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Designofmicrostrippatchantenna Using Hfss

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ABSTRACT

A two linear micro strip circular patch antenna has been proposed. The antenna design hasbeen validated by using High Frequency Structure Simulator Software (HFSS). The circular patchantenna is having different characteristics and dimensions. The antenna is positioned orthogonally toachieve excellentpolarization diversity. The antenna is mounted on a Roger's 5880 RT/duroidsubstrate (tm) and also contacting feeding technique is employed. The contacting feeding techniquehelps the antenna to reduce the interference between the patches. The substrate is having a density of1.6mm which makes the antennamorestrengthen. Thus the antenna works at the operatingfrequencyof 2.5 GHz which is utilized in the WIMAX applications. The power distribution on those circularmetal patches is same and the performance of an antenna is analyzed .Two linear micro strip circularpatch antennaachieves again of 7.61dB, andtheVSWRachievedby theantennais 1.15.Areasonable agreement of return loss is achieved. In addition, various shapes of the antenna arediscussed to see the performance of an antenna the parameters like VSWR, gain, and directivity,returnlossis calculated.

Keywords - Linear, Circularpatchantenna, Polarization diversity, Feeding techniques, HFSS.

INTRODUCTION

An antenna is an electrical device that converts electromagnetic energy into radio waves in the desired directions. Various types of antennas are available; they are wire antennas, lens antennas, aperture antennas, and micro strip antennas etc. The one type of antenna is micro strip antenna which was developed in the intermediate and late 20th century. In communication, micro strip antenna is also called a patch antenna, and the antenna is fabricated using copper board. The micro strip patch antenna is low-profile with many features. It is light weight, economical, and has a compact design. Patch antennas are also introduced as planar antennas. These micro strip patch antennas are composed of a flat metal plate that present at the vertex of a ground plane. The substrate is made up of the dielectric. There are several types of feeding technique like microstrip line feed, Aperture coupled feed, Coaxial probe feed, Coupled feed, Inset feed. When compared to other feeding technique, micro strip line is connecting straight to the edge of the micro strip patch antenna. There are various shapes of antenna they are square, rectangle, elliptical and circular. Similarly, the shape is not constrained. Instead of using other shapes, circular patches are used because they minimize loss less energy from radiation and thus have a higher proportion of quality factors than other configurations. Radiation pattern, frequency, gain, directivity, polarization, and VSWR are the main factors used to configure the antenna. Various forms of diversities such as space diversity, frequency diversity, pattern diversity, time diversity, directional diversity, and polarization diversity were habituated to increase signal strength depending on circumstances and expected interference. Polarization diversity needs two transmitting and receiving antennas with individual polarization. Thus the electric and magnetic fields carrying the signal information can be changed and such types of signals are used to transmit the desired information. Thus the obtained polarization is in the orthogonal position. The proposed system has been developed using HFSS simulation software and is centered on the Finite Element method. It provides only for simulation of passive circuits. It performs better in the frequency domain. The major advantage of HFSS is that its results are more proximate to the experimental results. HFSS can examine rudimentary performance characterization. It also gives magnetic and electric field visualization both in the near field and a far-field.

A wideband radiation reconfigurable rectangular micro strip patch antenna loaded with two inverted u-

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slots is proposed. It contains symmetrical inverted u-slots included with coaxial probes along the resonant length of the slot. In contrast to previous endeavours of U-form, micro strip slot, achieves good impedance bandwidth of 68% and additionally achieves strong polarization [2]. It covers the frequency of over ~2-4 GHz and it has a centre frequency of 3 GHz. Moreover, this extensive bandwidth is done via the use of a thin substrate of thickness 1.57mm. Peak advantage finished by using micro strip circular patch antenna is 9.6 and 6 dB which is received by using TM_{01} and TM_{02} modes, its conical type radiation pattern to the acquired null depth is beneath 30dB which makes this antenna appropriate for mono-pulse radar packages.

A Design and Analysis of Frequency Reconfigurable U-Shaped Slot Micro Strip Patch Antenna of area 42 mm × 37 mm is designed. Here the antenna consists of Rogers RT/duroid 5880 substrate. In recent times antenna is most compulsory in radio broadcasting domains. Micro strip patch antenna domain fortifies the time area. The U-shaped slot reconfigurable micro strip patch antenna has the functionality of extensive bandwidth for dual-band applications [3]. By transmitting the frequency of the antenna, the size of the dielectric substrate, radiating patch and the slot are modified. If the patch length is abbreviated the size of the slot is incremented. The exiting antenna operates on the frequency of 4.9 GHz and 7.5 GHz which has high loss and much less gain. With proper dimensions the U-shaped slot micro strip patch antenna operates on the mono-band frequency of 10 GHz. The minimum return loss accomplished at the solution frequency of 10 GHz is -31dB. For wideband traits the antenna well-known shows strong polarization and symmetrical radiation sample.

A bandwidth enhancement of micro strip patch antenna with low profile design is proposed. If the height of the antenna is strictly limited, the bandwidth is narrow, and the performance on the side frequencies is worse than that on the centre frequency [4]. The consequences of directed shorting load and coupled shorting load at the resonant frequencies of various patch antenna resonance modes are studied. By utilizing this concept, randomly shift the resonance modes of the patch antenna, and the frequency ratio of the dual band patch antenna can be surprisingly small. A way to clear up this trouble is to mix two modes into one single narrow band. However, nearly all of the two-mode resonance techniques stated is for wideband patch antennas because the frequency ratio of two bands is normally massive and tough to decrease. A detailed transmission line concept executed and mode shift idea is established for patch antennas. The newly proposed method solves the trouble of combining more modes of patch antennas and provides new design guidance for low-profile wideband patch antennas. A design of compact ultra wideband circularly polarized micro strip patch Antenna is proposed. Micro strip patch antennas are typically used, because they may be compact and it is simple to achieve a unidirectional radiation pattern with circular polarization [5]. But, the bandwidth of patch antennas is quite narrow which limits their use in UWB applications. By the way of including suitable shorting hundreds at the patch, the resonance frequency of the higher-order modes TM_{20}, TM_{30}, TM_{40}, and TM_{50} is decreased and combined with the dominant mode (TM_{10}). Those fives modes provide a wide running band with the aid of utilizing the bandwidth enhancement method, a compact ultra wideband patch antenna with a unidirectional radiation sample and circular polarization is designed. The size of the patch is simplest $0.5\lambda_0 \times 0.5\lambda_0$ and the peak is only $0.1\lambda_0$ (λ_0 is the unfastened space wavelength at middle frequency). Simulation and measured results display that the proposed antenna has a bandwidth of 85% for S_{11}<-10 dB and found out RHCP gain>6 dB from 2.2 GHz to 5.5 GHz. The proposed layout technique is appropriate for UWB Circularly Polarized patch antenna programs.

An incipient compact wideband circularly polarized (CP) micro strip antenna with multiple mode is proposed. The antenna consists of a CP rectangular-loop with sequential phase (SP) characteristics. Four strip-strains are driven elements, four L-shaped patches with I-slots, and four I-shaped patches as parasitic elements [6]. The square-loop is utilized to victual the two pairs of parasitic patch arrays in a capacitively coupled way. The proposed antenna has an extensive 3-dB axial ratio bandwidth (ARBW) of 18.9% (6.35 GHz, 5.75-6.95 GHz), and a huge 10-dB impedance bandwidth (IBW) of 23% (6.38 GHz, 5.65-7.12 GHz). Besides, the presented antenna functions flat benefit inside the CP operation bandwidth and compact shape. A tunable circularly polarized (CP) microstrip patch antenna advanced the use of 3-dimensional printing is proposed. The circular polarization is accomplished by a unique technique of introducing an L-formed in a square patch antenna. Moreover, by way of loading the four edges of the patch with shunt varactors, the

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frequency of the antenna can be tuned while preserving circular patch radiation[7]. The usage of 3-D printing for production permits the vertical integration of varactors between the patch and the ground, such as integration minimizes the interplay of varactors with the radiating residences of the antenna and results in decreased parasitic. Measured consequences show that the antenna has a frequency tuning range of 27.2% for CP operation with the centre of tuning variety around 1.9 GHZ. The 3dB axial ratio bandwidth stays above 3% for each constant frequency band of operation.A low profile circularly polarized (CP) narrows slots slotted-patch antenna for huge 3-dB axial ratio beam width (ARBW) overall performance is supplied. It includes two pairs of slender slots along the diagonal traces of a square patch with a feed [8]. Those pair of slender slots are conceived and positioned to serve as magnetic dipoles with quarter wavelength separation, forcing the amplitude of the orthogonal electric area components to be identical across a extensive angle. The 3-dB ARBW of the CP antenna is a sturdy feature of the mutual magnetic area which is viable to alter with distinct parameters of the slot. The location, dimensions, and gap between the slots are turned to attain extensive 3-dB ARBW. The minimal top gain achieved is 3.87 dB in the broadside course.

A high directive micro strip antennas are attractive for lines of communication due to low profile. To acquire an excessive directive radiation sample, the geometry of a patch running at a mode is modified to minimize the effect of out-of-segment currents [9]. Two high directive micro strip patch antennas running at changed TM_{30} and TM_{50} modes are provided. The benefit of the proposed approach compared to an antenna array is that no feeding community is required and as a consequence, the layout is less complicated and avoids the losses as a result of the feeding network. A prototype to validate the proposed method is built attaining a measured directivity of 14.6dB. The micro strip patch antenna has a total /2) and its measured bandwidth is four instances lambda/2) × 3(lambda size of three (then of an equal array of micro strip patches operating in its fundamental mode. A Compact Dual Circularly Polarized Antenna with Wideband Operation and High Isolation is proposed. It presents a dual-sense circularly polarized (CP) antenna with compact size, high isolation, and wideband characteristics. The antenna consists of a micro strip patch, an array of parasitic metal plates situated around the patch, and a 90° branch line coupler as alimenting structure [10]. Unlike the conventional design method, we demonstrate that the wide isolation bandwidth can be achieved with an imperfect coupler and imperfect matching at the radiating element. The final design with overall dimensions of $0.59\lambda_c \times 0.59\lambda_c \times 0.06\lambda_c$ (λ_c is the free-space wavelength at centre operating frequency) was fabricated and tested. Quantifications on the fabricated archetype show that the antenna has a bandwidth of 16.5% (5.0–5.9 GHz) with port isolation of better than 15 dB. In addition, a peak broadside gain of about 6.6 dB is procured. In comparison with other cognate works in literature, this antenna has advantages of wide operating bandwidth with high isolation while possessing a compact footprint.

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[1] FLOWCHART

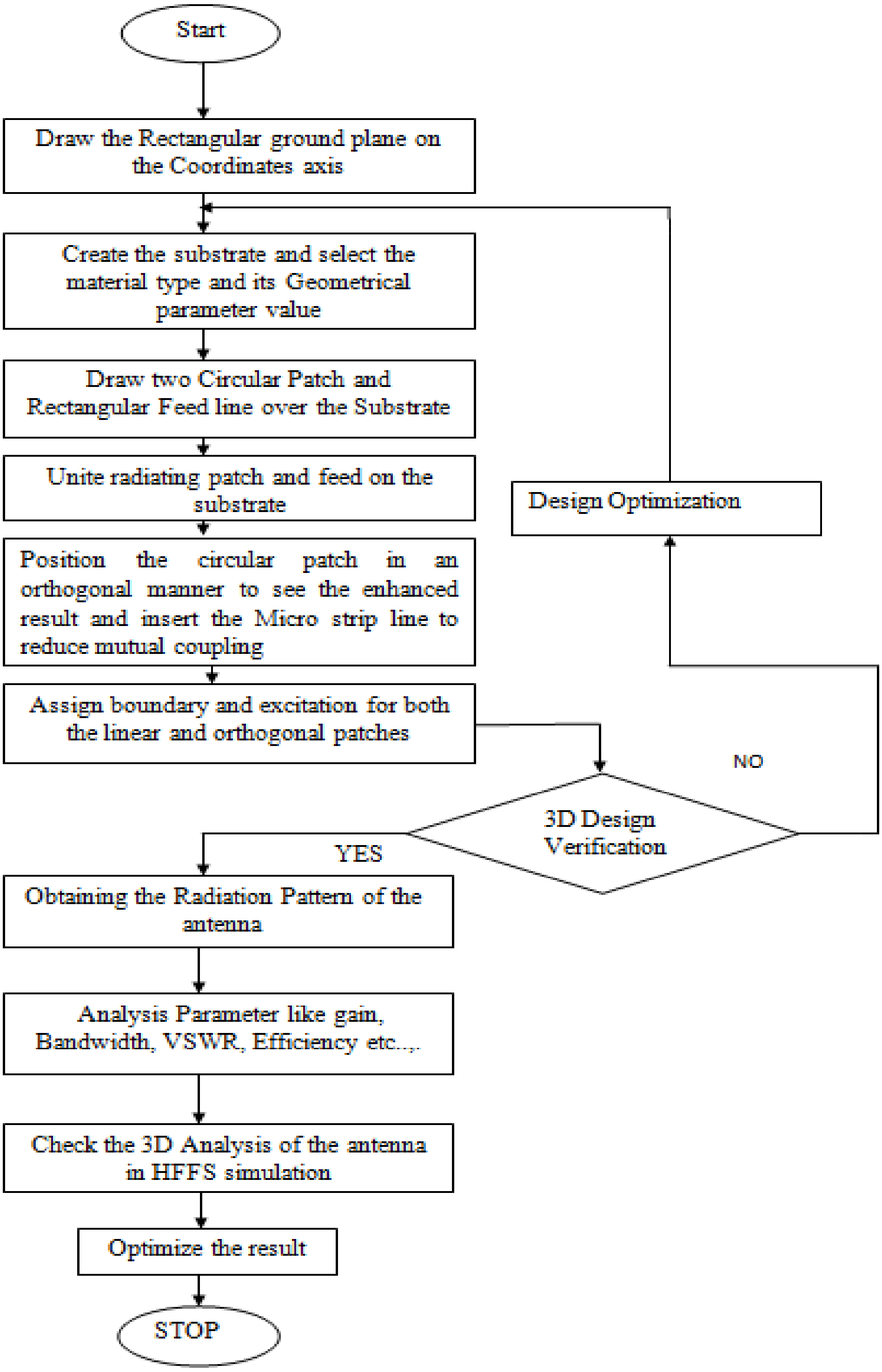

Fig1:Flowchartoftheproposedmethod

FLOW CHART DESCRIPTION

The Rogers substrate is created with its geometrical value of length 115.7mm, height 1.6mm,and width 87.39mm. Two circular patches are drawn on the substrate with a radius of 17mm andrectangular feed lines were given to an antenna. Unite the radiating patch and feed on the substrate.Place the linear circular micro strip patch antenna in opposite direction for getting better results.Micro strip feed line was drawn

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between two linear arrays to reduce the mutual coupling. Assignboundary and excitation for the patches. The 3D dimension of an antenna is verified to obtain aradiation pattern. The radiation boundary is included as part of the simulation, also the parameterslikegain, return loss, bandwidth, directivitywillbeobtainedfromthe designedantenna.

PROPOSED METHOD

To overcome the existing method the 2x2 linear micro strip circular patch antenna isdesigned. To strengthen the performance of the antenna 1x2 linear patches should be positionedorthogonally to achieve polarization diversity. The proposed antenna design includes two linearcircularpatchespositionedfacingoppositesides.TheRogerssubstrateiscreatedwithitsgeometrical valueoflength 115.7mm,height1.6mm,andwidth 87.39m.Thepatchesareconnected with the feed and the lumped ports. Two circular patches are drawn on the substratewith a radius of 17mm and rectangular feed lines were given to an antenna. Lumped ports ofthe antenna are always applied inside the radiation box. The two 2x2 linear circular patches areisolated by a micro strip feed line, to reduce the interference between the antenna. Unite theradiating patch and feed on the substrate. Assignboundaryandexcitationforthe patches.Place the linear circular micro strip patch antenna inopposite direction for getting better results. Micro strip feed line was drawn between two lineararraystoreducethe mutualcoupling.The 3D dimension of an antenna is verified to obtain a radiation pattern. The radiation boundaryis included as part of the simulation, also the parameters like gain, return loss, bandwidth,directivity will be obtained from the designed antenna. The geometric design of the ProposedAntennais showninfig2.

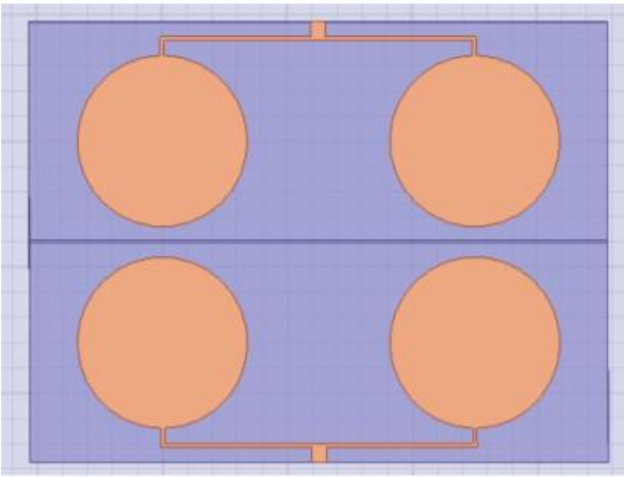

Fig 2: Geometric design of the proposed antenna

DIFFERENT SHAPES OF ANTENNA

The pentagon and hexagonal shape of 2x2 linear micro strip patch antennas are placedfacing opposite to each other. The gain, directivity and bandwidth achieved by two differentshaped antennas are quite low which is not suitable for WIMAX application. Comparing theresultswiththeproposedcircularpatchantenna,itachievestheimprovedperformanceofincreased bandwidth, gain, high directivity and VSWR is less than 1.2 which is contrast to thepentagon and hexagon shape antennas. The 2x2 linear pentagon and hexagonal shape micro strippatchantennais showninfig3&4.

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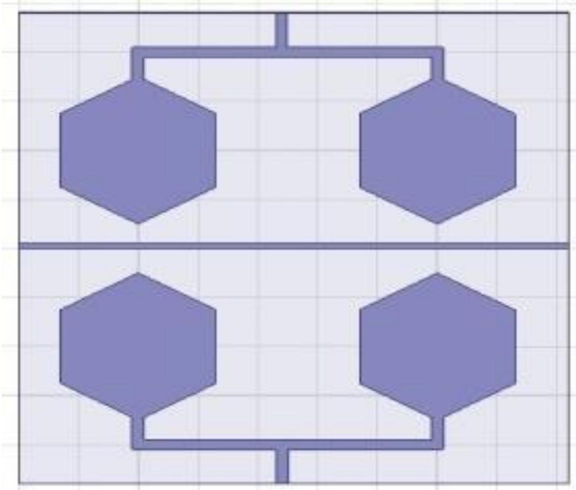

Fig 3: 2x2 linear Hexagonal shape micro strip patch antenna

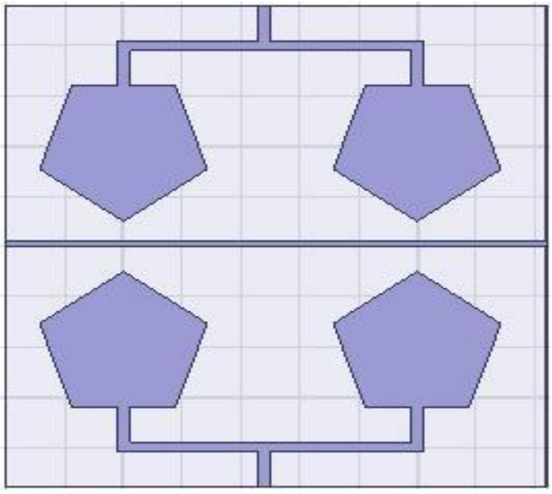

Fig 4: 2x2 linear pentagon shape micro strip patch antenna

[2] DESIGN PARAMETERS OF THE PROPOSED ANTENNA

Table 1: Design values of the proposed antenna

DIMENSIONS	VALUES(mm)
R	17
L_{sub}	115.7
W_{sub}	52.9
L_1	4.7
D	62.5
W_1	61.8
W_2	40.1
L_2	4
W_3	0.5
F	1.6

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DIMENSIONAL LAYOUT AND DESCRIPTION

The rectangular ground plane is drawn on the coordinate axis. The Roger'ssubstrate is created with its geometrical value of length 115.7mm, height 1.6mm, andwidth of 87.49mm. Two circular patches are drawn on the substrate with a radius of17mm and rectangularfeed lines of distance 52.9mm were given to an antenna. The rectangular feed line is inserted in the middle of the patches to reduce the interferences.

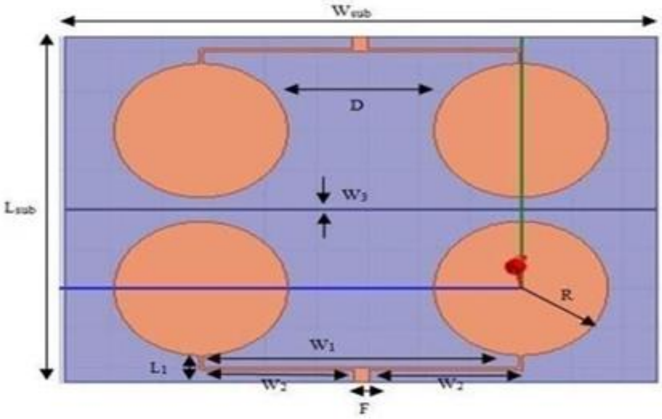

Fig 5: Dimensional layout of the proposed antenna

RESULTS AND DISCUSSION

REFLECTIONCOEFFICIENT|S_{11}|

The term reflection coefficient determines that how much frequency wave is returned byimpedanceisalackofcontinuityinthetransmissionlinemedium.The obtainedproposed antenna $S_{11}$is 13.58 dB that is 10% reflection and 90% of power is radiated into theantenna.

$$\text{ReflectionCoefficient} = \frac{VSWR-1}{VSWR+1}$$

$$= \frac{1.15-1}{1.15+1}$$

ReflectionCoefficient=0.069

RETURN LOSS

Returnloss(RL)isdefinedasthepowerlossinthereturnedsignalbyadisruption inatransmissionline.

$$\text{Returnloss} = -20\log_{10}(r)$$

$$= -20\log_{10}(0.069)$$

$$= -23\text{dB}$$

Whererisreflectioncoefficient

Thereturnlossachievedbytheantennais-23dBsothepowertransmittedto theantennaismaximumwithminimumreflection.

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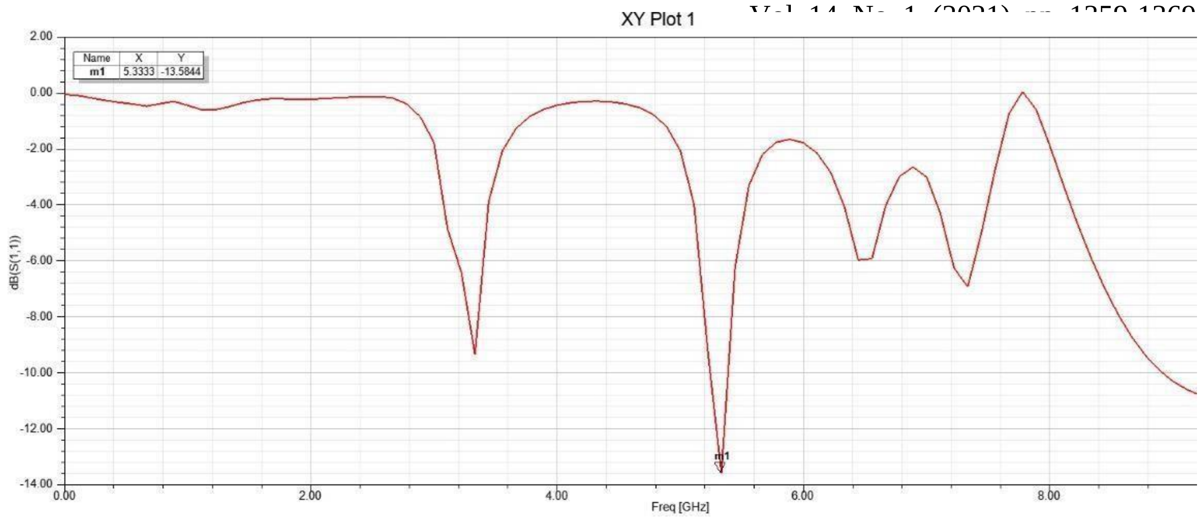
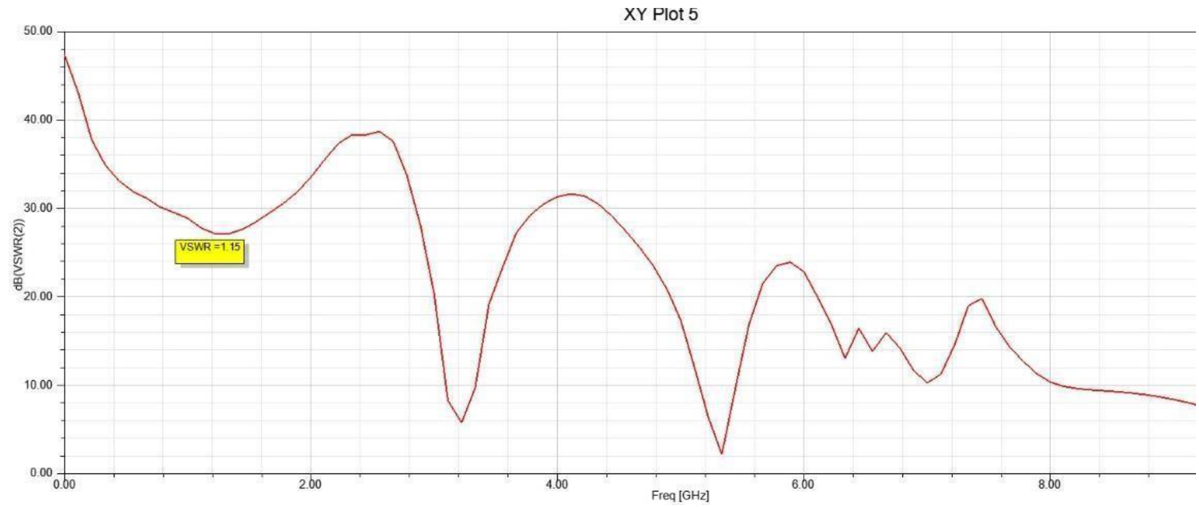


Fig 6: Simulated $|S_{11}|$ Graph

VSWR

VSWR – (Voltage Standing Wave Ratio), it is defined as the power reflected from the antenna into a medium of transmission line.

Fig 7: Simulated VSWR graph



$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

$$= \frac{1-|0.0069|}{1-|0.0069|}$$

$$=1.148$$

TheVSWRachieved bytheantennais1.15 which lessthan2.

GAIN

Itisdescribeasthecapabilitytotransmitpowerofan antennain specificdirection as comparedtoanydirectioninanisotropicantenna.Theobtainedgainoftheproposed designis7.61dB whichis greater thantheexistingdesign.

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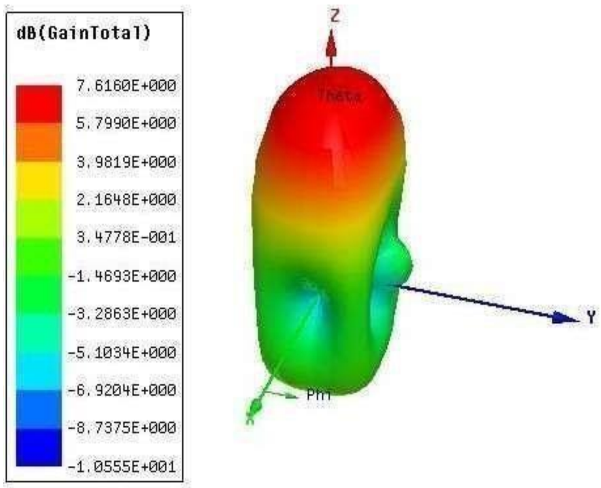
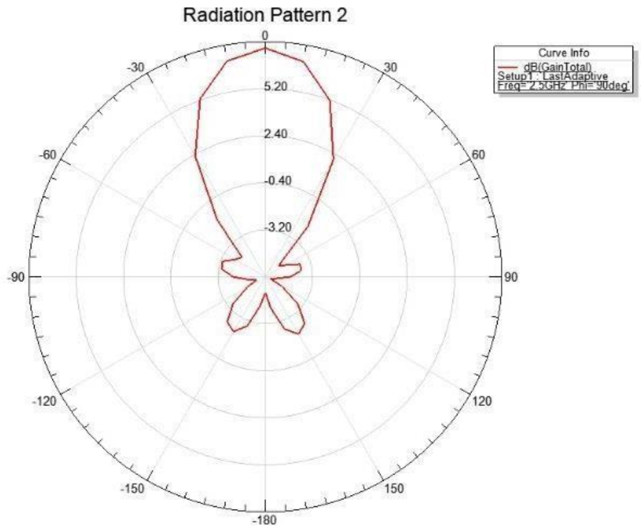


Fig 8: 3D Polar Plot (Gain Total)

RADIATIONPATTERN

It dependent upon the energy of the radio waves from the antenna. The patchantenna radiates energy in specific directions. From the fig 9 graph, itcan benoticedthat the antenna radiation is bidirectional. Here the far-field pattern is appearingin 90deg.

Fig 9: Simulated radiation pattern graph



COMPARISON OF GEOMETRIC VALUES OF DIFFERENT SHAPES OF ANTENNA

The following table shows the results of various shapes of micro strip antenna. The1x2 linear array antenna shows the better gain compared to orthogonally placed 2x2 linearmicro strip circular patch antenna but the VSWR achieved is good in orthogonally microstripcircularpatchantenna.

Table 2: The comparisons ofdifferent shapes ofpatch antenna

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The above mention table 2 shows that the comparison of differentshapes of patchantenna that the parameters like gain, directivity, VSWR, return loss of the proposed antenna.The comparison table helps to study the performance of existing and proposed design. Theproposed antenna has achieved high gain and directivity compared with other shapes of theantenna.

CONCLUSION

The techniquesfor enhancing the parameterslike gain,directivity, and VSWR andreturn loss are implemented and simulations are done using ANSYS HFSS electromagnetic simulator. The proposed antenna has total gain of 7.61 dB and its voltage standing wave ratio of 1.15. The return loss of -23 dB, directivity of 8.5 and bandwidth is achieved 5.3GHz. In proposed design the 2x2 linear circular patch antenna is placed orthogonally due to polarization diversity. Parameters are measured and compared with various geometrical values of different shapes by placing the antenna in a orthogonal position. From the analysis of three different shapes of micro strip patch antenna the circular patch antenna has obtained good result in various parameters. The proposed design isobserved at the desired operating frequency of 2.5 GHz. Then, the proposeddesigned antenna has excellent Omni-directional pattern. From the above results conclude that Maximum gain compared with existing design, VSWR is less than 1.2, directivity, and return loss, direction pattern and bandwidth have been achieved. It is suitable for WiMax applications.

DESIGN NAME	GAIN	DIRECTIVITY	VSWR	RETURNLOSS
1x2lineararraywithout horizontal feedline	6.76	6.80	1.03	-36dB
1x2 linear array with horizontal feedline	7.64	8.70	1.21	-20dB
Two linearorthogonallypositioned Pentagon shape Antenna	6.05	2.23	1.02	-41dB
Two linearorthogonallypositioned Hexagonshape Antenna	3.58	3.41	1.007	-49dB
Twolinearorthogonally positioned micro strip patchPentagonAntenna	7.61	8.55	1.15	-23dB

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