

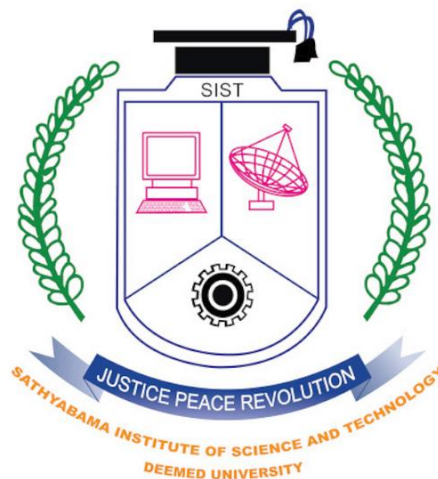
Design and Analysis of a Circular Patch Antenna for 5G Applications

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering Degree in Electronics and Communication Engineering

by

THOTA CHARAN (37130410)

B. VINOD KUMAR (37130440)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade “A” by NAAC
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **THOTA CHARAN (37130410)** and **B. VINOD KUMAR (37130440)** who carried out the project entitled **"Design and Analysis of a Circular Patch Antenna for 5G Applications"** under the supervision from September 2020 to April 2021.

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DECLARATION

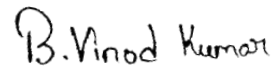
We, **THOTA CHARAN (37130410)** and **B. VINOD KUMAR (37130440)** hereby declare that the Project Report entitled “**Design and Analysis of a High Gain Circular Patch Antenna for 5G Applications**” done by us under the guidance of **Ms. L. Magthelin Therase, M.E.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 19.04.2021

PLACE: Chennai



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ABSTRACT:

The 5G technology requires and provides the high speed and high capacity for wireless communication like IoT, which has been used for all previous and current generations of mobile communication. In this project, a circular micro strip patch antenna has been designed at frequency of 28 GHz. A design has been analyzed at various stages of development. The patch has been designed on an FR-4 epoxy substrate material that has a dielectric constant of 4.4. Various parameters such as return loss, bandwidth, VSWR, gain, and radiation patterns are stimulated employing Ansys HFSS software. The designed antenna resonante at 28 GHz with return loss of -32.5274 dB, bandwidth of 4.52 GHz, VSWR of 0.2384, and gain of 2.9 dB which can be used for 5G applications.

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CHAPTER 1

INTRODUCTION

An antenna is called the device for the transmission and receiving of signals. An individual who needs a thought, idea, or doubt can do so through voicing. Communication occurs via sound waves. However, if two people want to communicate at longer distances, these sound waves have to be transformed into electromagnetic waves. An antenna is known as the device which converts the required signal to electromagnetic waves. An antenna is an electric power transducer that turns electric power into electric magnetic waves and vice versa. A transmission antenna or reception antenna can be used. An electromagnetic wave transmitting antenna converts and radiates electrical signals. A receiving antenna transform electromagnetic waves in electrical signals from the received transmission beam. The same antenna can be utilized both for transmission and reception in two-way communication. Whenever wireless communication is necessary, the necessity of an antenna arises in the field of communications systems. With the end goal of correspondence, a radio wire can send or get electromagnetic waves to set up a link framework.

1.1 WIRELESS COMMUNICATION

Without the aid of wires, cables or other forms of electric conductors the wireless transmission of information over a distance involves. Wireless communications comprise the full range of wireless communications techniques and devices which incorporate all the connection and communication processes between two or more devices using the WLAN signal.

1.1.1 Block diagram of Wireless Communication

The transmitter, Channel and Receiver are the three elements which can be separated from a typical wireless communications system.

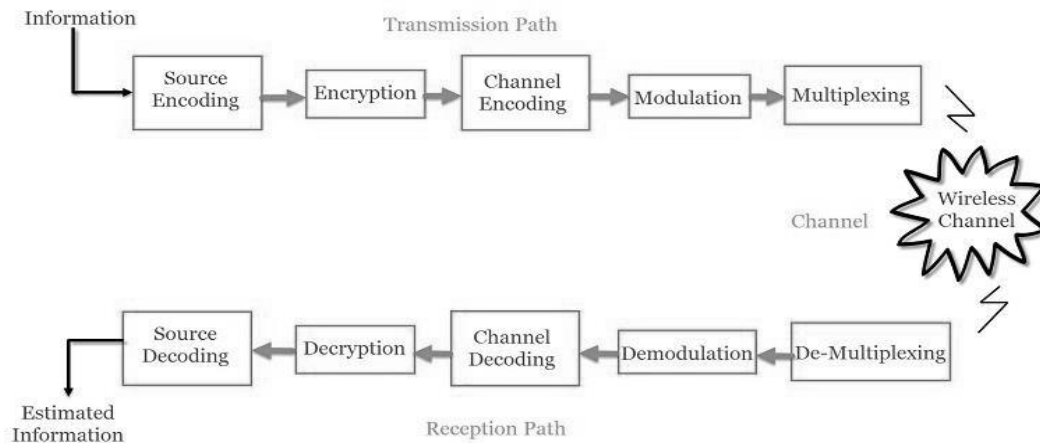


Fig: 1.1 Block diagram of Wireless Communication

1.1.1.1 The transmission path:

The Encoder, Encryption, Modulation and Multiplexing is a standard transmission track of a wireless communication system. The source signal is transmitted via encoder that convert the signals into a form suitable for use with signal processing techniques.

In this process, redundant signal information is removed to maximize resource use. Signal encryption is then carried by an Encryption Standard, to secure the signal and the information and prevent unauthorized access.

Channel encoding is a technology used to reduce signal deficiencies such as noise, interference, etc. During this process the signal is introduced to a small amount of redundancy, which makes it robust against the noise. The signal is then modulated with the appropriate modulation techniques (such as FSK, PSK, QPSK etc.) to enable antenna transmission of the signal.

The modulated signal is subsequently multiplied by other signals using a number of multiplexing technologies such as Time Multiplexing Division (TDM) or FDM to share the good bandwidth.

1.1.1.2 The channel:

The wireless channel shows the transmission medium of signal, i.e. open space. An unpredictable wireless channels are also extremely variable and random innature. The signal received may be filled with error, and this may lead to interference, distortion, noise, dispersal, etc.

1.1.1.3 The reception path:

The recipient's work is to get and reproduce the signal from channel as signal. The receive system paths includes demultiplexing, demodulation, decoding of channels, decoding of sources and decoding of sources. From the reception path components, it is evident that the recipient's function is just theother way round.

The Demultiplexer gets the sign from the channel and is isolated from different signs. Singular signs are demodulated by the suitable methods of demodulation and the first message signal is reviewed. The repetitive pieces are erased from the message with the channel decoder.

Since the message is scrambled, signal decoding eliminates the security and makes it a straightforward piece succession. At last, the source decoder gets this sign for returning the first message or sign sent.

1.1.2 Features of wireless communication

With many effective features, the development of wireless technology has led to advances.

The distance transmitted can be between a few meters and thousands of kilometres (such as remote control) (for example, radio communication).

1.1.3 Wireless - Advantages

Without a connection between two or more-point, wireless communication involves the transfer of information. Due to the absence of any physical infrastructure, there are certain advantages to wireless communication. Often this would include collapse of distance or room.

There are many advantages to wireless communication;

1.1.3.1 Cost effectiveness

Connection wires are used by wired communication. Communication in wireless networks requires no detailed physical or maintenance infrastructures. The costs are therefore lowered.

1.1.3.2 Flexibility

Wireless communication allows people, regardless of their location, to communicate. To receive messages, it is not required to stay in an office or a telephone stand

1.1.3.3 Convenience

Wireless communication devices such as mobile phones are very simple and thus permit everybody to use them anywhere. To receive or pass messages, there is no physical connection required.

1.1.3.4 Speed

Speed enhancements can also be seen. Accuracy and speed were greatly improved for network connectivity or accessibility.

1.1.3.5 Accessibility

Wireless technology facilitates easy access as ground lines are easily connected to the network in remote areas that cannot be properly laid.

1.1.3.6 Constant connectivity

Constant connectivity also guarantees that people will respond relatively quickly to emergence.

The important Wireless Communication System trending now:

- ❖ Broadcasting TV and radio
- ❖ Radar mobile telephone system satellite communication (Cellular Communication)
- ❖ System of Global Positioning (GPS)
- ❖ Communication infrared
- ❖ Wi Fi is free (Wi-Fi)
- ❖ Cordless phones Bluetooth Paging
- ❖ Identification of radio frequency (RFID)

1.2 MICROSTRIP PATCH ANTENNA:

Low-profile antennas are micro strip antennas. A micro stripe or patch antenna is a metal plot mounted on a floor with a di-electric material in between. These antennas are very small and have low radiation.

Micro slip antenna consisting of an very tinny metal strip on an floor plane, with an intermediate di-electric material. Through a photo-etching process on the di- electric material the radiating element and power lines are positioned. The square, circular or rectangular patch or micro strip is generally designed to facilitate analysis and production.

1.2.1 Frequency range of patch antennas:

For applications with low profile at frequencies above 100MHz, the patch antennas are popular.

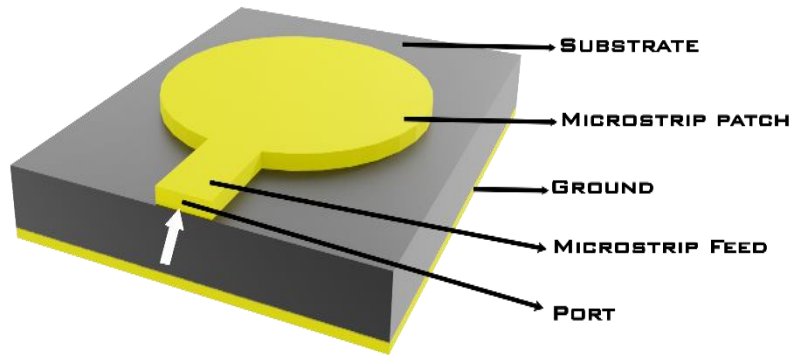


Fig: 1.2: Microstrip patch antenna

1.2.2 Different feeding techniques

A feedline is used for direct or indirect contact radiation. There are a number of different feeding techniques. The 4 most general techniques include coaxial enquiry feeding, micro strip connection, opening connection and close connection.

1.2.2.1 Coaxial probe feeding

The taking care of strategy for coaxial sensors is that a coaxial interior conductor will be joined to the radio wire's radiation fix while the outside conveyer is associated to ground plane. The upsides of coaxial taking care for are not difficult to produce, simple to coordinate, low false radiation and tight data transmission are inconveniences.

1.2.2.2 Microstrip line feeding

One of the simpler strategies to make Microstrip line feed is as it is a solitary driving band interfacing with the fix and accordingly can be viewed as an extension of the fix. The inset position is not difficult to demonstrate and simple to coordinate. The disadvantage of this strategy, notwithstanding, is that with the expanded thickness of the substrate, the surface wave and erroneously took care of radiation increment that restricts the data transmission.

1.2.2.3 Aperture coupled feeding

The opening associated feed includes two separate substrates, isolated by an earthbound plane. There is a micro strip feed line in the underside of the lower substrate, the energy of which is associated by a space in the ground plane, what isolates two substrates. This framework permits the feed system and the transmitting component to be autonomously upgraded. Top base ordinarily utilizes a thick low dielectric consistent base while it is a high dielectric substrate for a lower base. In the middle the ground plane segregates the feed from the radiation component, limiting impedance from counterfeit radiation for the arrangement of examples and virtue of polarization. Advantages permit indeptibility

1.2.2.4 Proximity Coupled feeding

Close connection has largest bandwidth, low falsified radiation. The manufacture, though, is hard. The match is controlled by stub feeding length and patch width-to-length ratio. It is capacitive in nature in its coupling mechanism. The main disadvantage of this feeding technology is that due to the 2 dielectric layers which essential appropriate harmonization, it is hard to produce. The overall thickness of the antenna is also increased. The various structures of the Microstrip antennas are available in the wide variety of antenna models, but the antenna has 4 basic parts: It is the following:

- Patch
- Dielectric Substrate
- Ground Plane
- Feed Line

1.2.3 Advantages of Micro strip patch antenna:

The following are the advantages of Micro strip patch antenna:

- ❖ Ease of installation
- ❖ Light weight
- ❖ Minimal rates

1.2.4 Disadvantages Micro strip patch antenna:

The following are the disadvantages of Micro strip patch antenna:

- ❖ Inadequate radiation
- ❖ Bandwidth of narrow frequency

1.2.5 Applications of Micro strip patch antenna:

The following are the applications of Micro strip antenna:

- ❖ Applications used in spacecraft
- ❖ Applications used in aircraft
- ❖ Used for applications with low profile antennas.

Table 1.1: Comparison of Advantages and Disadvantages of Micro strip patch antenna

Sr. No.	Advantage	Disadvantage
1.	Low weight	Low efficiency
2.	Low profile	Low gain
3.	Thin profile	Large ohmic loss in the feed structure of array
4.	Required no cavity backing	Low power handling capacity
5.	Linear and circulation polarization	Excitation of surface wave
6.	Capable of dual and triple frequency operation	Polarization purity is difficult to achieve
7.	Feed lines and matching network can be fabricated simultaneously	Complex feed structures require high performance arrays

Table 1.2: Comparison of Microstrip Patch Antenna, Microstrip Slot Antenna and Printed Dipole antenna

Sr. No	Characteristics	Microstrip Slot Antenna	Printed Dipole antenna	Microstrip Patch Antenna
1.	Profile	Thin	Thin	Thin
2.	Fabrication	Easy	Easy	Very easy
3.	Polarization	Both linear and circular	Linear	Both linear and circular
4.	Dual- Frequency operation	Possible	Possible	Possible
5.	Shape flexibility	Mostly rectangular and circular shapes	Rectangular and triangular	Any shape
6.	Spurious radiation	Exists	Exists	Exists
7.	Bandwidth	5-30%	-30%	2-50%

1.3 Electromagnetic band-gap (EBG)

Electromagnetic band-gap (EBG) structure is a construction that makes a stop band to impede electromagnetic influxes of certain recurrence groups by shaping a fine, occasional example of little metal patches on dielectric substrates. EBG alludes to such a stop band just as to substances that have such a construction. Uses of the EBG structure incorporate parts of electronic gadgets to smother electromagnetic commotion.

Then again, the EBG structure reflects minimal electromagnetic floods of the recurrence groups it can identify, and gets them at a high affectability. Additionally, its goal (the capacity to gauge and segregate electromagnetic waves) can be improved by setting the metal patches at a higher thickness. Because of these attributes, the EBG structure is likewise used for sensors to quantify electromagnetic radiation. Issues like minimization, wide band width with low constriction level, tunability and appropriateness with planar hardware all play a significant role in EBG

structure.

1.4 SUBSTRATES

Generally, Substrate or wafer is solid (usually planar) substance onto which an layer of another substance is practical, and to which 2nd substance follows. Substrate is the binding substance present between the radiating patch element and the ground plane. In patch antenna point of view, Substrate is a dielectric material over which patch is etched. There are numerous substrates present such as fr4, rogers duroid, tanonic, fabric etc. In this Project, Rogers Duroid RT 5880, Velcro, Fleece and Polystyrene Foam are used as substrates.

1.5. ANTENNA PARAMETER

1.5.1 GAIN OF THE ANTENNA

Gain is a proportion of the dimensions of the radio wire to coordinate the info power into radioactivity a specific way and is estimated at pinnacle radioactivity force. It is ordinary repetition to apply an isotropic radiator as orientation recieving wire. An isotropic radiator is a speculative lossless radio wire that transmits its energy correspondingly. This suggests that addition of an isotropic radiator is $G = 01$ (0 dB). It is ordinary repetition to apply at unit db.

1.5.2 DIRECTIVITY

Directivity is a boundary of a radio wire which estimates how much the radiation transmitted is amassed a solitary way.

1.5.3 RESONANT FREQUENCY

Resounding recurrence is the recurrence where the capacitive and inductive reactance's counteract one another. Now the radio wire shows up absolutely resistive, the obstruction being a blend of the misfortune opposition and the radiation obstruction.

1.5.4 RETURN LOSS

Return loss is deficiency of influence in sign returned/reflected by crisscross with ending load or with a gadget embedded in the line. Unit of return misfortune is decibels (dB).

1.5.5 RADIATION PATTERN

A radiation design characterizes variety of force emanated by a receiving wire as a component of course away from radio wire.

1.6 5G SPECTRUM IN THE MILLIMETRE WAVES

The 5G is the up-and-coming age of the 4G organization. Most of business 5G organizations are depending on range inside the 3.3 - 3.8 GHz range. Spearheading super high paces and the most reduced latencies are reliant on admittance to range in the last reach. Here, 26 GHz and 28 GHz have arisen as two of the main 5G range groups. They offer the amplest harmonization with limited client gear intricacy.

To expand adaptability, 40 GHz (37-43.5 GHz) is likewise significant. At WRC-19, nations upheld a blended ID of 26 GHz, 40 GHz, and 66 GHz for super fast and super low inertness purchaser, business and taxpayer driven organizations. The gathering likewise made it conceivable to begin utilizing 50 GHz for 5G.

CHAPTER 2

LITERATURE SURVEY

Design of 16 Element Rectangular Patch Antenna Array for 5g Applications

AUTHOR: Vishnumolakala Jyothika, Madu Sai Poorna Chandra Shekar

This paper represents the plan of 16 element rectangular patch array antenna for 5G applications this gives a sensible transfer speed about 28 GHz. This is the most component of this course of action could be a rectangular fix receiving wire outlined on the Rogers RT / Duroid 580 substrate ($\epsilon_r = 2.2$, $\tan\delta=0.00009$), which is recreated and optimized utilizing a commercially access recreation program. Length of rectangular fix antenna is 3.58 and breadth is 4.52. Within the later a long time the improvement in communication frameworks demand the advancement about low cost, negligible weight and low-profile radio wires this are able of keeping up tall execution over a wide range of frequencies.

A Compact Wide-Band Microstrap Filter Antenna Design for 2.40 GHz I.S.M Band and 4.G Applications

AUTHOR: Al Yasir, Moohammed K.Akhafaji

Another and limited four-post wide-band planar channel receiving wire setup is proposed in this paper. The effect of the dielectric material sort on the characteristics of the arrangement is moreover investigated and presented. The channel radio wire structure is outlined by a fourth-order planar band-pass channel (BPF) fed with a monopole microstrip receiving wire. The arranged channel receiving wire works at a center repeat of 2.4 GHz and has a respectably wide-band impedance information transmission of about 1.22 GHz and a halfwave bandwidth (FBW) of about half. The effects of three exceptional sorts of substrate material, which are Rogers RT05880, Rogers R03003, and FR-4, are investigated and presented using a comparable plan.

Design of Multiband Microstrip Patch Antenna For Wlan, Wimax And X-Band Applications

AUTHOR: Proonami , Challaapalli gunna shekhar, Phatan Sameer khan, Kokatam.vinay reddy, Marthala.Venkat sai, P. Pardhasaradhi

This letter portrays a little, single-feed, circularly captivated fix radio wire for broadband. The radio wire comprises of a microstrip fix and pins on the Reactive Impedance Surface motivated by meta material. The RIS structure, comprising of four or four ordinary metallical square fixes and 4 shorting pins which assists with improving the recieving wire data transfer capacity. The last enhanced construction displays an impedance data transfer capacity of 53.750%(4.650GHz,7.6170GHz) alongwith a 3-dB hub proportion transfer speed of 30.40%(4.62420GHz,6.336GHz). Besides, the work is radio wire yield a decent main side increase of 5.8 dBi at 5.52Ghz

A Compacted Multiple Slot Microstrip Antenna for Recent Mobile Communication

AUTHOR: Sugadav, Dr. E. Logashanmugam

This paper deals with a compact three-band antenna microstrip. At 3.60 GHz, 5.60 GHz and 7.90 GHz the frequency at which the antenna resonates. The triple band antenna design was miniaturized here. Due to its rigid structure and the loss of the substrate used here, FR-4 Epoxy resin. For the triple band, both simulation and measured results, the antenna as achieved a returnloss off <-10 dB. For this antenna, the VSWR value is under 2 and the gain is 0.86 dB. The antenna's dimensions are 13.6 x 13.6 mm² and thus the substratum used is a square substratum.

Design Array Antenna Using Diffirent Feeding Technique in HFSSAUTHOR:

K. DurgaRao and K. N. Pillai

This article deals with antennas in a design array using various feeding methods. Corporate feeding and series feeding techniques are the feeding methods used here. The return loss is -27.57 dB for a single microstrip antenna. VSWR 1.083 with 7.2601 dB of gain. The return loss is -10.5767 dB for series feed technique, 1,8406 for VSWR, 12.28 dB for Gain. The return loss for corporated feed is -29.818dB, VSWR is 1.0668 and a profit of 13.5 dB. The design was optimized with HFSS

software and simulated.

A High Gain Microstrip Patch Antenna with Slotted Ground Plane for Sub-6 GHz 5G Communications

AUTHOR: Olawye, Taiwoo and Kumar.P

This article is on the slotted ground-mounted patch antenna for wireless communications of sub-06 GHz 5th generation. This defective ground structure (DGS) technique has now been introduced. In the ground level, there is a "C"-shaped slot. FR4 epoxy resin is used as the dielectric material or the dielectric substratum. The relative permeability is 4.4 and insert feeding technology is used here. The antenna is 28.03 x 23.45 mm² in size. This clearly shows that the rectangular substratum used here resonates between 4.8 GHz and 5 GHz in the sub-6 GHz for 5G. The antenna maximum gain is 5.49 dB, the directivity maximum is 7.12 dB. The CST studio suite simulates and optimizes this antenna.

A 30GHz Microstrip Square Patch Antenna Array for 5G Network

AUTHOR: D. Oknwum, J. Abolariwa and O. Osaniye

This paper covers the 5G mobile communication microstrip array antenna. This antenna is designed for use in a wave band with a millimetre. FR 4 epoxy resin with a permittivity of 4.4 and a thickness of 1.6mm is dielectric or dielectric material used here. The substratum used is a large 10 x 10 mm² square substratum. The array consists of a 4 x 2 square array of antennas. At 30 GHz a high gain, power efficiency, and better bandwidth are achieved with this array of antennas.

Design and analysis of insert-fed reconfigurable antenna for 5G (sub-06 GHz) applications

AUTHOR: M. Vino, J. Belbin Lijjo, S. Allan, Dr. M. Sugadav

This paper is about the microstrip patch antenna for 5G (Sub-6GHz) applications. The dielectric substrate or dielectric material used in this antenna is FR-4 epoxy resin with permittivity of 4.4. The dimension of this antenna is 35.6 x 35.6 mm². The dimensions clearly convey that the substrate used is a square substrate. The thickness of the substrate is 1.1mm. The frequency at which the antenna resonates is 3.5 GHz and 6.68 GHz. The gain of 3.2 dB. The return loss of -23 dB for 3.5 GHz and -21 dB for 6.86 GHz. The minimal rated loss is achieved at 3.5 GHz which clearly indicates that this antenna is suitable for 5G wireless applications.

Design and Implementation of Microstrip Patch Antenna for 5G applications

AUTHOR: J. Colaco and R. Lohani

This paper discusses the 5G microstrip patch antenna with a frequency of 26 GHz. This paper is used on 5G millimetre. Specifications in India for the Radio Frequencies Spectrum range from 24.5 GHz to 29.5 GHz for millimetre wave bands. Rogers RT / Duroid with a 0.65mm substrate height and a dielectric constant of 2.2 is the dielectric substrate or dielectric material used in this case. This antenna is -3.4 degree in the reflection coefficient or in the return loss. The VSWR value of this particular antenna is 1.03 which is less than 2 at 26GHz. The maximum gain is achieved to be 10dB and the antenna radiation efficiency is about 99.5%. This antenna is optimized and designed using FEKO software.

Stacked frequency reconfigurable Yagi-like MIMO antenna system

AUTHOR: D. Hussain, R., Jehangir, S., Khan, M., & Sharawi, M

This paper is about Yagi-like various information numerous yield (MIMO) radio wire frameworks. This MIMO receiving wire comprises of 4 indistinguishable dynamic radio wire components. This antenna resonates between 1.5 GHz to 2.1 GHz. The dimension of this antenna is 100 x 100 mm² and the reflector size is 110 x 110 mm². The dimension clearly shows that it is a square patch antenna. The front to back ratio (FBR) of this particular antenna is ranging from 5 – 13 dB.

CHAPTER 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1 EXISTING ANTENNAS:

- ❖ The existing antennas are of compact size
- ❖ It has wide operating bandwidth
- ❖ The power handling capacity is moderate.

3.2 DRAWBACKS:

- ❖ The Gain is considered to be low.
- ❖ The radiation efficiency is less.
- ❖ The reflection coefficient is low.

3.3 PROPOSED ANTENNA:

- ❖ The dimensions are very less
- ❖ Defected Ground Structure (DGS) technique is used in the ground.
- ❖ Strip-line feeding is used here.

3.4 ADVANTAGES:

- ❖ The Gain, return loss, VSWR and other parameter values have been achieved in a more efficient manner.
- ❖ Higher Efficiency is achieved.
- ❖ Size reduction is done.
- ❖ Low power handling capacity.

3.5 COMPARISON OF PREVIOUS PUBLISHED PAPERS:

Table 3.1: Comparison of Parameters of the Reference Papers

SI.No	TITLE	GAIN	VSWR	RETURN LOSS (dB)	RADIATION EFFICIENCY (%)	DIMENSION (mm ²)
1.	Design Of 16 Element Rectangular Patch Antenna Array For 5g Applications	7.74dB	2.97db	-16.4376 dB	-	3.58 x 4.52
2.	A Compact Wide-Band Microstrip Filter Antenna Design for 2.4 GHz I.S.M Band and 4G Application	4.03 2.43 1.18	1.1937 1.58 2.2	15 12.06 6.0314	50	
3.	Design of Multiband Microstrip Patch Antenna For Wlan, Wimax And X-Band Applications	6.32		-39 dB	53.73	
4.	A Compacted Slot Microstrip Antenna for trends Mobile Communication	0.86 dB	< 2	- 10	-	13.6 x 13.6
5.	Design Array Antenna Using Different Feeding Technique in HFSS	7.260 dB, 12.207 dB, 13.50 dB	1.083 1.84 1.06	- 27.57 - 10.57 -29.81	-	18.62 x 21.42

SI.NO	TITLE	GAIN	VSWR	RETURN LOSS (dB)	RADIATION EFFICIENCY (%)	DIMENSION (mm ²)
6.	A High Gain Microstrip Patch Antenna with Slotted Ground Plane for Sub-6 GHz 5G Communications	5.49 dB	< 2	-	-	28.03 x 23.45
7	A 30GHz Microstrip Square Patch Antenna Array for 5G Network	Highgain	<2	-	-	10 x 10
8.	Design and analysis of insert-fed reconfigurable antenna for 5G(sub-6GHz) applications	3.2 dB	< 2	- 23	-	35.6 x 35.6
9.	Design and Implementation of Microstrip Patch Antenna for 5G applications	10 dB	1.03	- 33.4	99.5	6 x 6
10.	Stacked frequency reconfigurable Yagi-like MIMO antenna system	2.23 dBi	<2	- 11	-	100 x 100

CHAPTER4

EXPERIMENTAL OR MATERIALS AND METHOD

4.1. Software:

Ansyz HFSS is a (3D) electro magnetic (EM) simulations software that design and simulates high frequency electronic products, such as antenna, antenna array, RF or microwave, high speed connectors, filters and IC packets. Globally, the engineers are using Ansys HFSS to develop high-frequency, high-speed communications electronics, radar systems, state-of-the-art driver aid systems (DAAS), satellite devices, IoT products, and more.

The HFSS utilizes adaptable solvers and an instinctive GUI to give you unrivaled execution in addition to an exhaustive comprehension of all your 3D EM issues. HFSS offers amazing and complete Multiphysics examination of electronic items through incorporation with Ansys warm, primary and liquid elements instruments that ensure warm and underlying unwavering quality. HFSS represents best quality level precision and dependability, which can be sped up by elite registering (HPC) innovation, to address 3D EM's difficulties on account of its naturally versatile cross section strategies and complex solvers.

4.2. Substrate material:

The material has fantastic mechanical qualities and is exceptionally practical, making it ideal for a wide scope of electronic applications. As increasingly more microwave frameworks are being created for customer showcases, the expense of these frameworks is altogether diminished. The utilization of FR4 rather than expensive PTFE substrates for microwave circuits and receiving wires could prompt significant expense investment funds. In this paper, the attributes of this material at a microwave recurrence between 1 GHz and 15 GHz are portrayed in a work program embraced at ERA Technology as a component of their Membership Research Program. It is inferred that, because of its high misfortunes, the utilization of FR4 isn't feasible for receiving wire taking care of constructions. In any case, the material could be utilized instead of customary microwave substrate materials for high thickness microwave circuits, where the way lengths are more limited, and for broadband radio wire components, where misfortunes and supreme dielectric

steady qualities are looser, with tremendous expense investment funds. A multi-PCB that can communicate advanced signs at rapid in the high-recurrence area is needed for giving the fast organization climate to adapt to a lot of information. The FR-4 substrate is appropriate to arrange hardware with low dielectric misfortune and low permittivity.

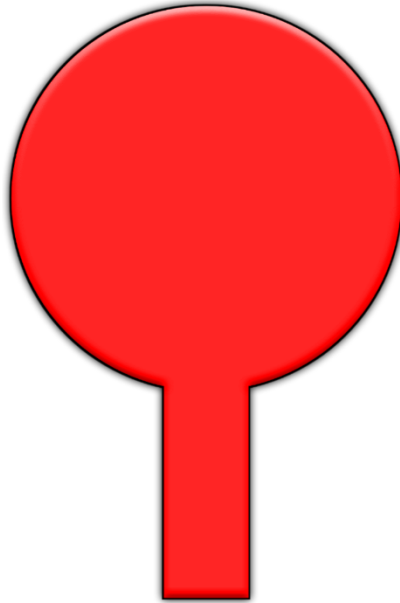


Fig:4.1: Patch Design of Antenna



Fig:4.2: Ground design of Antenna

4.3. Design Calculation

Since the antenna is designed based on rectangular patch antenna, hence the design calculation of rectangular patch is applicable. To obtain the dimensions of antenna need to specifications the dielectric constant of substrate (ϵ_r), the frequency (f_r) and height of the substrate (h). For a patch (w/h) > 01.

- ❖ For the efficient radiators, a width that gives to good radiation efficiency is

$$W = \frac{c}{2f_o \sqrt{\frac{(\epsilon_r + 1)}{2}}}$$

- ❖ Determine effective dielectric constants of the microstrop antenna

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12 \frac{h}{W} \right]^{-1/2}$$

- ❖ W is found determined the extensions of the length ΔL using the below equation.

$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{reff} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left(\frac{W}{h} + 0.8 \right)}$$

- ❖ The length of patch can be determined by solving for L

$$L = \frac{c_o}{2f_r \sqrt{\epsilon_{reff}}} - 2\Delta L$$

Where:

f_r is Frequency

W is Width of Patch

L is Length of Patch

h is thickness

ϵ_r is relative Permittivity of dielectric substrate

c is Speed of light = 3×10^8 m/s.

4.4. Values and Operations:

- ❖ Permittivity = 4.4
- ❖ Frequency = 24.1 GHz, 13.1GHz, 44.4GHz
- ❖ Velocity of Light = 3×10^{11} mm/sec
- ❖ Circle radius = 03mm

- ❖ Effective Permittivity = 2.7
- ❖ Radiation box: $(x, y, z) = (19, 19, 3)$

For Ground Length = 07 mm, Ground Width = 08 mm

1. Substrate Placing (3D)

Position: $(x, y, z) = (0, 0, 0)$

$X(\text{SGL}) = 15 \text{ mm}$

$Y(\text{SGL}) = 15 \text{ mm}$

$Z(h) = 0.8$

2. Ground (2D)

Position: $(x, y, h) = (0, 0, 0)$

$X(\text{SGL}) = 15 \text{ mm}$

$Y(\text{SGL}) = 15 \text{ mm}$

3. Feed Line (2D)

Position: $(x, y, h) = (4, 0, 0.8)$

$X(W_f) = 0.8 \text{ mm}$

$Y(L_f) = 3.5 \text{ mm}$

4. Port (2D)

Position: $(x, y, h) = (4, 0, 0.8)$

$X(W_f) = 0.8$

$Z(h) = -0.8$

CHAPTER 5

RESULT & ANALYSIS

5.1 PATCH ANTENNA DESIGN

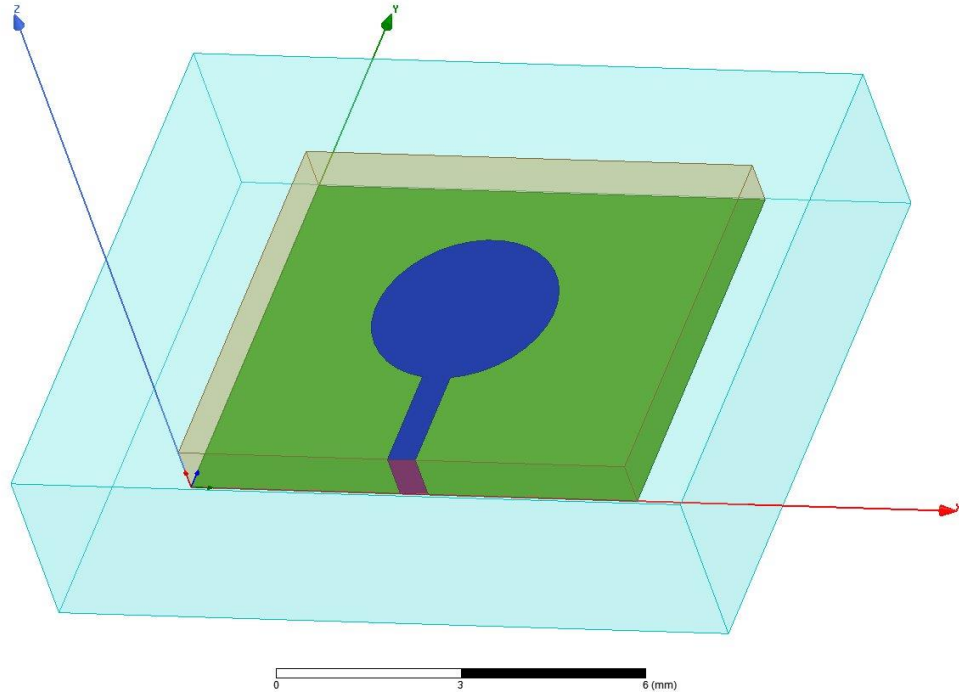


Fig: 5.1: Image of the patch Antenna

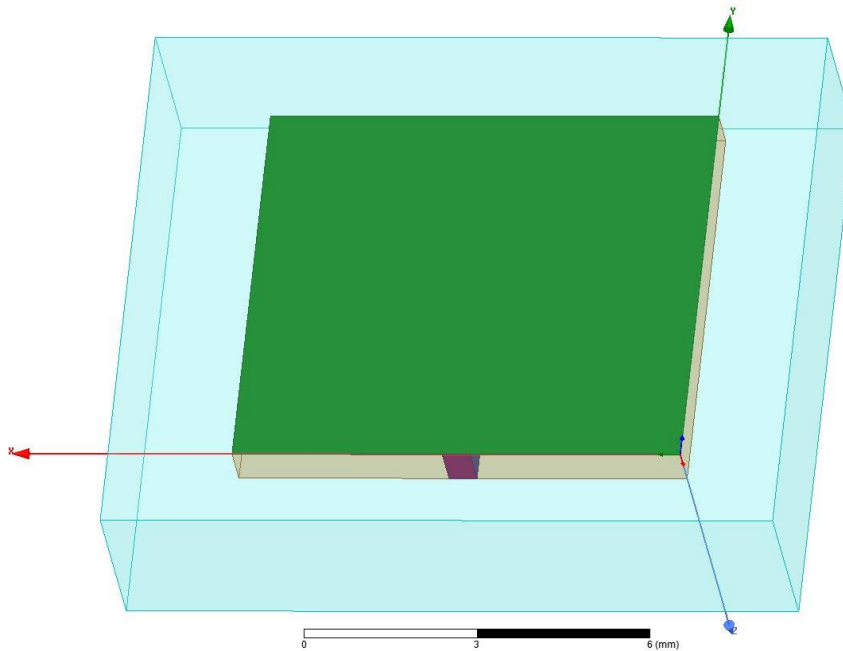


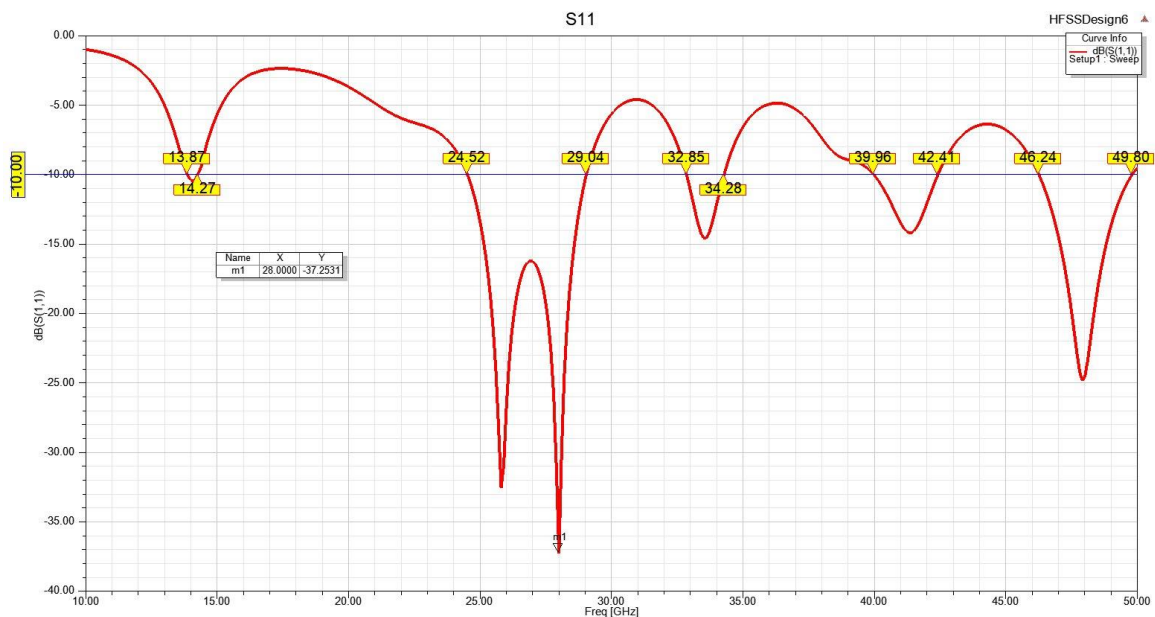
Fig: 5.2: Image of the ground

The design is done in HFSS software using FR-4 substrate material and analyzed.

5.2 RETURN LOSS:

The antenna's Return Loss is a numerical indicator reflecting the number of radio waves reaching a rejected antenna installation compared to an acceptable one. The antenna return loss is power loss in signal returned by a transmission line interruption. It is the part of a signal which is return due to a failure of impedance. At the maximum frequency of 28 GHz we have achieved a return loss of -37.2531 dB. The greater the return loss the antenna will gain.

Fig: 5.3: Return Loss



5.3 VSWR :

The VSWR is a value indication of variance between antenna and the supply line to which you are connected. The permanent wave ratio is also known as the (SWR). Prices vary from 1 to ∞ . VSWR price range. For most antenna systems, VSWR value less than 2 is considered suitable.

The Voltage Standing Wave Ratio (VSWR) represents the return loss in essence. VSWR refers to the current voltages created by radio waves moving in the transmission system. Although static waves and VSWR are very important, theory and statistics of VSWR often obscure what is going on. Fortunately, a good idea of the topic can be obtained without deepening the VSWR concept. Our value for VSWR is 0.3499dB for the frequency of 28 GHz.

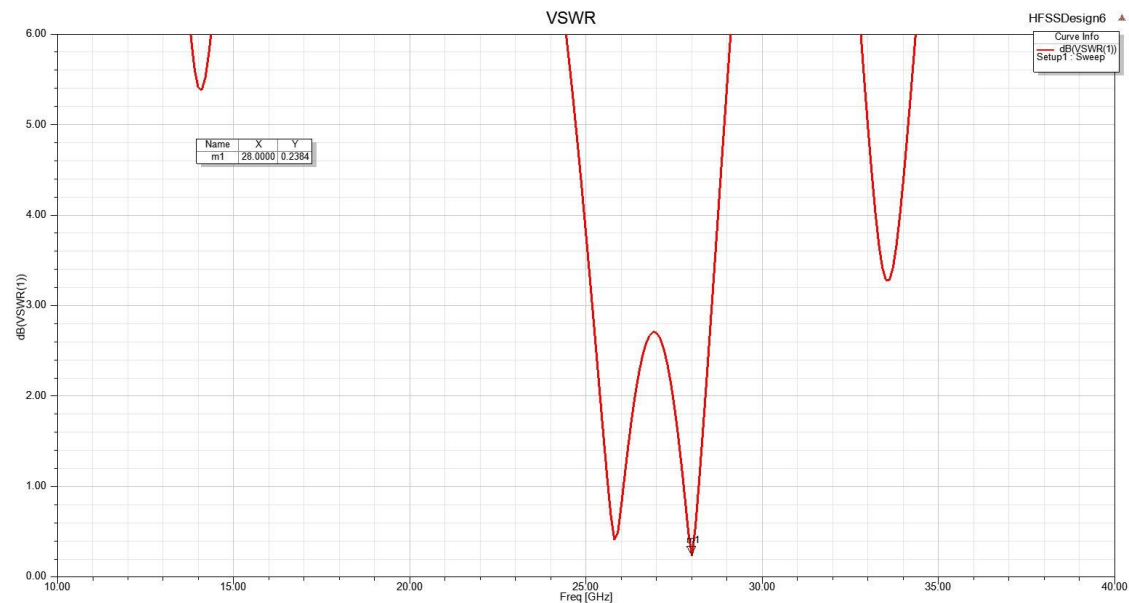


Fig:5.4: Voltage Standing Wave Ratio

5.3 GAIN:

The gain is often defined as measuring antenna generated power in all indicators from a remote feild source to the antenna axis, to antena power generated by the isotropic antenna. This measure is usually expressed in decibels, which are called isotropic decibels (dBi). A different definition compares the power obtained with the power obtained of a non-lost dipole antenna, units are as dB the antenna gain indicates that the antenna signal can send or receive how strong it is in a certain direction. Profit or gain is computed by comparing the rated power that the antenna transfers or receives in a particular way to the transmitted power or receives in the same condition by an appropriate antenna. The maximum gain is approximately 2.9 dB for 28 GHz.

Gain Plot @28 GHz

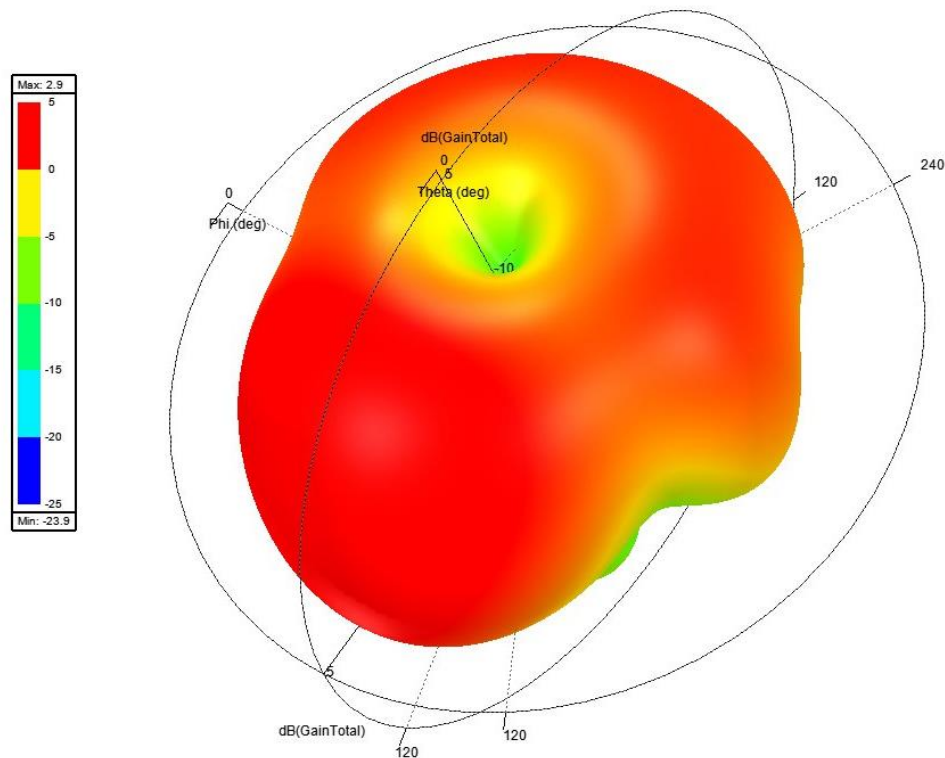


Fig :5.5: Gain at 28 Ghz

5.5 RADIATION PATTERN:

The solar radiation pattern (or antenna pattern or remote field pattern) in the field antenna design refers to the energy of a radio frequency from an antenna to another directly dependent source.

The remote field antenna pattern can be determined by an antenna range experiment, or by using an adjacent field scanner as well as radiation pattern extracted from it, the proximity field pattern can be detected. EM software such as HFSS can also calculate remote radiation patterns from the design of the antenna.

The antenna radiation pattern is a diagrammatic representation of the antenna-radiated signal. The red line is the angle of Azimuth in the below pattern, and the blue line represents the angle of elevation. The Theta is 0 and pi at 90 the azimuth and elevation angle meet each other at 0 degree. Now when Theta is 90 and pi at 0 the azimuth and elevation angle does not meet each other at 0 degree. This shows that the antenna has co-polarization with linear characteristics.

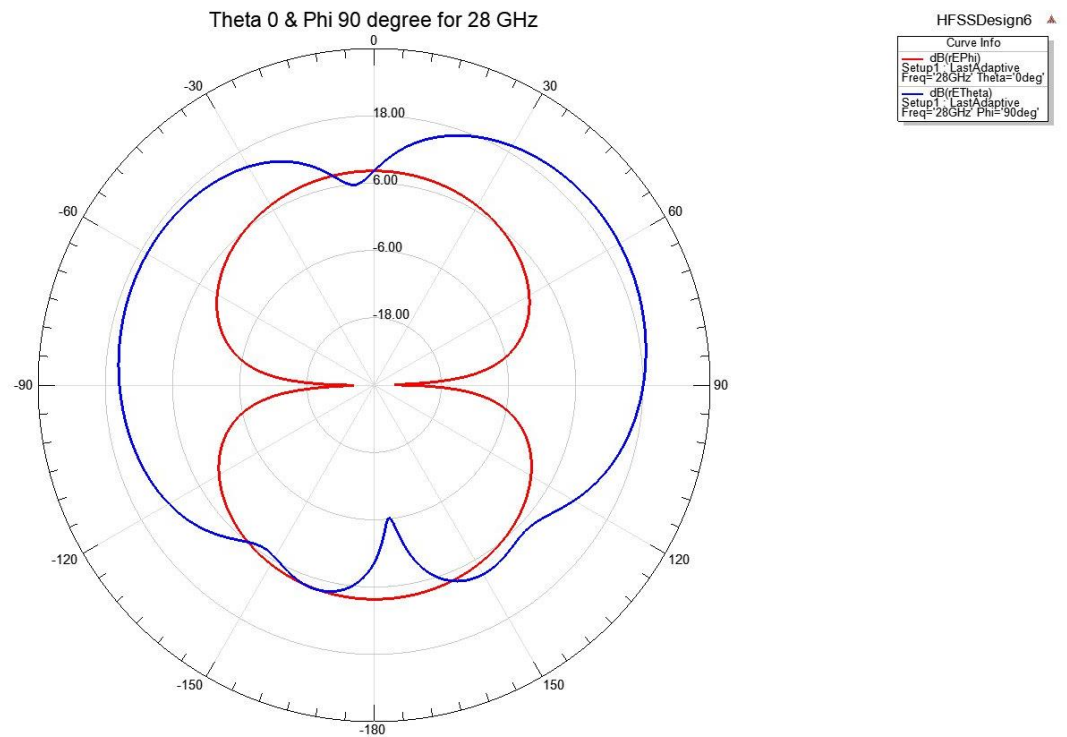


Fig: 5.6: Theta 0 & Phi 90 degree for 28 GHz

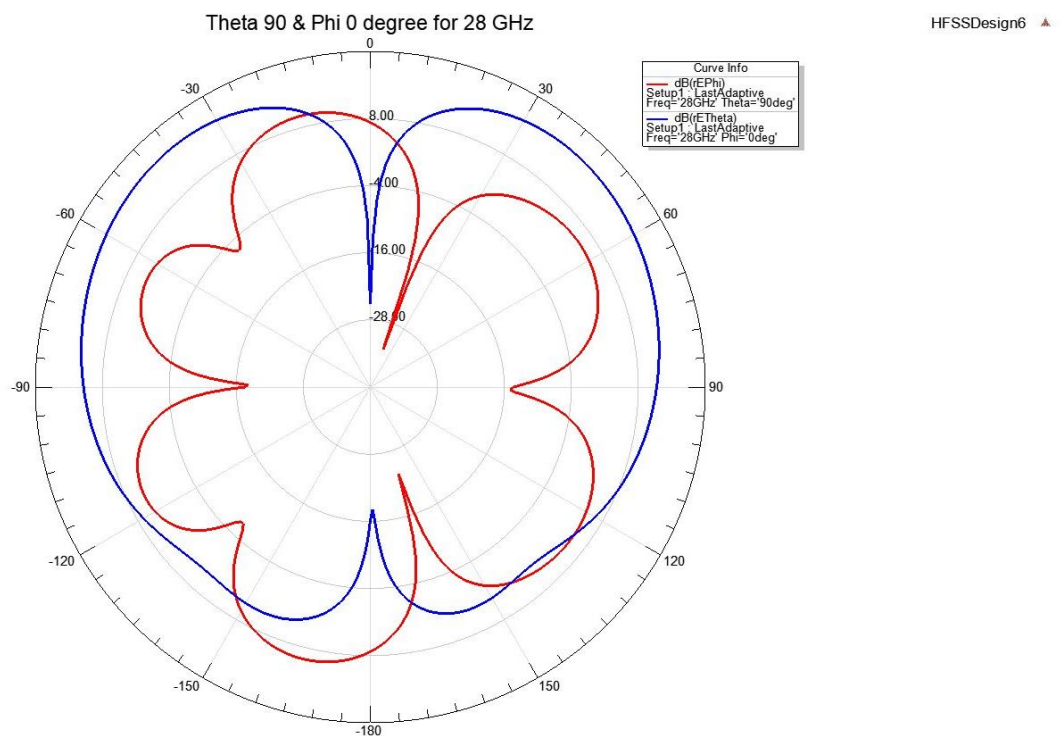


Fig:5.7: Theta 90 & Phi 0 degree for 28 GHz

5.6 Smith Chart

It shows smith chart of antenna which shows that impedance equal to 0.9979 Ohm at 28 GHz.

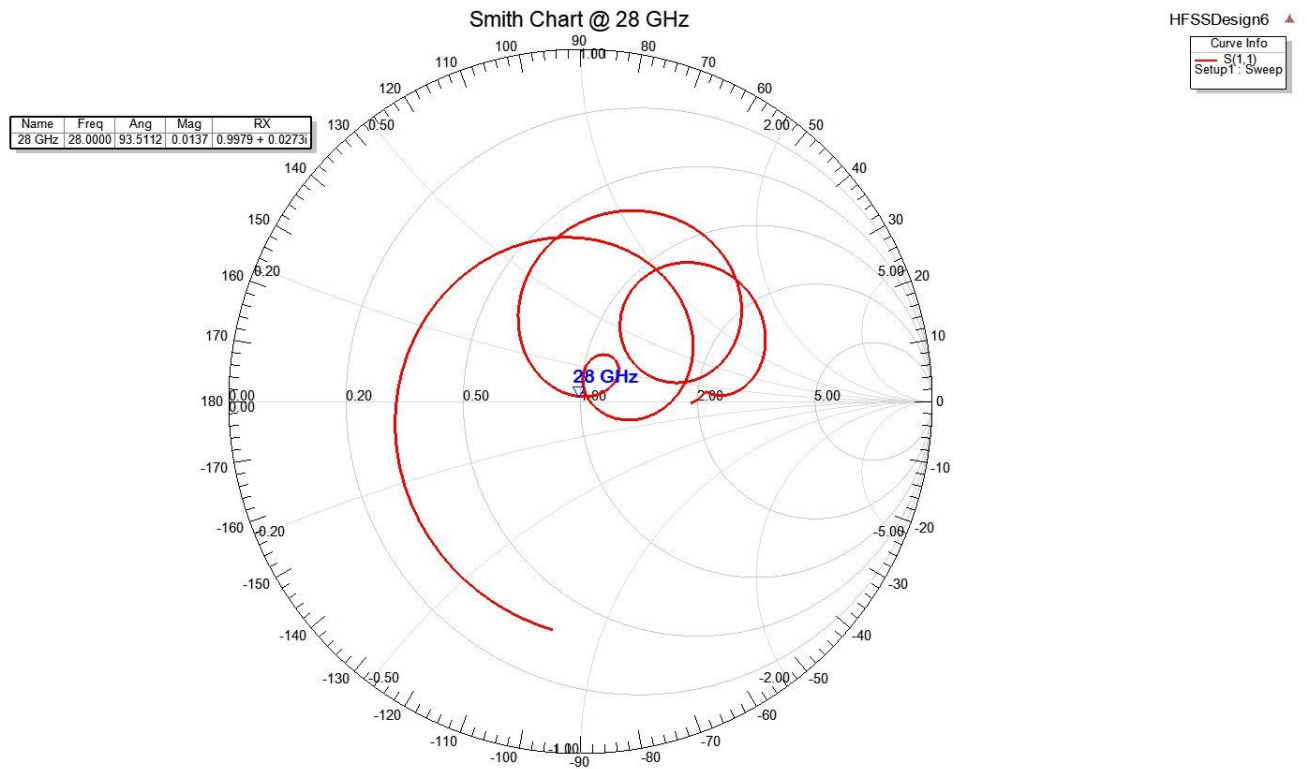


Fig:5.8: Smith Chart of 28 GHz frequency

CHAPTER 6

CONCLUSION & SUMMARY

In this project, a compact circular patch microstrip antenna has been proposed for 5G remote service. The tremendous expansion in versatile information, innovations are drawing closer from 4G to 5G. The radio wire resonates at 28 GHz with return loss of -37.2531 dB and can be utilized in future 5G remote gadgets. The proposed circular patch microstrip antenna shows great radiation example and great gain of 2.9 dB. The construction of the antenna is extremely low profile and can be handily coordinated in gadgets where space is a significant issue.

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