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ENHANCED BANDWIDTH OF MCROSTRIP PATCH ANTENNA FOR WIRELESS APPLICATIONS

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ABSTRACT

The Microstrip antenna is extensively used in wireless applications above 1GHz frequency. It is low profile antenna used in Mobile, Aircraft, Medical applications. The bandwidth of microstrip antenna is narrow. In this paper 1.6mm, FR-4 microstrip antenna without and with multiple DGS is designed, simulated with HFSS , fabricated and measured performance of bandwidth and other parameters, also compared. Results shows that bandwidth of 198MHz from 100MHz, a 98% enhancement in bandwidth is achieved. There is also performance enhancement of VSWR and $S_{11.}$

Keywords— Microstrip Patch Antenna, Wireless communication, Multiple DGS, HFSS, Network Analyzer

I. INTRODUCTION

Communication Engineering plays a vital role in progress of human society and developments. Wireless Communication is most important part of Electronics and Communication Engineering. Antennas are very vital part of Communication Engineering. Microstrip Antenna are widely used in wireless communication above 1GHzfrequency.

Microstrip antenna have a no. of advantages such as low profile, easy to fabricate and easy to interface with ICs. The Microstrip antenna working can be explained with various methods described in [1-2] . It is used aircraft, satellite, mobile and medical applications. The disadvantages of Microstrip Patch Antenna (MPA) are narrow bandwidth and low gain. Various research groups are working on these issues. The bandwidth enhancement techniques are described in [3-12].

The bandwidth of MPA can be enhanced by modifying shapes and dimensions[3]. The most literature describes design optimization microstrip antenna bandwidth on size and shape optimization. The MPA bandwidth depends on width of patch and thickness of dielectric material used [4]. The material optimization is not carried out much. This is because inhomogeneous material fabrication problems and very less access to analysis tools. The bandwidth enhancement by using different substrates optimum topology or material design of dielectric substrate is described in [5-7] for a MPA. The bandwidth enhancement using parasitic elements is described by author in [8]. Reducing size of antenna and increasing bandwidth using Transformation electromagnetics is explained in [9]. The method of using parallel resonant strip for increasing bandwidth of planar tablet computer antenna is described in[10].

For a Probe feed U slot MPA, Characteristics mode analysis of 3 different methods, with experimental results is described in [11]. The 3 techniques are ReSF, Dimensional invariance (DI) and DI ReSF. On critical

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parameters such as slot thickness, probe radius, variation of fed point Characteristic mode analysis, on characteristics of U-slot MPA are discussed. Enhancement of impedance bandwidth for microstrip monopole slot antenna is explained in [12]. Compared to these methods proposed antenna gives higherbandwidth

In this paper microstrip patch antenna MPA is designed for 4GHz, with substrate height of 1.6mm of FR-4 with dielectric constant of 4.4. The bandwidth of 1.6mm is compared with bandwidth of multiple DGS method implemented to enhance the bandwidth. The bandwidth enhancement and other performance parameters are compared. The paper is organized as follows. The proposed antenna design is explained in section II. Simulation results of FR4 antenna and fabricated antenna measurements & testing are given in Section III. Bandwidth enhancement and performance parameters of reference antenna and modified FR-4 Fabricated antennas compared and discussed in section IV. Conclusion is described in section V.

II. DESIGN OF PROPSEDMPA

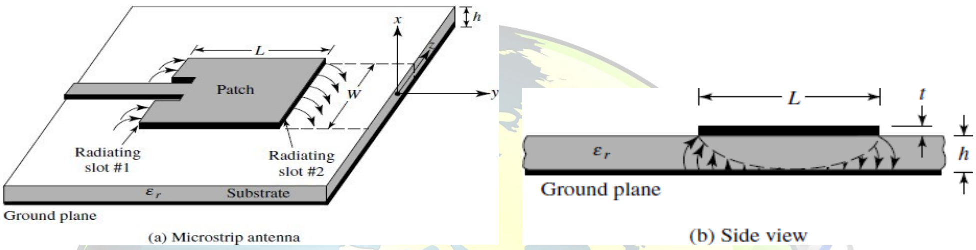

Figure 1 : Microstrip Patch Antenna structure

The structure of Microstrip Patch Antenna is shown in Figure 1. In MPA the length, width & height are design parameters. Length is the resonating parameter. The width is designed such that it is larger than Length. Generally W is equal to 1.5times of Length is selected in normal conditions. Length, Width and feeder dimensions are design parameters that are calculated as explained below.

A. Calculating Length & width of Antenna.

A Rectangular microstrip patch antenna for resonating frequency of 4GHz with FR 4 of thickness of 1.6mm is designed by steps of following formulae. [1-2]The length and width calculations are given below.

√ ------------- (1)

√

Where C is speed of light , It is 3 X 10^8 m/s fr is Resonating frequency
Er is the dielectric constant of substrate. Normal value is 4.4 for FR-4.

The effective dielectric constant is calculated by

() √)) ----- (2)

The extended length is calculated by

= 0.412*h [(Eeff +0.3) (W/h + 0.264) / (Eeff - 0.258) (W/h + 0.8)] ----- (3)

The Length L of microstrip antenna is calculated by

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( ) ---------------------- (4)
√

After calculations, the dimensions of microstrip antenna with FR4 dielectric material, MPA are tabulated in the Table 1.

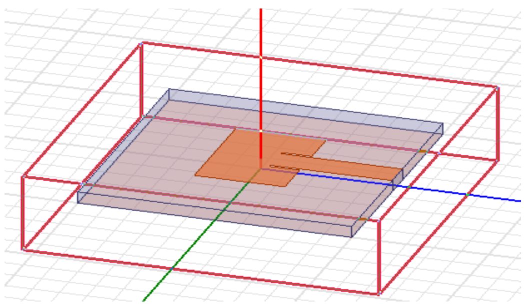
Table 1 : MPA dimension with FR-4 dielectric materials.

Sl. No.	Description	Width - W in mm	Length – L in mm
1	FR-4	22.6	16.6mm

B. FeedingTypes

There are 2 types of feeding for MPA [1-2]. Contact type and non- contact type. In contact there are 2 types namely Microstrip Line feed and Probe feed. In Non-contact type Aperture coupled feed and Proximity coupled feed. In this paper Microstrip line feed is used. The Feed point and Feeder dimensions are calculated asin[1].

III. SIMULATION, TESTING &MEASUREMENTS.



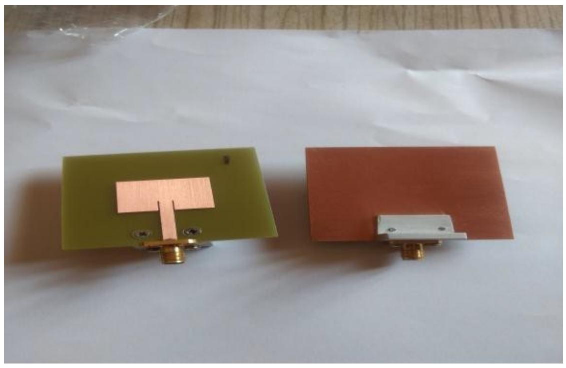


Figure 2 : MPA modeling simulationusingHFSS. **Figure 3 : Patch and Ground view of fabricated MPA.**

MicrostripPatchantennadesignedwith1.6mmthicknessofFR-4,ismodeledandsimulatedusing HFSS is shown in figure 2. Figure 3 shows the patch and Ground plane of Fabricated MPA.

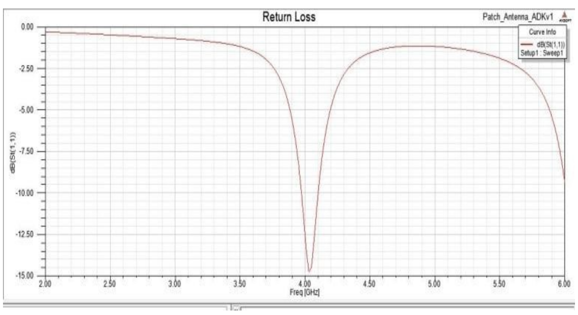
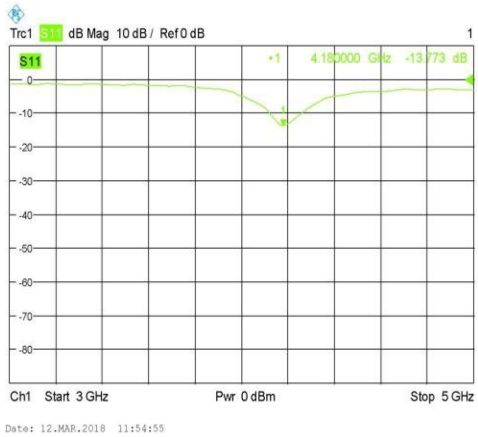


Figure 4 : Simulation of S_{11}withHSS **Figure 5 : The Fabricated MPA S_{11}**
measurement using NetworkAnalyzer



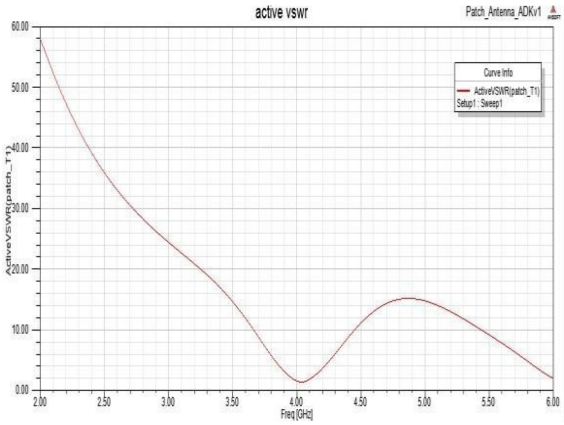
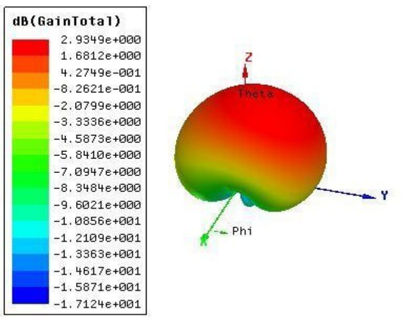


Figure 6 : Ref MPA S_{11}measurementresult

Figure 7 : Ref. MPA VSWR simulationresult

Figure 8 : Ref. MPA VSWRmeasurementresult

Figure 9 : Ref MPA Impedance and Smith chartresults.



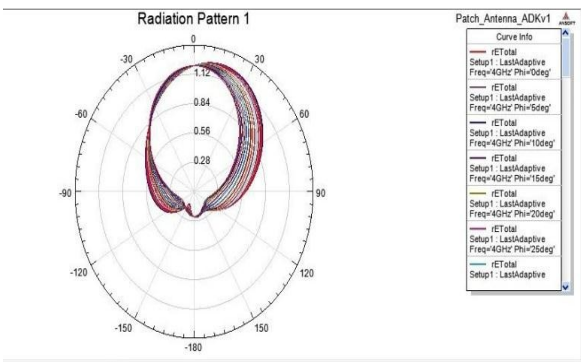


Figure 10 : Ref. MPA 3D gainsimulationresult

Figure 11 : Ref MPA Radiation pattern simulationresult Figure 4 shows the simulation results of S_{11} and Bandwidth of Reference MPA. The value of S_{11} and-
10dB bandwidth with simulation are -17dB and 100MHz. The HFSS simulation value of VSWR and impedance of reference MPA are 1.6 and 50 ohm. Figure 5 shows the actual fabricated MPA measurement with Network Analyzer. Figure 6 shows the measurement result of S_{11} and -10dB bandwidth of reference MPA. The measurement values of

S_{11} -14dB and -10dB bandwidth is equal to 100MHz. The Figure 7 & Figure 8 shows the VSWR simulated and measured results. Figure 9 shows impedance Smith chart measurement result characteristics of reference MPA. The values of simulated and measured VSWR are 1.6 and 1.58. Measured input impedance is 60 ohms. Figure 10 shows the simulated 3D gain characteristics and Figure 11 shows the simulated radiation pattern. The measured results are matching with simulation results

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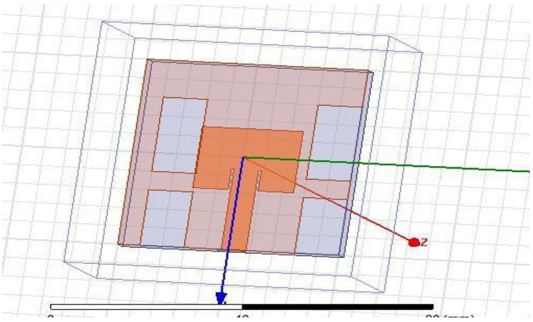

Figure 12 : Multiple DGS MPA simulation Modeling Using HFSS

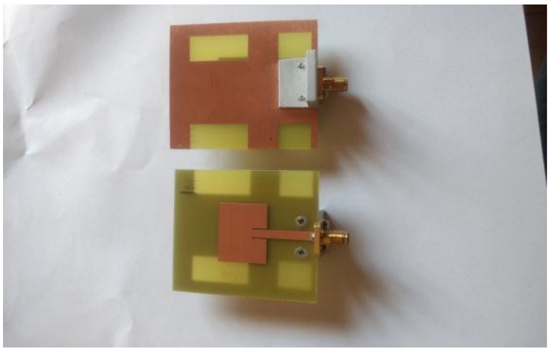

Figure 13 : Multiple DGS Fabricated MPA pictures

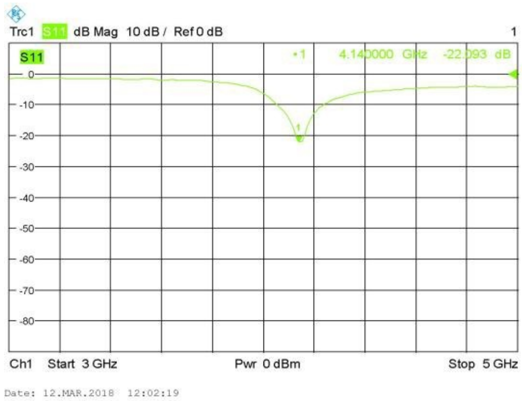

Figure 14 : Multiple DGS S_{11}andBandwidth Measurementresult

Figure 15 : Multiple DGS VSWR measurement result

Figure 16 : Multiple DGS impedance and smith chart results

Simulation results of S_{11} and Bandwidth of Multiple DGS MPA value are -20dB and 200MHz. The HFSS simulation value of VSWR and impedance of reference MPA are 1.2 and 50 ohm. Figure 12 shows the modeling of Multiple DGS MPA simulation with HFSS and Figure 13 shows actual fabricated MPA. Figure 14 shows the measurement result of S_{11} and -10dB bandwidth of Multiple DGS MPA. The measured values of S_{11} is-23.24dBand-10dBbandwidthisequalto198MHz.TheFigure15&Figure16showstheVSWRandimpedance Smith chart measurement result characteristics of proposed MPA. The values of VSWR is 1.1 and impedance of 56.4 ohms. The measured results are matching with simulation results.

IV. COMPARISON OFRESULTS

The comparison of reference MPA and prosed MPA are given in Table 2 below.

Table 2 : The comparison of reference MPA and proposed MPA

Sl. No.	Description	Reference MPA	Proposed MPA
1	Resonance frequency	4.18 GHz	4.14GHz
2	S_{11}	-14 dB	-23.24 dB
3	Bandwidth	100 MHz	198 MHz
4	VSWR	1.58	1.1
5	Input impedance	60 ohm	56.4 ohm
6	Gain	2.9 dB	2.85 dB

The Comparison of reference MPA and Proposed MPA measurement results is shown in Table 2, indicates that the performance of Proposed MPA with multiple DGS is enhanced by 98MHz as compare to reference MPA. Also there is improvement in input impedance, VSWR, S_{11} in proposed MPA. The gain is almost same.

V. CONCLUSION

In this paper, 1.6mm FR-4 MPA and 1.6mm FR-4 MPA with Multiple DGS designed, simulated, fabricated and measured the performance of $S_{11,}$bandwidth,VSWR,input impedance and gain. The performance of Proposed MPA with multiple DGS is enhanced by 100MHz to 198MHz as compared to reference MPA. Improvement in input impedance, VSWR and S11 in proposed MPA are also observed. The simulated and measured bandwidth is enhanced by 98% by Multiple DGS technique. Hence we can conclude that there is a performance enhancement in bandwidth,$S_{11,}$Input impedance and VSWR with Multiple DGS microstrip patch antenna.

REFERENCES

[1] C.A. Balanis, –Antenna TheoryAnalysis and Design‖, John Wileyand Sons. Inc. October2003.

[2] R.Satyanarayana&. Dr. Shankaraiah, –PerformanceEnhancementof ProbeFeed Microstrip Patch Antenna forWirelessApplicati- ons ‖ IEEE 978-1-5386-2361-9/172017

[3] HalappaR.Gajera—EdgeTruncatedsquaremicrostripPatchAntenna[ET-CSMPA]forwirelessapplication.‖IEEE978-1-4577-1457- 3/11 ,2011

[4] SudhanshuvermaandPreethamKumar—PrintedEggcurvedslotAntennaforWidebandApplication.‖ Progress in Electromagnetics B , Vol. 58 , 111-1212014

[5] Gullu Kiziltas , Pschoudokis and Norboru kikruchi –Topology Design optimization of Dielectric substrates for Bandwidth improvement of a patch Antenna. — IEEE Trans. On Antennas and Propagation Vol. 51 , No 10, October2003

[7] Hassein Mosallaei and Kamal sarabandi , — Antenna Miniaturization and Bandwidth Enhancement using a Reactive impedance substrate. — IEEE Trans. On Antennas and Propagation Vol. 52, No 09 September,2004

[8] Y. Sung. — Bandwidth Enhancement of Microstrip Line fed printed wide slot Antenna with parasitic centre patch — IEEE Trans. On Antennas and Propagation Vol. 60, No 4 April2012

[9] Semyoung oh, Member IEEE , Hanjun Lee and Mingoo Shin — Miniaturization of Microstrip Antenna by using Transformation Electromagnetics‖IEEEAntennasandWirelesspropagationLetters,Vol.15,2016

[10] Kin Lu Wong Tusung Ju ww & Po-wel Li n — Small size Uniplannar WWAV Tablet Computer Antenna using parallel resonant strip for Bandwidth Enhancement — IEEE Transaction Antenna and Propagation , Vol. 61 , No 1, Jan2013

[11] Marhrukh Khan student member IEEE and Chatterjeee Member IEEE — Characteristics Mode analysis of a class of Empirical design techniques for probe-fed , U slot microstrip antenna.‖ IEEE Transaction on Antennas & propagation ,Vol . XX , No X ,2015

[12] *Kuan-Wei Li, Wen-Bin Tsai and Chien-Jang Waung " Enhancement of impedance Bandwidth for the Microstrip Monopole Slot Antenna. " Progress in Electromagnetic Research Symposium (* PIERS) Shangai China 8-11 Aug2016