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Original Research Article

A MICROSTRIP TRUNCATED RECTANGULAR RING SHAPED PATCH ANTENNA FOR ULTRA WIDE BAND

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Abstract: Microstrip patch antenna is very useful antenna in the field of communication in different bands like L, S, Cu, X and different frequency range. In this proposed work design a new antenna that is based on microstrip rectangular ring shaped patch antenna. Further for the improvement of proposed design change the substrate of the antenna there are three different substrate used in the proposed design. The substrate used in the antenna they are air, fr4-epoxy and duriod. The duriod substrate based microstrip patch antenna perform good result as compare to other antenna in terms of S-parameter and VSWR return losses, number of bands and frequency range. The proposed design is simulated on HFSS software. The result of proposed design gives better result as compare to other pervious antenna.

Keywords: Microstrip Patch Antenna (MSA) , HFSS, substrate, Dielectric Constant, FR- 4 and duriod.

1.0 Introduction:

Microstrip patch antenna is separate entity in microwave communication because of its several advantages like low profile, low cost, planar structure and easy integration with printed circuit board. Microstrip patch antenna is one of the most preferred antenna structures due to their low profile and ease of fabrication. They are useful because they can be directly printed onto the circuit boards. They have many applications, especially in wireless

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communication and in satellite communication. For satellite communication, a very high frequency of microwave range is used. The structure of antenna is shown in figure 1.1. In this figure shows the basic parts of antenna of microstrip.

Microwave spectral region which formed by electromagnetic radiation. Its wavelength range is 1m to 1milimeter and frequency range is 0.3 to 300 GHz. It covers both UHF and EHF bands. Microwave covers SHF band (3 to 30 GHz) at minimum and RF engineering often restricting the range between 1 and 100 GHz (300 and 3 mm). The common applications are within the 1 to 40 GHz range. [1, 2]

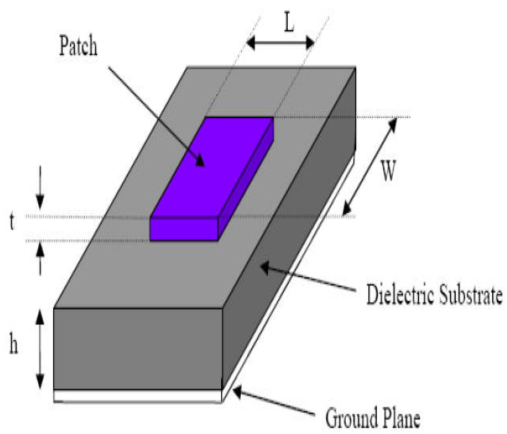

Fig. 1 *Show the Microstrip patch antenna part*

In the previous work, different work is done that is shown in below. The research paper entitled "Compact and Small Planar Monopole Antenna with Symmetrical L- and U-Shaped Slots for WLAN/WiMAX Applications." Authors are Mahdi Moosazadeh and Sergey Kharkovsky, *Fellow, IEEE* shown the Dielectric resonators using high-permittivity materials. A small and triple-band microstrip-fed printed monopole antenna used for Wireless Local Area Network (WLAN) and Worldwide Interoperability for Microwave Access (Wi0-MAX).

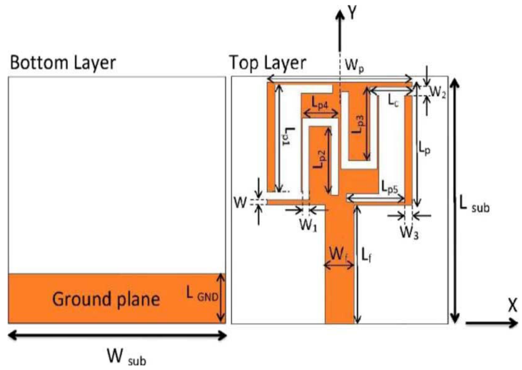

Fig. 2 *Configuration of the proposed based antenna*

The proposed antenna consists of a rectangular patch with L- and U-shaped slots and ground plane. A parametric study on the lengths of the U-shaped and L-shaped slots of the proposed antenna is provided to obtain the required operational frequency bands-namely, WLAN (2.4/5.2/5.8 GHz) and WiMAX (2.5/3.5/5.5 GHz). Omni directional radiation pattern and acceptable antenna gain are achieved over the operating bands.

The research paper entitled "CPW-fed Slot Patch Antenna for 5.2/5.8GH Application of WLAN **"In microwave and millimeter wave applications, slot antennas fed by CPW are receive increasing attention".** In this paper, a CPW-fed patch antenna with slots is presented. The antenna consists of patch structure with two rectangular slots on it. The physical size of the proposed antenna is 30mm ** 24 mm.* Antenna was designed on a polygon poly guide substrate with dielectric constant = 2.32 and thickness of 1.59 mm. The impedance bandwidth of the proposed antenna is 4.1 GHz ranging from 4.8 GHz to 8.9 GHz and has a fractional bandwidth of 60%. The proposed CPW-fed slot patch antenna produces a 30% higher bandwidth compared to the conventional CPW-fed patch antenna. The antenna is resonating at 5.5 GHz and gives monopole radiation pattern at this frequency. This antenna can be used in 5.2 GHz/5.8 GHz WLAN application.

The research paper entitled **“Planar multi-band t-shaped monopole antenna with a pair of mirrored l-shaped strips for WLAN/WiMAX operation”** whose publishers are J. H. Lu and Y. H. Li given compact design of planar T-shaped monopole antenna with multi-band operation for WLAN/WiMAX system is proposed. By insetting a pair of mirrored L-shaped monopole strips, multi resonant modes close to 2.45/3.5/5.5 GHz band are excited to meet the specifications of WLAN/WiMAX system and the obtained impedance bandwidth across the operating bands can reach about160/1100/2690MHz for the 2.45/3.5/5.5 GHz bands, respectively. Only with the physical size of antenna (30*42*0.8 mm3), the proposed monopole antenna has operated at very high frequency. The measured peak gains and radiation efficiencies are about 3.2/3.5/5.4 dB and 72/98/96% for the 2.45/3.5/5.5 GHz band, respectively.

Chien-Yuan Pan, Tzyy-Sheng Horng, Wen-Shan Chen, and Chien-Hsiang Huang, ***Dual Wideband Printed Monopole Antenna for WLAN/WiMAX Applications”***\A novel printed monopole antenna with dual wideband is presented for simultaneously satisfying wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) applications. The antenna structure consists of a rectangular monopole with a microstrip feed line for excitation and a trapezoid conductor-backed plane for band broadening. The measured 10 dB bandwidth for return loss is from 2.01 to 4.27 GHz and 5.06 to 6.79 GHz, covering all the 2.4/5.2/5.8 GHz WLAN bands and 2.5/3.5/5.5 GHz WiMAX bands.

Table 1 *Parameters of Antenna*

Reference.	Frequency Range	No of Bands	VSWR
Previous Antenna	2 to 8 GHz	3	2
Proposed Antenna	2to 15GHz	6	1.10

2.0 Two Substrates

2.1 RT/Duroid: RT/duroid 5880 high frequency laminates are PTFE combine reinforced along with glass microfibers. The result in exceptional dielectric constant uniformity is obtained due to randomly oriented microfibers. The dielectric constant of high frequency laminates is the lowest of all products, and low dielectric loss make them well suited for high frequency/ broad band applications where dispersion and losses need to be minimized. Because of its extremely low water absorption characteristics, RT/duroid5880 laminates are ideal for applications in high moisture environments.

RT/duroid 5880 laminates are easily cut, sheared and machined to shape, and resistant to all solvents and reagents normally used in etching printed circuits or plating edges and holes. RT/duroid 5870 and 5880 laminates have the lowest electrical loss of any reinforced PTFE material, low moisture absorption, are isotropic, and have uniform electrical properties over frequency.

Rogers RT/duroid 5880 high frequency laminates are used in:

- commercial airline broadband antennas
- microstrip and stripline circuits
- millimeter wave applications
- military radar systems
- missile guidance systems
- point-to-point digital radio antenna

2.2 FR-4 –EPOXY : FR-4 or (FR4) is a grade designation assigned to glass reinforced epoxy laminate sheets, tubes, rods and printed circuit boards (PCB). FR-4 is a composite material composed of woven fiberglass cloth with an epoxy resin binder that is flame resistant (self-extinguishing). FR-4 glass epoxy is a popular and versatile high-pressure thermo set plastic laminate grade with good strength to weight ratios. With near zero water absorption, FR-4 is most commonly used as an electrical insulator possessing considerable mechanical strength.

3.0 Proposed Design

The design of these micro strip antennas (MSA) demands small size, light weight, low profile, low cost and sometimes the easy fabrication and integration with monolithic microwave integrated circuits (MMIC). To fulfill these requirements, the planar micro strip antenna (MSA) are considered HFSS-13' which has finite element method electromagnetic simulator the antenna provides the Gain of 6.7dB and Directivity of 8.5 dB at the 8GHz. This frequency is used in many applications such as mobile network, S, Ku, X, wireless local area network, WiMAX and Bluetooth technology. The Microstrip patches antennas in terms of pattern, directivity, gain, and electric far field determined by using HFSS software.

Configuration and Design of the Proposed Antenna: To design the Ring shaped truncated MSA by using the substrate which is FR4 εr-4.4, Resonating frequency at between 1.83GHz to 11.25 GHz, height of antenna is2.18 mm are calculated.

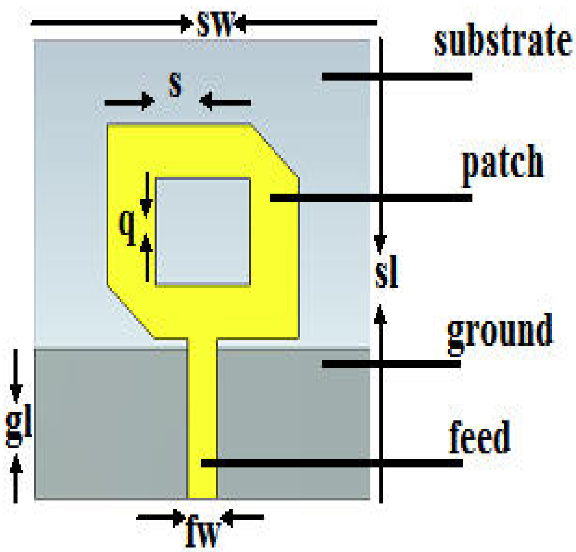

Fig 3. *Design of MSA Top view*

Use of software simulation here it is explained the Ring shaped truncated MSA to reach Bandwidth along with Gain. The aim of the paper is to design a Micro-strip Patch Antenna, and study the effect of antenna dimensions Length (L), Height (h) and substrate parameters relative Dielectric constant on the Radiation Parameters of Bandwidth and Gain. The use of truncated patch, results in an improvement of the antenna gain and beaming. The proposed antenna is studied thoroughly and FR4 substrate has been used to design the micro-strip antenna (MSA) which is ε_r-4.4 in between ground and patch. The simulation design of MSA and that for the simulation result of various parameters of the antenna such as return loss, gain, radiation patterns etc. are also explained. The method of characterization of the MSA and the basic facilities used for the simulation result of antenna parameters are also highlighted. Ring shaped truncated MSA can be easily manufactured, by using the substrate of εr-1 of height 2.18mm which is mounted over the ground size of 19.65mm length and width 50mm. Figure above Shows which is characterized by height 'h' for dielectric constant ε_r-4.4, in this substrate of length 60mm and width 50mm. The patch length is 28.5mm and width 28.5mm has the truncation of 7.5mm and it has square cut 'q' of 14 mm.

Table 2

S. No.	Antenna Parameters	Parameters
1.	Dielectric Constant of the Substrate (ε_r)	ε_r -4.3
2.	Electrical Loss Tangent of Substrate (tan δ)	0.0023
3.	Height of the substrate (h)	4 mm
4.	Width of Ground Plane	32 mm radii
5.	Patch (a) Dimension	32*21 mm radii
6.	Length of the srip Feed Line	18.2*2.5 mm

4.0 Simulation AND RESULT

The optimized dimensions of the geometric parameters are listed in table no. 1. The -10dB impedance bandwidth of the measured Return Loss reached 12 GHz, which covers the range from 2 GHz to 14 GHz, or approximately 527.7% with respect to the centre frequency of 8 GHz. There is good agreement by the simulated results of the software HFSS Design has been simulated. All the comparable results of the software's are achieved by simulation and approximation for proposed design. Results are as below. Gain is very high as comparison to design antenna first this is suitable for multiband performance. The antenna provides the Gain of 6.7dB and Directivity of 8.5 dB at the 8GHz. This frequency is used in many applications such as mobile network, S, Ku, X, wireless local area network, Wi-MAX and Bluetooth technology.

<u>Design 1 Substrate is Air:-</u>

<u>Properties of air</u>

Name	Type	Value
Relative Permittivity	Simple	1.000
Relative Permeability	simple	1.000
Dielectric loss tangent	simple	0.00
Magnetic loss tangent	simple	0.00 tesla
Measured Frequency	simple	9.4e+009Hz
Mass density	simple	1.1614 kg/m^3

Fig 4. Shows the properties of Air

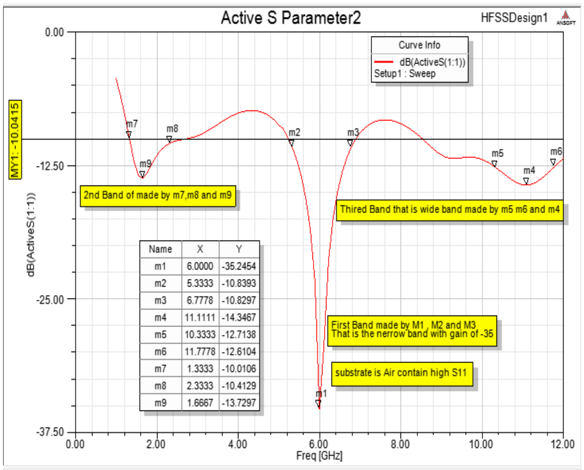

Fig 5. *Shows the S parameter*

The pervious design have some drawback its S parameters is good but the VSWR is not good. So implement the design 2 for overcome the pervious design problem that is based FR4-epoxy Substrate Properties shown in below.

<u>Design 2 Substrate is Fr4 –Epoxy :-</u>

Relative Permittivity	Simple	4.4	
Relative Permeability	Simple	1	
Bulk Conductivity	Simple	0	siemens/m
Dielectric Loss Tangent	Simple	0.02	
Magnetic Loss Tangent	Simple	0	
Magnetic Saturation	Simple	0	tesla
Lande G Factor	Simple	2	
Delta H	Simple	0	A_per_meter
- Measured Frequency	Simple	9.4e+009	Hz
Mass Density	Simple	1900	kg/m^3

Fig 6. *Shows the Properties of FR-4 Epoxy*

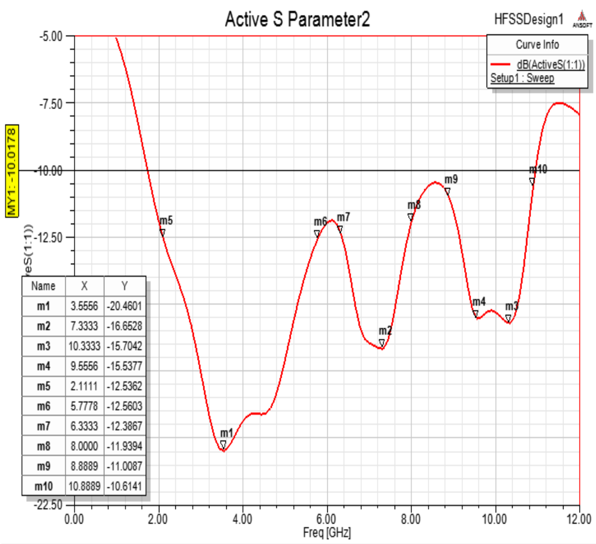

Fig 7. *S parameter of Fr4 – epoxy*

In the previous design VSWR is more than 2 in 2 points. The design 2 shows the improvement good VSWR all VSWR is less than 2 and in some frequency is near about 1 shows good result

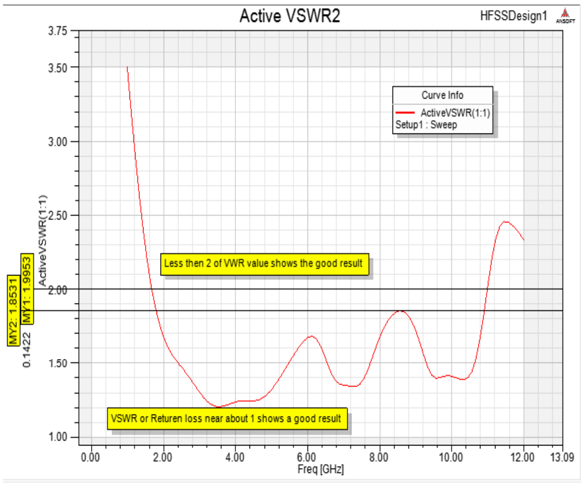

Fig 8. VSWR of Proposed Design 2 based Fr4 – epoxy

Design 3 Final Proposed Design based Duroid –

The last and final design is design 3 that is based duriod martial based design. In this design shows better result as compare to Base Paper and the pervious design 1 and design 2 In the last final design obtain 6 bands frequency range is 2 to 15 GHz VSWR is almost less than 2. All the parameter of good antenna is obtain in this design.

	Name	Type	Value	Units
	Relative Permittivity	Simple	2.2	
	Relative Permeability	Simple	1	
	Bulk Conductivity	Simple	0	siemens/m
	Dielectric Loss Tangent	Simple	0.0009	
	Magnetic Loss Tangent	Simple	0	
	Magnetic Saturation	Simple	0	tesla
	Lande G Factor	Simple	2	
	Delta H	Simple	0	A_per_meter
	- Measured Frequency	Simple	9.4e+009	Hz
	Mass Density	Simple	0	kg/m^3

Fig 9. Properties of Duroid

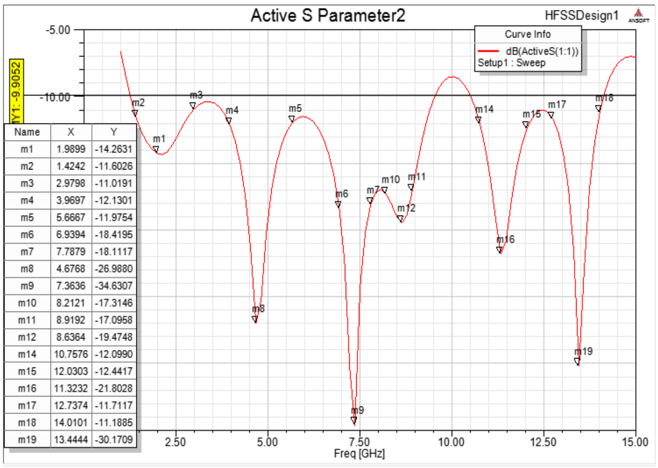

Fig 10. S parameter of final design 3 duriod based substrate

Below -10db line number of dips consider a band

Band 1 (m1,m2,m3)

Band 2 (m4,m5,m6)

Band 3(m6.m7,m9) Band 4 (m10.m11,m12)

Band 5 (m14,m15,m16)

Band6 (m17,m18,m19)

Clearly see that there are 6 six band obtain in final design. In the base paper obtain 3 bands. The Frequency range is also improved 2 to 14 GHzBest Result obtain in 7.50 GHz Range

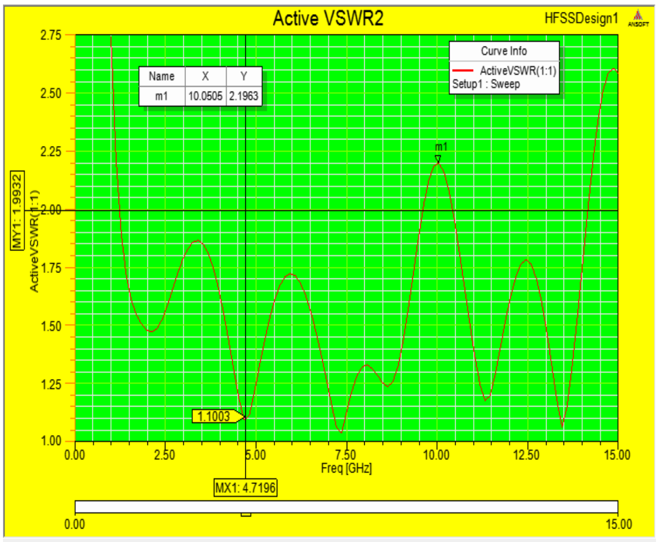

Fig.11 VSWR plot of proposed design

5.0 Conclusion and Future Work

In this proposed work design antenna on 3 different substrate The better result of proposed design 3 as compare of base paper and proposed two design [design 1 and design 2] Duriod is good martial for antenna design There are 6 band obtained in S parameter calculation Its shows that proposed antenna is a multi band antenna. Also shows the good result in terms of VSWR. These Microstrip Patch Antenna extends Ultra wide bandwidth not only covering WLAN range, can also be used for high power, Rf efficient radio, L, S, Cu, X, and Military purpose applications. In future proposed design implement on Hardware. Use the proposed design for different Wireless and Wi-Fi and Wi-Max devices. Because proposed antenna cover the different frequency range and frequency band. Apply proposed design on army antennas because in defense system required multi band antennas. Try to improve the frequency Range, Currently proposed final design worked on 2 to 14 GHz range. Try to more improvement in frequency range 2 to 30 GHz that covers all the UWB ranges. Try to overcome the loss of proposed design 3 in terms of VSWR and return loss.

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