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Dual Band Compact Hexagonal Microstrip Antenna with Quadrangular Slot and I Shaped DGS

Banuprakash R, Hariprasad S A

Abstract*: Here an hexagonal printed antenna is reported. The antenna has measurement volume of 800 mm³. It operates at the frequencies 2.9 GHz, and 6.3 GHz with S_{11} of -10.17 dB and -14.49dB respectively. It has produced acceptable gain of 2.065dB for 2.9 GHz and 3.45dB for 6.3 GHz. The frequencies obtained are useful for aeronautical radio location and satellite applications. The antenna is designed using HFSS software and tested using ZVH vector network analyzer.

***Keywords* : Dual band, radio location, HFSS, VNA.**

I. INTRODUCTION

The designers come across many challenges due to the intense progress of contemporary wireless networks and the pertinent applications [1]. Multiband antenna has become proficient in current mobile communications. Incorporating several frequencies into a movable device is done through ample significant efforts [9].

Due to its unique features printed antenna is the most prevalent in today's microwave communication . It consists of radiating metal on one side and metal groundplane on the other side, in between these two sides a dielectric medium is present. It devises the amenity of being low outline, low cost, simple structure to construct[3]. Patch antenna offers linear or circular polarization with multiple frequency operation.[6].

To acquire the required frequency, with S_{11} below -10dB , to improve the bandwidth , to improve the gain and for better radiation patterns slots can be made either on patch and on ground plane which is defective ground structure(DGS) [2][10].

Different structures of patch can introduce wider bandwidth like U shaped slot and E shaped radiating element [4]. Lower dispersion, wider bandwidth and less radiation loss can be exhibited by slot antennas than microstrip antennas. The connection of active and passive elements in series and parallel for improving the gain becomes easy if the feed is coplanar waveguide. [14].

Slots of an antenna can be of different shapes like rectangular, square, circular. A wideband response can be obtained by combination of patch resonance and the resonance created by slot.[11]. The variations of slot dimensions provide more effects on the Circular Polarization and minute impact on impedance [7].Fractal geometry can also be used to improve impedance bandwidth of printed antennas by making similar type of slots with different measurements [12][13].

The slots are not only responsible for producing the multiple frequencies by disturbing the current distribution but also improves the impedance matching of an antenna. For this a small portion of metal portion can be etched based on the distribution of current[15]. To enhance the performance of an antenna the slot dimensions play a vibrant role . The substrates with higher value of dielectric constant are vital in miniaturizing the antenna size[8].

II. ANTENNA GEOMETRY

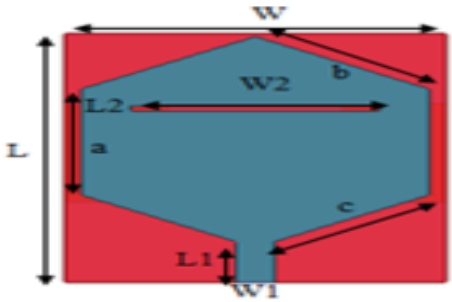

Figure1.Front View

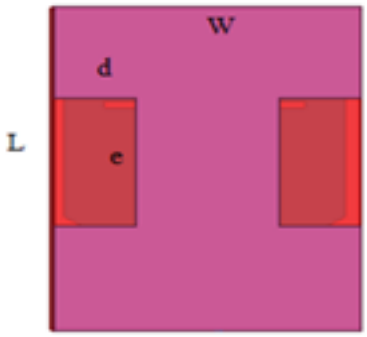

Figure2. Back view

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* Correspondence Author
Banuprakash R*, Electronics and Telecommunication Engineering, BMS Institute of Technology and Management, Bengaluru, Visvesvaraya Technological University, Belagavi, India. Email: r.bhanuprakash@bmsit.in.
Hariprasad S A, Electronics and Communication Engineering, School of Engineering and Technology , Jain University, Bengaluru, India.

L	25mm
W	20mm
L_1	4.1mm
W_1	2mm
L_2	0.5mm
W_2	13mm
a	6mm
b	5mm
c	5mm
d	5.3mm
e	10mm

Table 1: The measurements of the design

III. SIMULATED RESULTS

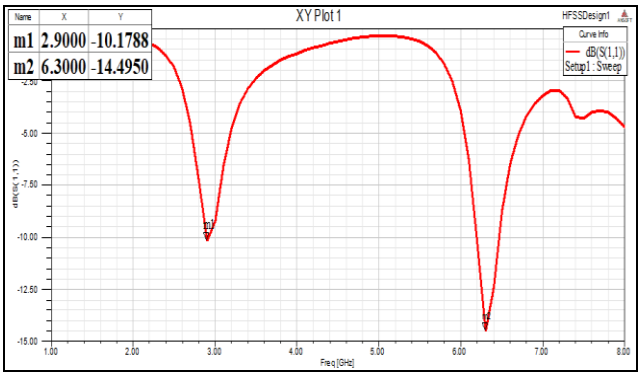


Figure3. S_{11} vs Frequency

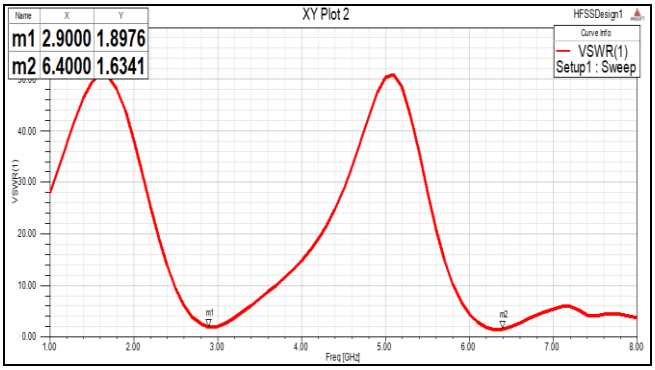


Figure4. VSWR

Parametric Analysis:

The antenna with hexagonal patch generated a frequency of 4.2GHz with a return loss of -10.45 dB. To transform it as multiband antenna a rectangular slot of 0.5x13mm^2 is made on the patch, frequency obtained was 6.3GHz. The return loss is minimized through I shaped defective ground and slot on patch with dimension of 1x13mm^2. The frequencies obtained were 2.9 and 6.3 GHz correspondingly.

Steps	Structure		Frequency (GHz)	S_{11} (dB)
1.	Hexagon patch		4.2	-10.45
2.	Patch with	0.5x13 mm^2	6.3	-10.10
	slot dimension	1 x 13 mm^2	3.2 6.5	-5.81 -7.13
3.	With slot on patch and DGS		2.9 6.3	-10.17 -14.49

Table 2: Design steps

GAIN:

The plot of gain for above mentioned frequencies are as follows :

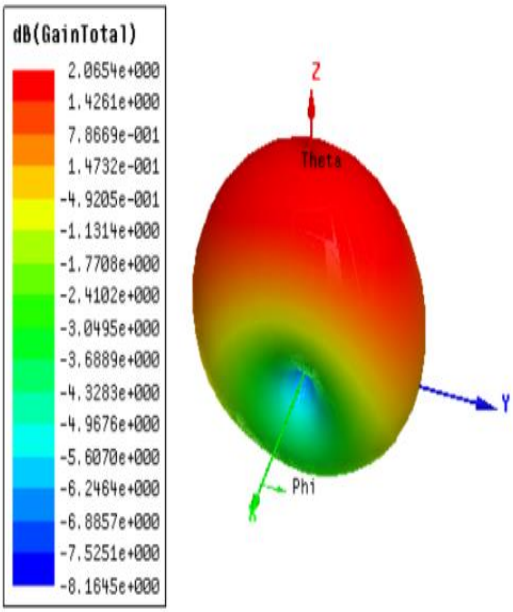


Figure.5: For 2.9GHz

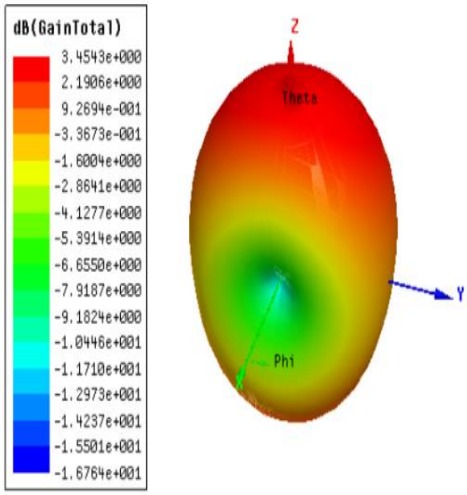


Figure.6: For 6.3GHz

IV. FABRICATED ANTENNA

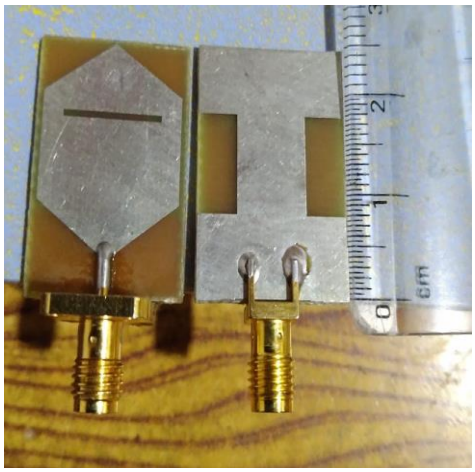


Figure7: Fabricated Antenna

V. MEASURED RESULTS

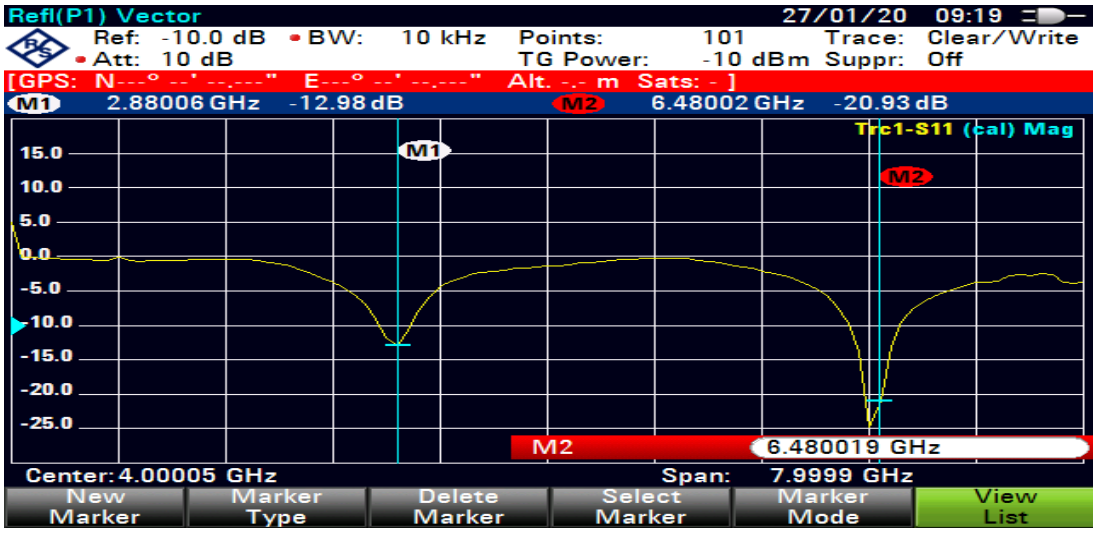


Figure 8: Measured S_{11}

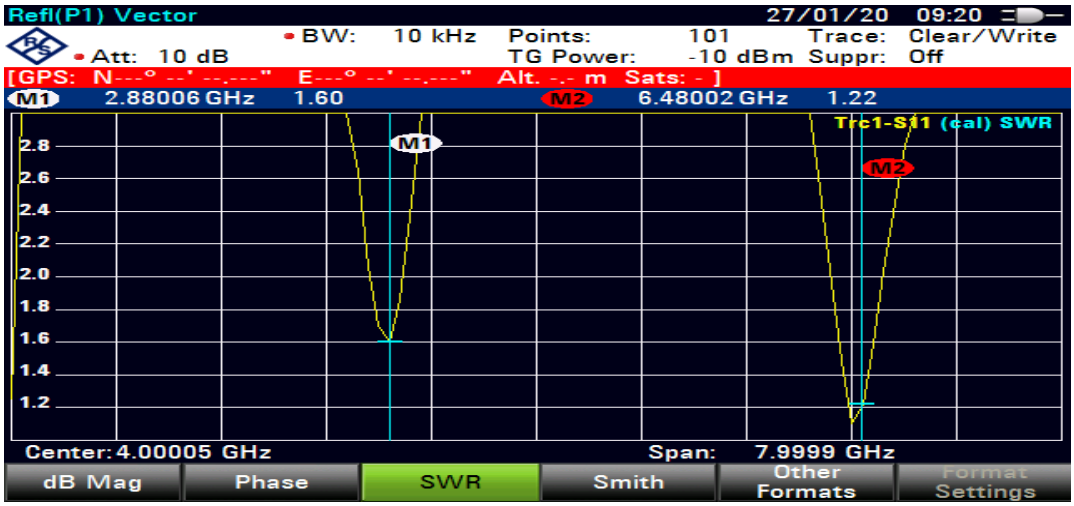
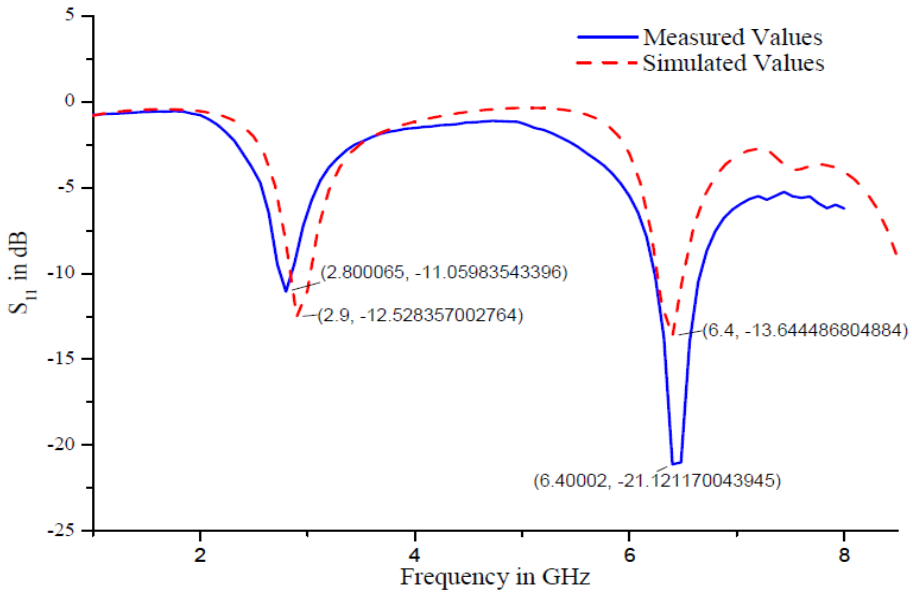


Figure 9: Measured VSWR

SIMULATED Vs MEASURED RESULTS



Parameters	Simulated		Measured	
Frequency in GHz	2.9	6.3	2.88	6.48
S_{11} in dB	-10.17	-14.45	-12.08	-20.93
VSWR	1.89	1.63	1.6	1.22

Table3: Simulated Vs Measured results

V. RADIATION PATTERNS

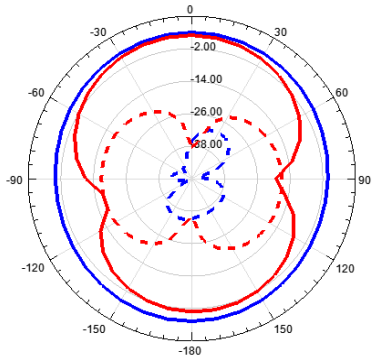


Figure 10: For 2.9GHz

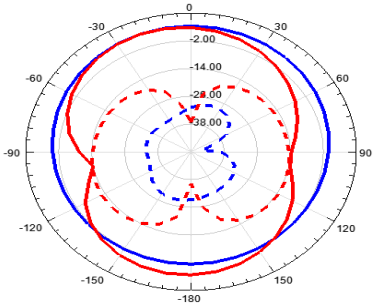


Figure 11: For 6.3GHz

COMPARISON OF PROPOSED ANTENNA

Ref. no.	Total area (mm^3)	Operating bands (GHz)
[5]	34x30x1.6	5.8
[4]	135x135x1.2	1.85/2.19/ 2.5
[2]	50x33x0.8	2.4/3.5
[3]	50x33.5x1.6	1.9 / 2.8/5.1
[1]	26x32x1.6	3.4/6.7
[15]	24x30x1.5875	2.84/ 1.54
Proposed antenna	25x20x1.6	2.9/6.3

Table4: Comparison with literature

VI. CONCLUSION

The insertion of slots produced multiband frequencies. The defective ground expands the performance of antenna by reducing standing wave ratio.

The proposed antenna operates at 2.9GHz and 6.3GHz with S_{11} of -10.17dB, and -14.45 dB respectively. As the size reduces there is a challenge to produce good gain.
With the help of I shaped DGS the gain obtained is acceptable for the miniaturized antenna with total volume of 800 mm^3

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AUTHORS PROFILE

Banuprakash R presently working in Electronics and Telecommunication Engineering department, BMS Institute of Technology and Management, Bangalore, India, He is BE, M.Tech, and pursuing Ph.D in the field of RF communication. He published around 15 research papers on antennas in international journals and conferences. He has got Best Paper award twice for the research papers in IEEE conferences. Guided 20 UG projects. He was Resource Person for the training program on RF communication at different institutes.

Hariprasad S A completed B.E degree in the year 1991, M.E in the year 2000, He Completed PhD degree in the year 2011 and two additional highest degrees, doctor of science degrees in the year 2013 and 2014 for the post-doctoral research work on communication and embedded systems.Working with Department of Electronics and Communication Engineering, Jain University, Bangalore. He also established industry supported labs and served as visiting professor for various reputed colleges in Bangalore. He executed funded projects tuning to 1 crore rupees for various government funding agencies. Guided 34 PG projects, 40 UG projects and guiding 8 PhD students. He has delivered expert talk in conferences and workshops in the area of embedded systems and Microwave Engineering domains. Worked as main Coordinator as well as mentor for input/output and outcome Based Education Accreditation models. Won awards for best teacher for publishing international conference paper and text book. He has published 60 research publications in both International and National Journals and presented papers in National and International conferences. He has written text book on Advance Microprocessor.