature of being a single solution to many requirements associated with different frequency bands. For the compact communication devices and systems, a multiband antenna with efficient transmission and reception performance is essential. In this review paper, various methods implemented by different researchers to achieve multiband operation in microstrip patch antenna with improved parameters for different standards of wireless communication are summarized.

KEY WORDS: *Multiband, Microstrip patch, DGS, Slot, Multibanding etc*

How to cite this paper: Kirti Mishra | Abdul Samee Khan | Ashish Pouranik "A Review on Recent DGS Techniques on Multiband Microstrip Patch Antenna for Wireless Applications" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-6, October 2021, pp.1539-1544, URL: www.ijtsrd.com/papers/ijtsrd47637.pdf

IJTSRD47637

I. INTRODUCTION

Wireless technology has undergone enormous changes in recent times as regards its frequency of allocation, standards of operation, the device size and techniques to improve and enhance the performance of wireless systems. The demand for wireless devices has greatly increased with the emergence of new wireless standards that are not only compact but also multi-functional in nature1. Antenna is one of the integral parts of these wireless devices. The miniaturization of hand held devices has led to a requirement for compact and lightweight antennas that can be easily integrated to RF packages. Therefore, the demand for antennas covering different homogeneous and heterogeneous wireless communication bands on the same platform has greatly increased. With multi banding features being introduced by different wireless standards, the antenna engineers are met with the challenging task of designing antennas that are efficient, conformable, and compact with low profile and cost and have sufficient bandwidth to support various bands.

These compact antennas are designed using time domain electromagnetic and circuit modeling techniques and optimized using parametric analysis to achieve improved antenna performance. The antenna systems thus obtained are used for practical wireless communications systems such as IEEE802.11a WLAN, IEEE802.16 WiMAX, Bluetooth Industrial-Scientific-Medical (ISM) devices, Global System of Mobile Communications (GSM) and Local Multipoint Distribution Systems (LMDS).

The most suitable candidate for such systems is Micro Strip Antenna (MSA) possessing many characteristics like small size, low profile, conformable, and cost effective Improving these parameters and creating multiband antennas are becoming main design considerations of MSAs for wireless applications.

Many techniques for antenna miniaturization with multiband functionality have been proposed in literature. This paper aims to present a comprehensive review of the various techniques and designs for compact multiband microstrip antennas.

Microstrip patch antennas are very useful as planar antenna structure having advantages like low profile, low manufacturing cost, low power requirements etc. A patch antenna hence now's required to be utilized in different fields of science & technology for various applications. Many antenna applications cover different frequency bands of the spectrum & there's a requirement to style an antenna which may perform adequately for several frequency bands without changing the configuration or structure of the antenna [1]

II. REVIEW OF LITERATURE SURVEY

With fast bounce toward greater era of technology, a definitely linked surroundings of devices is no longer a theoretical concept. With enlarge in wide variety of offerings presented in single wi-fi device, a demand of compact multiband antennas has augmented. Microstrip antennas make the first-class in shape for the present-day eventualities of compact sized and mild weight devices, as these are small and conformal on distinctive constructions [1].

The microstrip antenna is inherently a single band antenna with low bandwidth and low acquire values. Different methods such as the use of one of a kind patch shapes, meandering & slotting, imposing Defected Ground Structures (DGS) have been proposed in the literature for introducing multiband operation and enhancing the different parameters of patch antennas which are mentioned in this paper.

For instance, in [2] the authors have applied approach of slotting the patch and floor aircraft for introduction of multiband operation, as proven in fig.1. The c-shaped slot presents a resonating frequency at 5GHz and a mixture of T and I fashioned DGS presents resonating height at 3.4GHz and 7.47GHz with substantial return loss as discovered from fig. 1b. The strategies carried out make the proposed antenna eligible for multiband operation via masking C-band, WiMAx and Wifi bands.

A easy method of slotting the radiating patch of antenna (fig.2a) is proposed in [3]. In this paper the L. prasadet.al. has carried out multibanding by means of the introduction of more than one slots at the radiating and non- radiating edges which leads to technology of 4 exclusive resonating frequencies at 1.8Ghz, 3.6Ghz, 4.53Ghz, 5.73Ghz making it operable over the GSM band and different non cell WiMAX and WiFi/ WLAN bands.

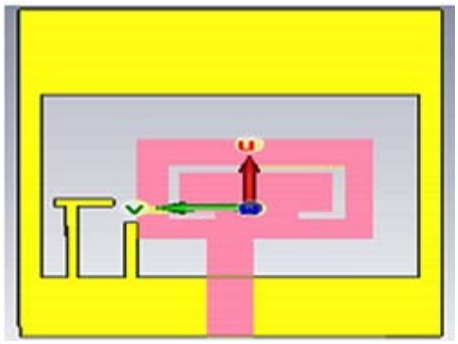

Fig.1a: Proposed Antenna with C-slot and DGS[2]

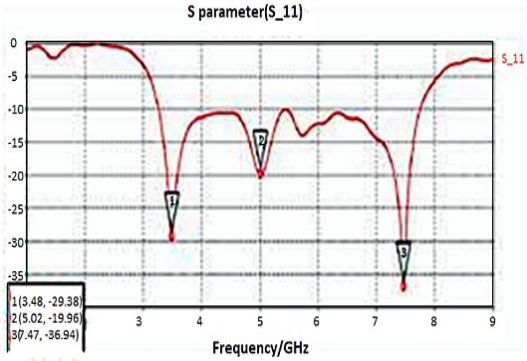

Fig. 1b: Return loss of the proposed antenna

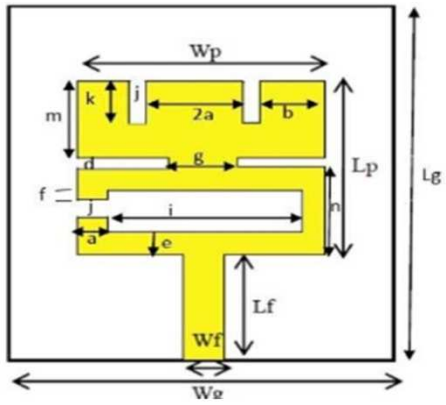

Fig.2a: Proposed Antenna with multiple slots [3]

The cost of return loss and bandwidth justify the antenna layout parameters(fig.2b). The authors in [2-3] have simulated the antenna graph on Computer Simulation Tool (CST). The proposed patch antennas in [2-3] have been carried out on FR-4 substrate with thickness 1mm and 1.6mm respectively.

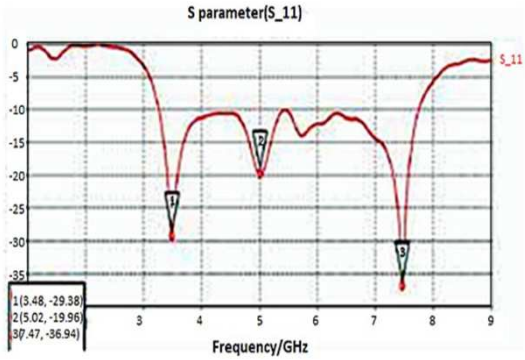

Fig. 2b: Return loss of designed antenna at different bands.

As shown in fig.3a, the authors in [4] have proposed the patch antenna loaded with C-shaped and L-shaped slots. The FR-4 primarily based patch antenna is simulated on HFSS software. The rectangular antenna is designed for resonating frequency 3.4GHz with substrate thickness of 1.57mm. The C-shaped slot introduces a 2nd resonating height at 6.67GHz and L-shaped slots end result in the 0.33 resonating top at 7.39 GHz making antenna overlaying C and X-band simultaneously. The S11 parameter has been proven to confirm the effects in fig.3b.

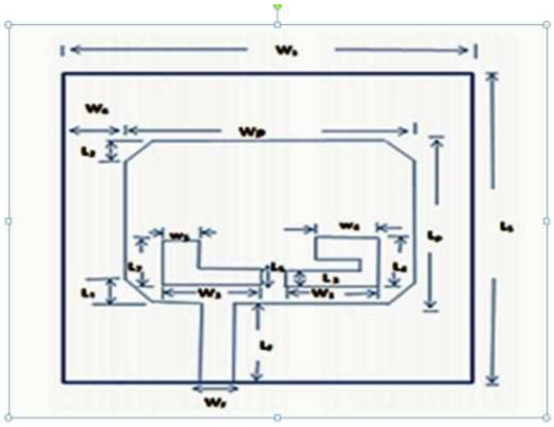

Fig.3a: Geometry of proposed patch antenna with C -shaped and L- shaped slots [4].

P. Pujitha and G. Guru Prasad have proposed a multiband patch antenna diagram in [5] (as proven in fig.4a). The authors have implanted more than one inverted L-shaped slits on the radiating patch of the antenna.

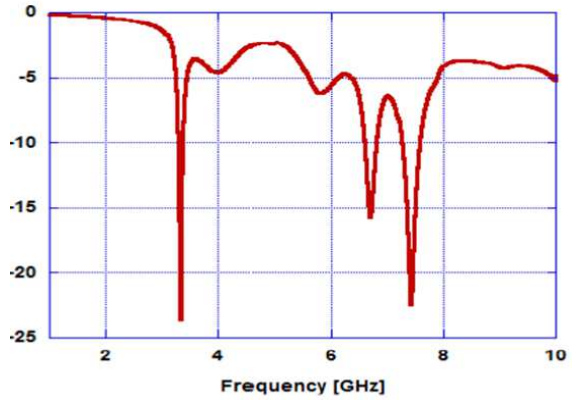

Fig. 3b: Simulated S11 for proposed antenna

The slits in the antenna shape account for 4 resonating frequencies at 0.9GHz, 1.8GHz, 2.4GHz and 3.5GHz which can virtually be considered to have sizable price for S11 parameter which is properly past -10dB for the a number bands generated in fig.3b.

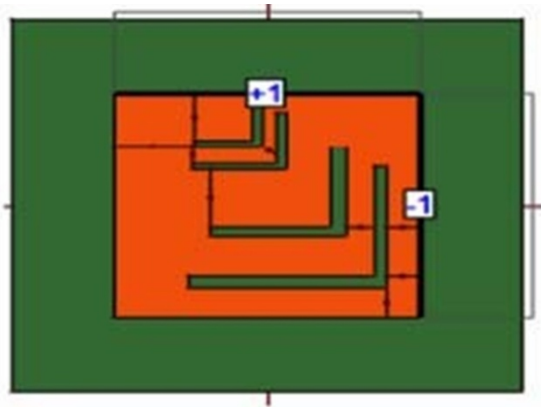

Fig.4a: Inverted L-shaped slotted Patch antenna [5]

As proposed in [2-5], a aggregate of slotting and DGS methods have been applied for introduction of multiband operation. However, the proposed strategies do now not grant any bandwidth enhancement. Also, the buildings are much less compact. Thus, the state-of-the-art tendencies in structuring multifrequency antennas with basic overall performance enhancement of patch antennas are mentioned next.

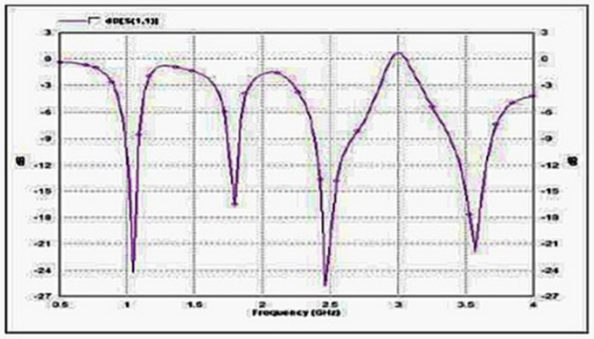

Fig 4b: Return loss of the proposed Multiband Antenna.

III. DIFFERENT TECHNIQUES & CONFIGURATIONS

The subject of lookup of multifrequency antennas for homogeneous as nicely as heterogeneous wi-fi bands for a number of purposes has grow to be very sizable and new developments and methods for designing antennas that can aid conversation in many bands at the identical time are growing at a very quickly rate. This additionally takes into consideration different ideal traits which enhance the antenna overall performance like small size, elevated reap and bandwidth and radiation characteristics. Here are enlisted a few methods which generate a couple of resonances and beautify the overall performance of microstrip antennas:

A reconfigurable paper substrate-based antenna has been proposed in [6]. The fantastically compact antenna helps multiband operation 1.5 and 4GHz vary catering to a wide variety of licensed wi-fi bands like GSM 1800/1900, Personal Communication System

(PCS), Digital conversation Systems (DCS), Universal Mobile Telecommunications System (UMTS), LTE bands. It additionally covers the non-cellular ISM bands like Wireless LAN / WiMAX, Satellite Digital Multimedia Broadcasting (S- DMB) bands. A distinctive design of the proposed plan is as proven in fig.5a. The primary radiator has been designed to function at 3.4GHz whereas the L-shaped and U-shaped radiators help 1.9 and 2.4 GHz resonating frequenciesThe proposed antenna has an compact shape with dimensions of 30×40×0.44 mm3.

As in [3], a multiband double layered microstrip patch antenna is presented, consisting of two tri-slot elements, which are fed by a proximity coupling from a particular feeding structure located on another layer. The antenna works at four frequency bands, which is achieved through forming the antenna patch by three slots. Whereas low gain of approx. 1.13dBi makes it less applicable in practical use. In [4], one microstrip G-shape antenna for multiband operations is proposed first & so as to extend its gain; a uniform dual-element patch antenna is additionally proposed for an equivalent band. The array elements are fed by just one feed network, which improves the impedance bandwidth of the 2 element G-shape microstrip antenna.

In [5], a frequency tunable dual-band Multi ring microstrip antenna fed by an L-probe with varactor diodes is proposed. so as to tune operating frequencies of the multi-ring microstrip antenna, two varactor diodes are mounted on each ring patch. An L-probe placed under the ring patches is employed to feed them. In [6], a replacement microstrip monopole antenna with triple band coverage capability is proposed. to realize multiband characteristics, ground plane & feed line has been modified. Finally, inserting PIN diodes on the bottom plane of the antenna has led to 3 different desirable switchable bands of operation.

In [7], the authors have applied a mixture of methods i.e. DGS and implementation of an Artificial Magnetic Conductor (AMC) shape for keeping the multiband operation with miniaturization of the patch antenna as well. The proposed shape , helps C and X-bands with resonating frequencies at 5.5GHz, 6.81GHz and 9.3GHz which is tested from the S-parameter plot in fig6b. The proposed set of strategies have decreased the patch place by using 53.4%.

The twin band antenna proposed by using S.K. Vijayet.al. in [8] is excellent healthy for WLAN and WiMAx applications. The bow-tie formed radiator is loaded with break up ring resonator (SRR) to supply multiband operation except compromising with compactness of structure. The dimensions of FR-4 primarily based patch antenna are 50×28×1.6 mm3. The placement of SRR's close to the triangular element of the radiator has led to an increased Voltage standing wave ratio (VSWR) larger than two Also, it covers a huge vary of frequencies from 1.7 GHz to 3.58 GHz, as proven in fig. 8b, making it appropriate for purposes which require excessive bandwidth

The fractal geometry-based antenna has been proposed through Xiaoying Ranet.al. in [9]. The antenna has been carried out on FR-4 substrate. The authors have applied binary branch geometry (as proven in fig.8) to obtain multiband operation and miniaturization of the proposed design. The layout covers six-frequency bands namely, TD-SCDMA, WCDMA, CDMA2000, LTE33-41, and Bluetooth frequency bands, and (4.9–5.5 GHz) for WLAN frequency band. The typical shape has a compact dimension of 50×40×1.6mm^3.

In [7], a multiband MPA incorporating inverted L & T-shaped parasitic elements is proposed to hide 3 bands. an extra refinement of the multiband microstrip antenna concept involves adding a stub, which increases the antenna size, and a slot, which produces the radiation diagram of the harmonics. Multiple bands covered are future Evolution time-division duplexing number 34 (LTE TDD No. 34: 2.0175 GHz), wireless local area network (WLAN: 2.45 GHz), and Worldwide Interoperability for Microwave Access (WiMAX: 3.5 GHz) bands. Inverted L & T-shaped parasitic elements that resonate through perturbation & coupling with the MPA are utilized in this design.

In [8], DGS (Defective Ground Structure), which consists of 4 arms spirals is introduced & produces 5 resonant frequencies. Microstrip patch antennas, however, suffer from variety of disadvantages because the patch length is around half wavelength and therefore the antenna resonates at a fundamental TM010 frequency. DGS method is additionally used for size reduction also as multi-band operations. Inset feed is employed as feeding technique for this antenna design. Maximum gain achieved is 4.5dBi.

TABLE I. COMPARISON TABLE

Ref no.	Technique used	Resonance Frequency	Return Loss(S11)	Size	Maximum Gain
[1]	Defected Ground Structures and Slotting of patch	5GHz, 3.4GHz and 7.47GHz	19.96dB , -29.38dB and - 36.94dB	18 x 25 x 1 mm3.	4.5dB
[2]	multiple slots at the radiating and non- radiating edges	1.8Ghz, 3.6Ghz, 4.53Ghz and 5.73Ghz.	- 23.33dB., -28.105dB, - 18.8dB and -18.07dB.	70x 60x 1.6mm3	5.71
[3]	Slotting	3.32GHz, 6.67 GHz and 7.39 GHz.	-23 dB, -15.74 dB and -22.4dB	25× 37× 1.575 mm3	Not specified
[4]	Rectangular slots on the patch	0.9GHz, 1.8GHz, 2.4GHz, 3.5GHz	-25dB, -21dB, -24 dB and -16dB	Not specified	5.1dBi
[5]	L and U shaped strips and PIN diodes	1.9GHz, 2.4GHz and 3.4GHz	-25dB, - 15dB and -20dB	30 x 40 x 0.44 mm3	5.1 dBi
[6]	AMC with Concentric Ring FSS and DGS	5.5GHz, 6.81GHz and 9.3GHz	Beyond - 35 dB for all bands	25× 24.86 mm3	6.76 dBi
[7]	SRR DGS	2.45GHz, 3.5GHz and 4GHz	-23dB and 30.5dB	50x28mm2	4.2 dBi
[8]	fractal bionic structure with resonant coupling technique	1.85–2.9 GHz and 4.9–5.5 GHz	-25dB and -17 dB	50 x40 × ×1.6mm3	Not specified

The effectiveness of the techniques used to achieve multibanding along with the improvement of other parameters have been summarized and presented as a comparison table 1.

DGS consists of periodic or non-periodic defects etched beneath the planar cable (e.g., micro strip line, coplanar etc) within the ground plane. It alters the shield current distribution by changing line capacitance and inductance and confines it to the periphery of the perturbation

IV. CONCLUSION

Various methods used to gain multibanding such as slotting and DGS have been proposed in [2-5]. These methods are easy to put in force and grant the required multiband operation at the favored wi-fi bands. The multibanding reasons the antenna to cowl a range of purposes and offerings simultaneously. The strategies proposed in [6-9] are a aggregate of slotting, DGS and SRR implementation. In addition to multiband operation, these mixed methods furnish the enhancement of bandwidth in the a couple of resonant bands obtained. Also, miniaturization of the antenna constructions is finished to an extent which brings about the compactness in the gadget size. These sorts of multiband antennas are of excessive demand currently which can assist transmission and reception in more than one wi-fi standards, services and structures.

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