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Isolation Enhancement of 3GHz Probe Fed Rectangle Microstrip Patch Antenna by Second Resonance Suppression Technique for Wireless Applications

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Abstract: ***Microstrip patch antenna is very popular and extensively used in GHz wireless communications. The demand of increased wireless communication applications, needs increase in bandwidth, gain, efficiency and isolation of microostrip patch antenna. Microstrip patch antenna is a low profile antenna but has narrow bandwidth, low gain, low efficiency and isolation. In this paper a microstrip patch antenna is designed with 1.6mm RT Duroid substrate material. The bandwidth, gain and isolation were found to be 60MHz, 7.5dB and -40dB with dual resonance. The bandwidth and isolation enhancement is achieved withsecond resonance suppression technique. The second resonance suppressed by using two slots. Simulations were conducted with different lengths of slots and at different positions and compared. A bandwidth of 270MHz, gain of 7.9dB and an isolation of -46dB are obtained. Bandwidth increase of 450% and 115% isolation increase are achieved.***

Keywords : HFSS, Isolation, Microstrip Antenna, Wireless Communication

I. INTRODUCTION

Antenna is a basic need in wireless communication.

The microstrip antenna is extensively used 1 GHZ frequency and above in Wireless communication. Microstrip antenna is designed using a dielectric substrate material and two layers of conductors. The conductor on top side of substrate is called patch and another on bottom side of substrate is called as ground. The area of ground is larger than patch. The different types of patches are rectangular, square circular and other shapes [1]. Microstrip antenna have a number of advantages. They are low profile, simple fabrication method, simple to interfacing of ICs. The working of Microstrip antenna can be explained by various methods like Transmission line model and Cavity models[2]. It is used in aircraft, mobile, medical and satellite applications. The disadvantages of Microstrip Patch Antenna (MPA) are less bandwidth and less gain. Various research groups are working on these issues. The bandwidth enhancement techniques are DGS, Dimensional change, use of different substrates etc [3-4]. An isolation is an important factor is selection and application of Microstrip Antenna. Detailed isolation enhancement techniques are described below. The authors describes a MPAR application (Multi –Funct- ional Phased Array Radar) antenna of Low Cross Polarization along with high isolation [5]. The feed design is used is Hybrid type of feed. A balanced feed and cross coupled feed are used for vertical and horizontal polarizations. The observations of Simulations and measurements, shows a input isolation of of 45 & 43dB between the horizontal & vertical ports. In this design fabrication, a cross polarization less than -36dB is obtained.

The authors explains a wideband decoupling element, design in MPA for mutual coupling reduction [6]. The design of decoupling unit cell with a resonator of asymmetrical loop is carried out. The stop band characteristics of wideband is 2 to 5 GHz. The resonator is implemented using 2 element dual band MPA. This design has more than 15dB additional isolation, in V slot dual band. A Ku band DP (dual polarised) MPA array for broad band high isolation and low cross polarisation, is designed by authors using Q SIW [7]. (Quasi Substrate integrated wave guide) The MPA array, which is excited by a multi stage structure of different output using 2 orthogonal, 4 way parallel feed networks. The Q SIW improves bandwidth & isolation. For vertical & horizontal ports, 26.37% & 27.77% impendence bandwidth are achieved. Better than -34 & -40dB cross polarization for 2 ports are obtained. The achieved isolation is better than 32 dB between 2 ports. A planar dual-polarized patch antenna with ultra wideband (UWB) technologies and high port isolation[8] of a monopole and a feed line. These designed to for achieving UWB characteristic and 2 two modes which are orthogonal. In ground slots are used for impedance matching. A cross polarization ratio of 32 dB on the xoz-plane, 29dB on yoz plane for port 1 and a cross polarization ratio of 37 dB on the xoz-plane, 41 dB on the yoz- plane. The isolation is 25 dB over the whole operating band and UWB is from 5.4 to 8.3GHz A dual polarised frequency scanning antenna[9] is designed by authors. The concept used is beam matching of radiation patterns of 2 linear polarised antenna.

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It is fabricated & tested. A special phase matching process is carried out. Results of H & V polarisation beam, with pointer angle mismatch less than 0.2, in the frequency bandwidth of 2.75 to 2.95GHz.

A dual polarisation slot antenna for wideband [10], high isolation is designed by authors.. The dual polarised high isolation MPA & low cross polarisation for MPAR.(Multifunction phased array application Radar.) The antenna design is a uses double later with two pairs of parallel MPA line baluns, on both top & bottom layers. The excitation is capacitive coupling, orthogonal circular dipole modes. The antenna is fabricated & tested. The test results shows a relative bandwidth of two ports are 59% & 52.8% in the band of 2.4 to 2.6GHz and 2.4 to 4.12GHz. The isolation of ports is below 35dB & cross polarisation is less than 20dB.

A dual element MIMO MPA with high port isolation for wireless local area communication[11] is designed by authors. The aperture coupling is used for two square MPA. The feeding is orthogonal, uses a T structure. The antenna's simulation & measurements of prototype are compared. The impedance bandwidth of antenna is 100MHz (2.40 to 2.50GHz & second band impendence bandwidth is 260MHz. (5.74 to 6.0GHz)The port isolation in first band is minimum 28.93dB and -16.7dB in the second band.

Isolation improvement and suppression of mutual coupling between two MPA's which are closed spaced [12] are explained by authors. A unique concept of using structure of H shape is used. There is no deteriation in gain, bandwidth & FB (front to back ratio) with proposed H shape structure. This structure is based on DGS (defected ground structure) concept. The simulation results are compared with measurement results of prototype. A high isolation at 5.2GHz, bandwidth of 3.2%, gain of 4.9dBi& FB ratio of 24dB are obtained. This concept is used in reducing mutual coupling of antenna arrays.

A 5.8GHz, high isolation, MIMO diversity MPA with two elements, for WLAN application[13] is described by authors. Two rectangular MPA 0.1A0 on FR-4 is designed. The isolation is enhanced by 3 techniques. They are by using slits,shorting pins and mutual coupling reduction technique. The antenna is fabricated & tested. The isolation is less than -35dB in the frequency range 5.63 to 5.93GHz range. The measured results are matching with simulation results. This is suitable for WLAN application.

A dual polarised application, a planar antenna with ring shape[14] is described by authors. A rectangular t in each arm of the slots. By using Microstrip line f stepped section is presented, two adjacent arms are excited. A kite shaped slot stub is used to increase the isolation. The impedance bandwidth of antenna is 3 to 12GHz. The isolation is more than 20dB. The peak gain is 4 to 6 dBi.

A 5.8GHz, WiMax application[15] dual polaraised MPA is designed by authors. The design consists of a dual polarized square MPA, with dual feed 45 degrees. It is present on a silicon crystal solar cell, which is operated as a parasitic patch. It provides DC / RF isolation. The MPA operating frequency band is 5.66 to 5.91GHz. The gain is 7.6dBi.

Substrate Wave guide technology based high isolation & RCS dual polarized brand band[16] aperture coupled MPA for Ku band is designed by authors. A SIRMHS (substrate integrated rows of metalize via holes) are inserted in conventional reference antenna. This is to improve the isolation & impedance bandwidth. The surface current of ground plane is reduced much using RCS. The simulation & prototype results are found to be comparable. Isolation is greater than 40dB, S11 less than 20dB , with 21% bandwidth improvement. In prototype , RCS is 23dB in the band of 12.2-16GHz with angle of 30 degrees.

C band, high port-port isolation, dual polarised wideband MPA[17-18] with an aperture coupling is described by authors. The design has substrate, reflector, director and patch. The bandwidth and isolation are increased by using 4 shorting pins. The centre frequency is 5.25GHz and bandwidth increase is 50%. The isolation is 31.5dB. The reflector improves FB ratio to more than 20dB. The peak gain is 9.2dBi. The design is easy to fabricate and can be used in base station of Wi-Fi applications.

Compared to these methods the proposed method is simple, low cost and gives better results. A 3GHz rectangular microstrip patch antenna (RMPA) is designed with 1.6mm RT Duroid substrate. The performance of the RMPA is simulated. A second resonance is observed. To enhance an isolation and bandwidth, the second resonance suppression technique is used. The organization of paper is described here. Introduction and literature study are described in section I . Section II gives design, feeding of RMPA and proposed Probe feed antenna design. Section III describes modelling and simulation of Conventional RMPA and proposed RMPA using HFSS. Also simulation results are described. Section IV gives brief comparison of reference RMPA, Proposed RMPA and results are discussed. Section V describes conclusion and future work. Acknowledgements are given in Section VI.

II. PROPOSED ANTENNA DESIGN

Rectangular microstrip patch MPA configuration is most widely used. The mathematical model of RMPA can be explained using models of Transmission Line and Cavity [2].

A. *Transmission Line based Model*

Transmission line modelling is most accurate for thin dielectric substrates. Fundamentally Transmission model represents the RMPA by two slots, separated by low impedance Zc transmission line having length of L. Mathematical model of RMPA using Transmission model is described here. In this analysis the resonating frequency fr, Substrate dielectric material dielectric constant and dielectric material thickness or height h of dielectric substrate material are known. The design parameters W - RMPA Width and L Length are calculated.

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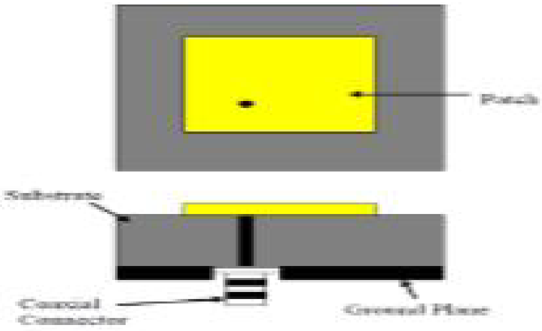

Fig. 1. Probe Feed MPA structure

The RMPA is shown in Figure 1 . The conductor material is copper or gold. Substrate material is RT Duroid. The RMPA Width W and Length L are is calculated as given in the equations [2-3]. After calculations, the dimensions of rectangular microstrip patch antenna (RMPA) with RT Duroid dielectric material is as given in the Table 1.

Table I

Rmsa Dimension With Rt Duroid Substrate

Sl. No.	Dielectric Material	Width (mm)	Length (mm)
1	RT Duroid	45	30

B. Types of Feeding , Computation of feed point :

There are two types of feedings for MPA as given below.

1) Contact feeding.

2) Non-contact feeding.

In contact feeding there are 2 methods. Line feeding and Probe feeding. In Non contact feeding, Aperture feeding and Proximity coupling feeding are well known methods

The simple method is Microstrip Line feed. In this line feeding we have 3 types . They are

1) In-set feeding

2) Centre feeding

3) Off-set feeding

This method provides good impedance matching without use of additional matching device.

The second method is probe feed for RMPA. This method very popular and frequently used for feeding microstrip patch antenna.

The third method is Aperture coupled method of feeding RMPA. It is also known as Electro-magnetic coupling. The advantage of Electro-magnetic coupling is low spurious feed radiation, higher reliability, easy matching of impedance.

Proximity coupling technique for RMPA is fourth method.

The advantage of Proximity coupled / indirect feed is less spurious feed radiation. The matching of impedance simple with good reliability. Upto 13% bandwidth can be obtained. The fabrication is tedious process which also requires alignment.

In proposed RMPA, Probe feed is used. The location of probe are calculated as per formulae given in [2]. Then probe position is optimized for optimum performance.

III. ANTENNA MODELING, SIMULATION AND TESTING

Figure 2 shows the modeling and simulation of reference 3GHz RMPA of RT Duroid using HFSS. Figure 3 shows the modeling and simulation of Proposed 3GHz RMPA of RT Duroid RMPA with two slots.

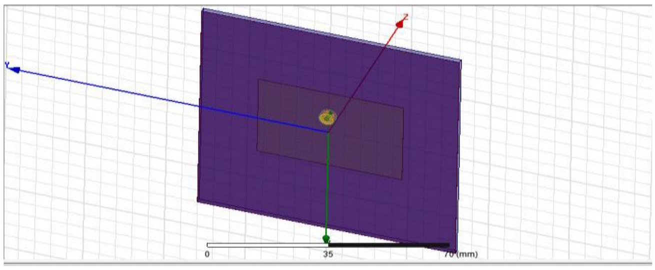

Fig. 2. Reference MPA Modeling using HFSS

Figure shows the MPA modeling of refrence antenna of RT Duroid with thickness 1.6mm.

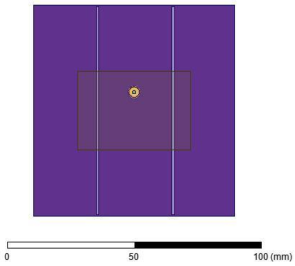

Fig. 3. Proposed MPA Modeling using HFSS with full length Slots

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of full length. Design of RT Duroid microstrip antenna is modelled and simulated by HFSS is shown in Figure 2. This reference antenna has single layer substrate of RT Duroid material withvthickness of 1.6mm. This antenna has resonating frequency of 3.08GHz and bandwidth of 60 MHz and maximum gain of 7.9dB. There are two resonances first at 3.08GHz with S11 - 23dB and second at 4.96GHz with S11 at -7.33dB. To suppress the second resonance two slots were introduced. Then slot and probe positions were varied to to suppress second resonance. Then slot length were varied from full length, patch full length, 20mm slot length and 10mm slot length. The details of simulation are given below. Figure 3 shows the MPA modelling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of full length. Then at different slots lengths and probe positions are simulated.

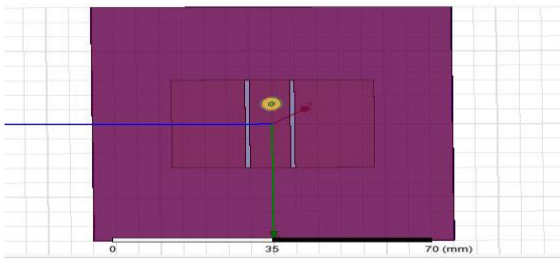

Fig. 4. Proposed MPA Modeling using HFSS with patch full length slots

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of patch fulllength. Figure 4 shows the MPA modeling of proposed antenna of RT Duroid with thickness1.6mm and two slots of patch full length.

Figure 5 shows the MPA modelling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm @ probe position 1.Figure 6 shows the MPA modelling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm length @ probe position 2. Figure 7 shows the MPA modelling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm @ probe position 3. Figure 8 shows the MPA modelling of proposed antenna of RT Duroid with thickness 1.6mm and two slots 10mm @ probe position 1.

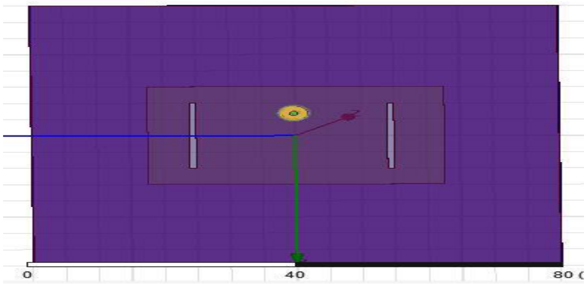

Fig. 5. Proposed MPA Modeling using HFSS with 20mm length slots @ p1

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm @ probe Position.

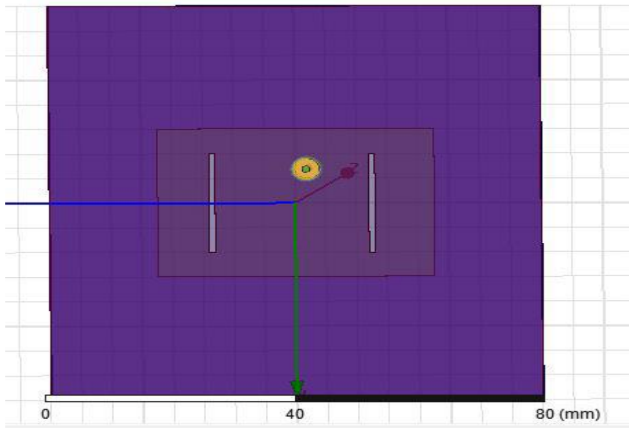

Fig. 6. Proposed MPA Modeling using HFSS with 20mm length slots @ p2

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm length @ probe position 2.

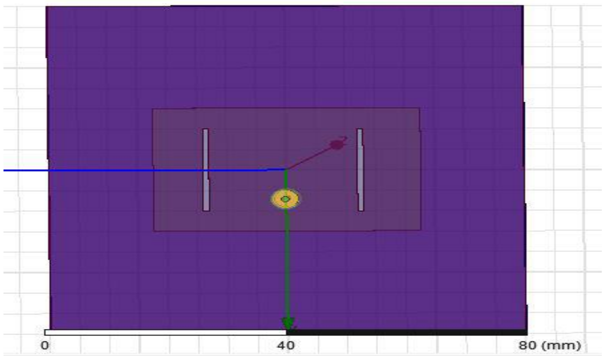

Fig. 7. Proposed MPA Modeling using HFSS with 20mm length slots @ p3

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 20mm @ probe position 3.

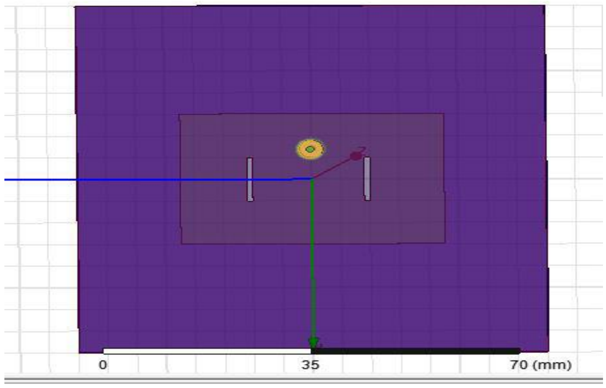

Fig. 8. Proposed MPA Modeling using HFSS with 10mm length slots @ p1

Figure shows the MPA modeling of proposed antenna of RT Duroid with thickness 1.6mm and two slots of 10mm @ probe position 1.

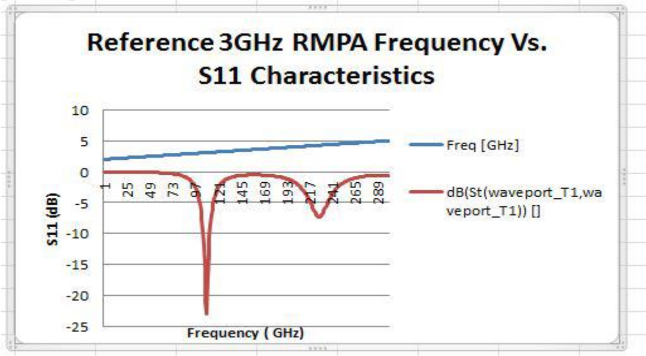

Fig. 9. S11 of refrence MPA

Figure shows the MPA S11 of reference antenna of RT Duroid with thickness 1.6mm. The Maximum value of S11 is -23dB. There are two resonance frequencies first one at 3.08GHz and second one at 4.26GHz.

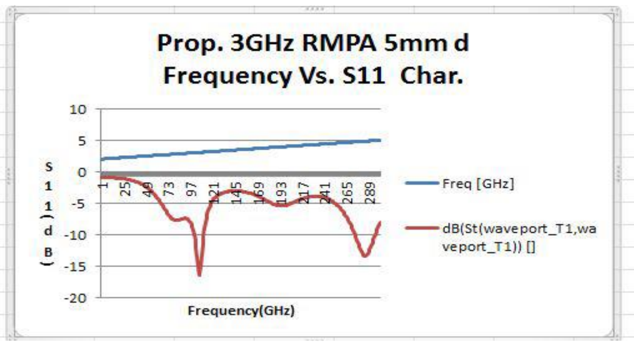

Fig. 10. S11 of 1.6mm RT Duroid Proposed MPA with slot at 5mm from Centre

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6 mm and Slot positions 5mm from centre. The value of S11 is -16.41dB. There are two resonance frequencies. First resonance frequency is at 3.05 GHz and Second resonance frequency is at 3.95 GHz. In Figure 9, resonance at 3.08GHz and second one at 4.26GHz. The first dominating resonating frequency, bandwidth is 60MHz.To suppress second resonance , two slots introduced as shown in Figure10.

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It shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6 mm and Slot positions 5mm from centre.The value of S11 is -16.41dB. There are two resonance frequencies. First dominating resonance frequency is at 3.05vGHz with -10dB bandwidth is 100MHz. The Second resonance frequency is at 3.95 GHz.

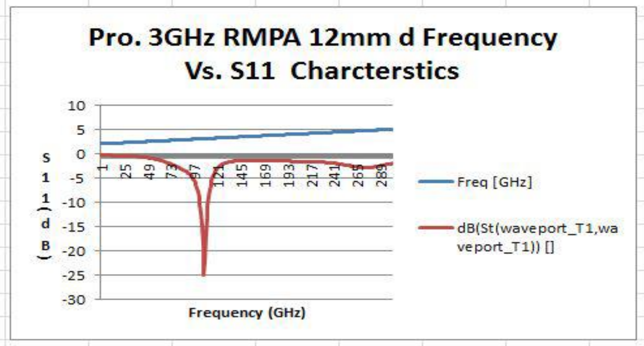

Fig. 11. S11 of 1.6mm RT Duroid Proposed MPA with slot at 12mm from Centre

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm and Slot positions 12 mm from centre. The value of S11 is -25.1dB. There is no second resonance. The second resonance is suppressed at this position. Figure 11 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm and Slot positions 12 mm from centre. The value of S11 is -25.1dB. The dominant resonant frequency is 3.06GHz, with -10dB bandwidth of 90MHz.There is no second resonance. The second resonance is suppressed at this position. Figure 12 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm and The value of S11 is -25.1dB. There is no second resonance. The second resonance is suppressed at this position.

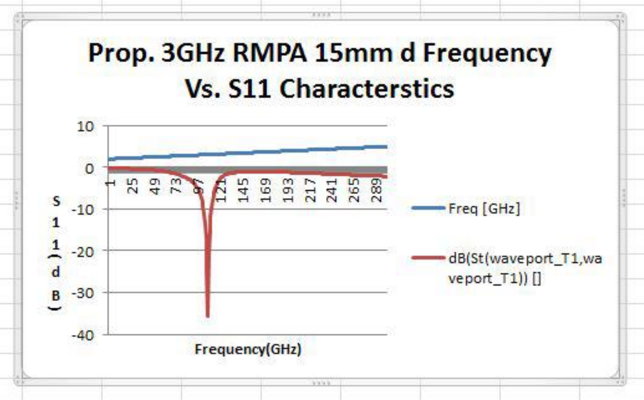

Fig. 12. S11 of 1.6mm RT Duroid Proposed MPA with slot at 15mm from Centre

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm and Slot positions 15 mm from centre. The value of S11 is -35.6dB. There is no second resonance. The second resonance is completely suppressed at this position. In Slot positions 15 mm from centre, The value of S11 is -35.6dB. The dominant resonant frequency is 3.07, with -10dB bandwidth of 80MHz. There is no second resonance. The second resonance is completelly suppressed at this position.

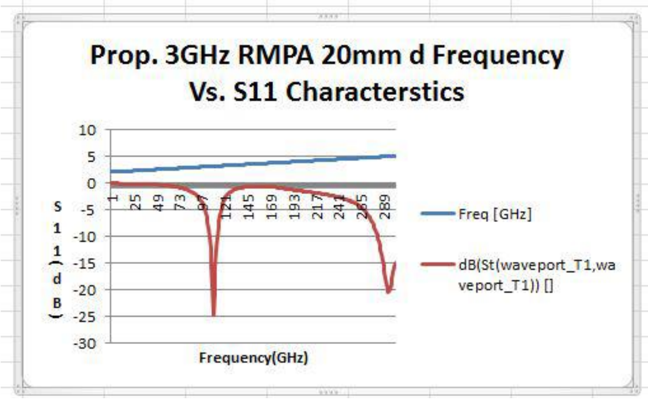

Fig. 13. S11 of 1.6mm RT Duroid Proposed MPA with slot at 20mm from centre

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm and slot positions 20 mm from centre.The value of S11 is -24.79dB. There is a second resonance. The first resonance at 3.08GHz and second resonance at 4.93GHz.The value of S11 is -24.79dB . The dominating primary resonance frequency is 3.08GHz, with -10dB bandwidth of 80MHz.There is a second resonance at 4.93GHz. From these observations it found with two full length slot , 12mm from centre positions gives optimum performance.

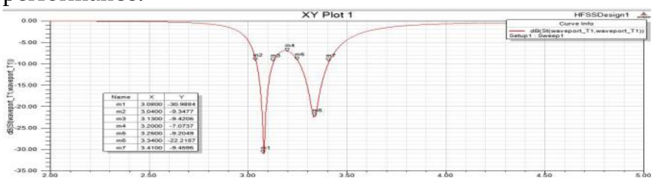

Fig. 14. S11 of 1.6mm RT Duroid with 2 slots of 20mm at Probe position 1

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 20mm and probe positions 1. The value of S11 is -30.98dB. There are two resonance frequencies. The second resonance is not suppressed at this position.

The slot length and probe positions are varied to get possibility of better performance. So 20mm and 10mm slot lengths were simulated. Figure 14 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm , Slot length 20mm and probe positions 1. The value of S11 is -30.98dBThere are two resonance frequencies.The of dominant resonant frequency is 3.08GHz. The -10dB bandwidth is 90MHZ. The second resonance is not suppressed at this position. It is 3.34GHz.

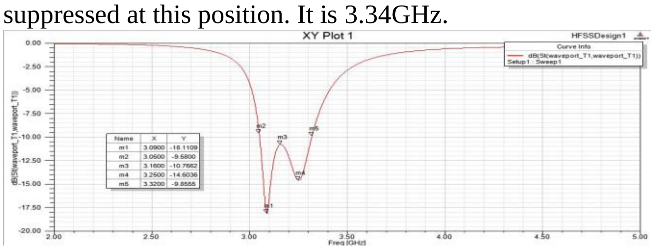

Fig. 15. S11 of 1.6mm RT Duroid with 2 slots of 20mm at Probe position 2

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 20mm and probe positions 2. The value of S11 is -18.11dB. There is only one resonance frequency. The second resonance is suppressed at this position. Figure 15 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm, Slot length 20mm and probe positions 2. The value of S11 is -18.11dB. There is only one resonance frequency of 3.08GHz. The -10dB bandwidth is maximum of 270MHz.The second resonance is suppressed at this position. Figure 16 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm, Slot length 20mm and probe positions 3. The value of S11 is -18.8dB. There is only one resonance frequency. The second resonance is suppressed at this position. Figure 17 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1.6mm, Figure14 shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 20mm and probe positions 1. The value of S11 is -30.98dB. There are two resonance frequencies. The second resonance is not suppressed at this position.Fig. 15. S11 of 1.6mm RT Duroid with 2 slots of 20mm at Probe position 2

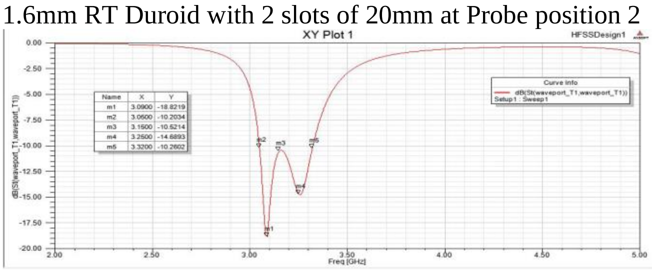

Fig. 16. S11 of 1.6mm RT Duroid with 2 slots of 20mm at Probe position 3

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 20mm and probe positions 3. The value of S11 is -18.8dB. There is only one resonance frequency. The second resonance is suppressed at this position. Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 20mm and probe positions 2. The value of S11 is -18.11dB. There is only one resonance frequency. The second resonance is suppressed at

this position . Slot length 10mm and probe positions 1. The value of S11 is -23.9dB. There is are two resonance frequencies. The dominant resonant frequency is 3.07GHz, with 70MHz -10B bandwidth. The second resonance frequency is 4.14GHz. The second resonance is not suppressed at this slot length and position. From these observations, it is found with 20mm slot length at probe position 2, second resoance is suppressed with optimum performance.

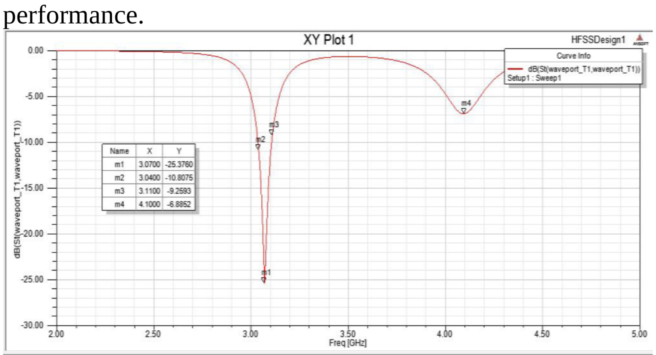

Fig. 17. S11 of 1.6mm RT Duroid with 2 slots of 10mm at Probe position 1

Figure shows the MPA S11 of proposed antenna of RT Duroid with thickness 1. 6mm, slot length 10mm and probe positions1. The value of S11 is -23.9dB. There is are two resonance frequencies. The second resonance is not suppressed at this position. From our research above simulations it is observed with two slots of full length at 12mm and 15mm from centre and slot

length of 20mm from centre position 2 & 3 second resonance are suppressed.

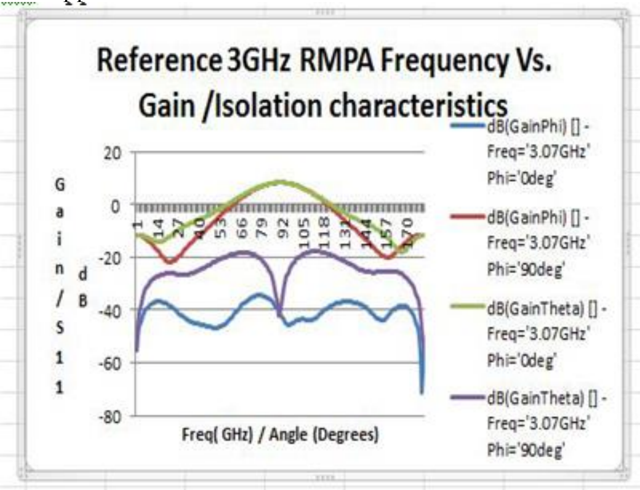

Fig. 18. Gain and Isolation Characteristics of 3 GHz refrence MPA

Figure shows the 3GHz MPA refrence antenna of RT Duroid with thickness 1.6mm. The value

of gain is 7.9dB and isolation is -40dB. Figure 18 shows the 3GHz MPA refrence antenna of RT Duroid with thickness 1.6mm. The value of gain is 7.9dB and isolation is -40dB. Figure 19 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 5mm from centre. The value of gain 7.63dB and isolation is -41.6dB. Figure 20 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 12mm from centre. The value of gain 7.7dB and isolation is -45.8dB. Figure 21 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 15mm from centre. The value of gain 7.53dB and isolation is -36dB. Figure 22 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 20mm from centre. The value of gain 7.25dB and isolation is -43dB.

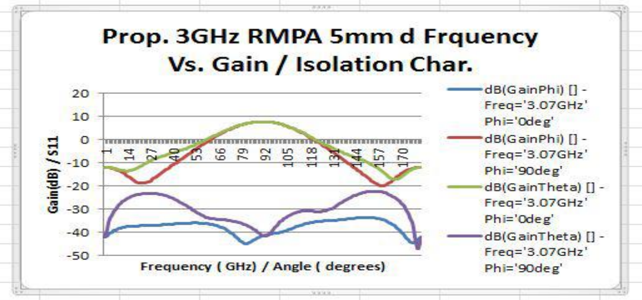

Fig. 19. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two full length slots from 5mm from Centre

Figure shows the MPA Gain and Isolation Characteristics of 3 GHz Proposed MPA with two full length slots from 5mm from centre.

The value of gain 7.63dB and isolation is -41.6dB. Figure 23 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with 20mm full length slots in position 1 from Centre. The value of gain 7.9dB and isolation is -40dB. Figure 24 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two 20mm length slots in position 2 from centre. The value of gain 6.8dB and isolation is -32dB. Figure 25 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two 20mm length slots in position 3 from centre. The value of Gain 7.85dB and isolation is -19.37dB. Figure 26 shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two 10mm length slots in position 1 from centre. The value of gain 8.3dB and isolation is -48dB. The various simulations of gain and isolation for different slot length and probe positions are given above.

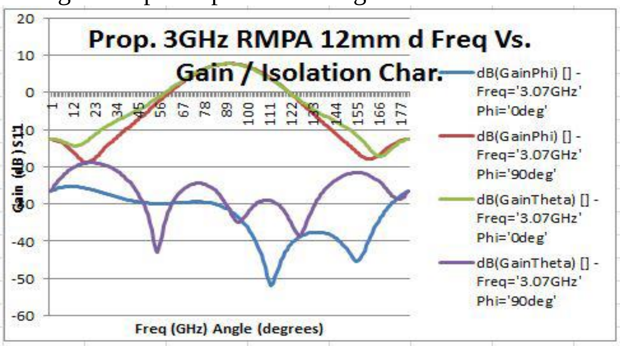

Fig. 20. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two full length slots from 12mm from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 12mm from centre. The value of gain 7.7dB and isolation is -45.8dB.

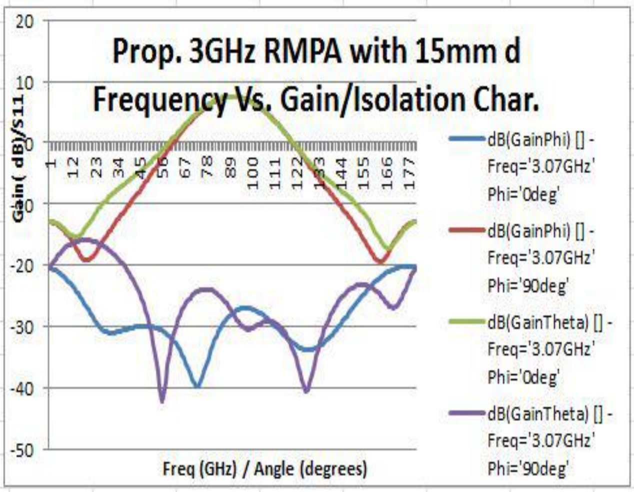

Fig. 21. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two full length slots from 15mm from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 15mmfrom centre.The value of gain 7.53dB and isolation is -36dB. It found that full slot length with 12mm from centre and 20mm slot length at probe position 3 gives optimum performances.

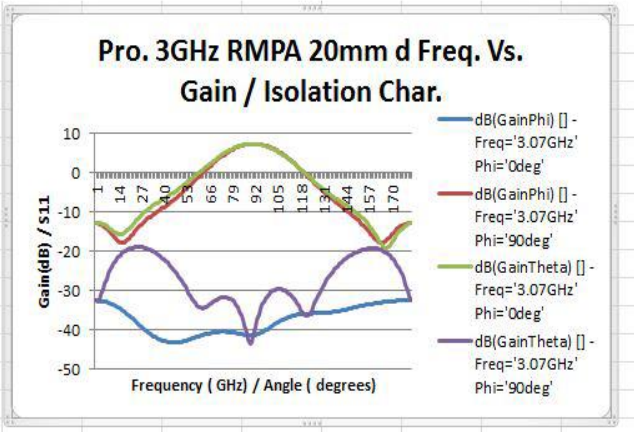

Fig. 22. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two full length slots from 20mm from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two full length slots from 20mm from centre. The value of gain 7.25dB and isolation is -43dB.

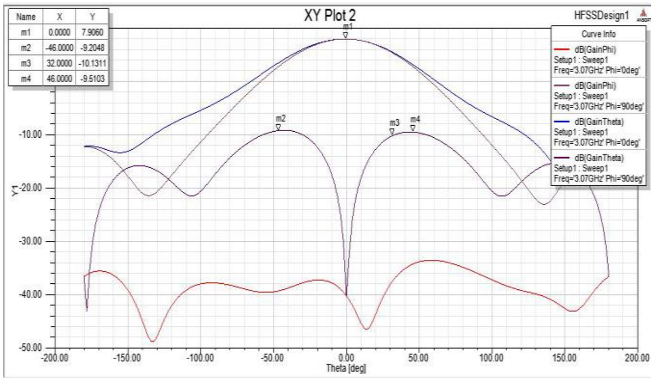

Fig. 23. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two 20mm length slots in position 1 from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with 20mm full length slots in position 1 from centre. The value of gain 7.9dB and isolation is -40dB.

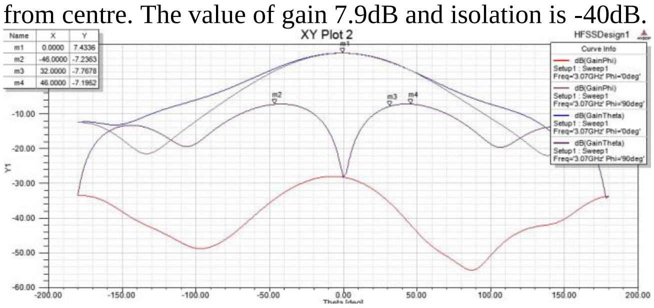

Fig. 24. Gain and Isolation Characteristics of 3 GHz Proposed MPA with two 20mm length slots in position 2 from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz Proposed MPA with two 20mm length slots in position 1 from centre. The value of gain 6.8dB and isolation is -32dB. GHz proposed MPA with two 20mm length slots in position 3 from Centre. The value of gain 7.85dB and isolation is -19.37dB.

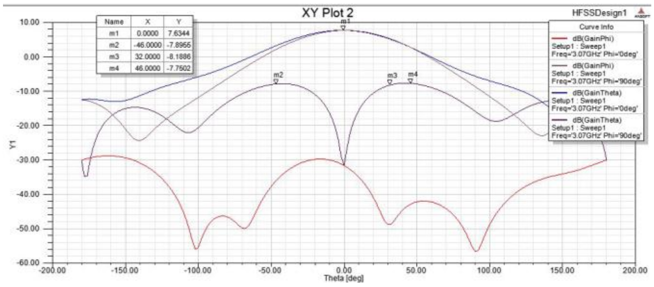

Fig. 26. Gain and Isolation Characteristics of 3 GHz Proposed MPA with

two 10mm length slots in position 1 from Centre

Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two 10mm length slots in position 1 from Centre. The value of gain 8.3dB and isolation is -48dB.

IV. COMPARISON OF RESULTS

The comparison of RT Duroid 1.6mm reference and proposed RMPA with two slots are described below.

A. *Performance comparison of Reference and Proposed RMPA with full length slots*

The comparison of RT Duroid 1.6mm reference and proposed RMPA with two full length slots are shown in Table 2

TABLE II

PERFORMANCE COMPARISON OF REFERENCE AND PROPOSED RMPA WITH FULL LENGTH SLOTS

Sl no	Parameter	Reference RMPA	Proposed RMPA
1	Resonance Frequency	3.08GHz	3.06GHz
2	S11	-23 dB	-25.1dB
3	Bandwidth	60 MHz	90MHz
4	Gain	7.9dB	7.7dB
5	Input impedance	50 ohms	50ohms
6	Radiation Pattern	Hemisphere	Hemisphere
7	Isolation	-40dB	-46dB
8	VSWR	1.48	1.17

The comparison of RT Duroid 1.6mm thickness reference and proposed RMPA with full length two slots given in above Table 2. From comparison, it is found resonance frequency is of reference and proposed RMPA are almost same near the design frequency of 3GHZ. There is improvement of -2.1dB of S11 in proposed RMPA. The bandwidth is icrease by 150% than refrence RMPA. The Isolation is 6 dB more . The gain is almost same in both Antennas. The directivity and Radiation pattern are comparable. Input resistance are same. VSWR is less and hence it is better. The input resistance is 50 ohms. The VSWR of reference RMPA is around 1.48 and the VSWR of Proposed RMPA is 1.17 is and it is good matching of antenna with transmission line. Isolation of proposed RMPA is 115% more when compared with reference antenna. It is 6dB (115%) improvement than reference antenna. The proposed RMPA has better an isolation performance Enhancement.

B. Performance comparison of Reference and Proposed RMPA with 20mm length slots

The comparison of RT Duroid 1.6mm reference and proposed RMPA with 20mm length two slots are shown in Table 3.

TABLE III

PERFORMANCE COMPARISON OF REFERENCE AND PROPOSED RMPA WITH 20MM LENGTH SLOTS

Sl no	Parameter	Reference RMPA	Proposed RMPA
1	Resonance Frequency	3.08GHz	3.06GHz
2	S11	-23 dB	-18.12dB
3	Bandwidth	60 MHz	270MHz
4	Gain	7.9dB	6.8dB
5	Input impedance	50 ohms	50ohms
6	Radiation Pattern	Hemisphere	Hemisphere
7	Isolation	-40dB	-42dB
8	VSWR	1.48	1.2

The comparison of RT Duroid 1.6mm thickness reference and proposed RMPA with 20mm length two slots given in above Table 3. From comparison, it is found resonance frequency is of reference and proposed RMPA are almost same near the design frequency of 3GHZ. There is decrease of -5dB of S11 in proposed RMPA. The bandwidth is 4.5 times (450%) more when compared to reference RMPA. It is 270MHz. The Isolation is 2dB more. The gain is almost same in both Antennas. The directivity and Radiation pattern are comparable. Input resistance are same. VSWR is less and hence it is better. The input resistance is 50 ohms. The VSWR of reference RMPA is around 1.48 and the VSWR of proposed RMPA is 1.2 is and it is good matching of antenna with transmission line. Isolation of proposed RMPA is 105% more when compared with reference antenna. It is 2dB (105%) improvement than reference antenna.The proposed RMPA has better an isolation performance enhancement.

V. CONCLUSION

Rectangular microstrip patch antenna(RMPA) is designed with RT Duroid 1.6mm and with full length two slots and 20mm length two slots. The isolation enhacement with full length two slots prposed RMPA is 6dB (115%) more than refrence RMPA and 2dB (105%) more than reference RMPA. Hence it can be concluded that RT Duroid 1.6mm RMPA with full length two slots RMPA has better isolation for 3GHzWireless application. RT Duroid 1.6mm RMPA d with 20 mm length two slots RMPA has more bandwidth for 3GHz Wireless application.

The Future work RMPA bandwidth enhancement can be extended for various shapes of microstrip patch with other Fig. 26. Gain and Isolation

Characteristics of 3 GHz Proposed MPA with two 10mm length slots in position 1 from Centre Figure shows the MPA gain and isolation characteristics of 3 GHz proposed MPA with two 10mm length slots in position 1 from Centre.

The value of gain 8.3dB and isolation is -48dB. types of feed methods, different shapes of slots and different substrate materials.

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