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SRR INSPIRED MICROSTRIP PATCH ANTENNA FOR 9.59 GHZ RESONANT FREQUENCY

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ABSTRACT-
In this proposed paper, a single band micro strip patch antenna with SRR (split ring resonator) loaded on ground for 5g wireless uses,is presented.The resonance frequency of this antenna is 9.59 Ghz. The paper presents the design simulation and analysis of a patch antenna loaded with 7.6 gigahertz split ring resonator for operating at 9.59 gigahertz frequency. The incorporation of the SRR aims to enhance the performance characteristics of the patch antenna including bandwidth, gain and radiation pattern. The design methodology involves electromagnetic simulation techniques using software tools such as CST microwave studio or Hfss. The performance parameters are evaluated and compared with the conventional patch antenna without the SRR loading. The result demonstrated significant improvement in terms of bandwidth and radiation characteristics, making the proposed antenna suitable for various wireless communication applications operating at 9.59 GHz frequency.Presented antenna gives the return loss -42.93 dB at 9.59Ghz resonance frequency.

KEYWORDS- Microstrip patch antenna, SRR (split ring resonator), Bluetooth HIPERLAN, Wimax, game.

1. INTRODUCTION:-

Patch antennas hold prominence in diverse wireless communication applications due to their compactness, low profile and ease of integration. However, achieving broad bandwidth and heightened gain remains a persistent challenge especially for antennas operating at higher frequencies. Recent endeavors have exploded innovative design mythologies, including the integration of Metamaterial-inspired structure such as split ring resonator, to ameliorate the performance of antennas..It plays a crucial role in radio communication, wheather used with a transmitter or receiver. Antenna's role in 5G networks enabling efficient communication and supporting various applications. There are some key uses in the context of 5G:-
Srr loaded patch antennas enhance bandwidth and performance characteristics. They can be used for LTE, GSM, WiMAX, Bluetooth, and other wireless communication systems. The Srr loaded microstrip patch antenna plays a virtual role in satellite communication networks. They ensure reliable connectivity for remote areas and Maritime applications.In smart cities, SRR-loaded antennas facilitate communication between devices, sensors and urban systems. Applications include environmental monitoring, traffic management, and energy efficient solutions,enabling V2 X (vehicle to everything) communication in connected vehicles management and autonomous driving, smartphones and efficient connectivity for users. Srr loaded patch antennas are integrated into smartphones, tablets, wearables and other portable devices. They provide compact and efficient connectivity for users.

2. Antenna Design:-

The design process involves several steps, including geometry optimization, electromagnetic simulation, and performance analysis; the patch antenna is designed to resonate at 9.59 gigahertz utilizing standard micro strip patch design techniques. The antenna dimensions of the patch are determined based on the desired resonance frequency and substrate parameters. Subsequently,Split ring resonator structure is incorporated into the patch antenna design. The dimensions of the SRR are optimized to achieve the resonance at the Desire frequency and to provide the desired electromagnetic

coupling with the patch antenna . Dimensions of the Presented Antenna is shown in the table given below:-

s.no.	parameters	value
a.	width of ground wg	19.38mm
b.	length of ground lg	19.38mm
c.	width of substrate Wsub	19.38mm
d.	length of substrate ls	19.38mm
e.	width of patch wp	9.69mm
f.	length of patch lp	6.89mm
g.	width of feed strip ws	3.11mm
h.	length of strip	4.368mm
i.	l1	2.2mm
j.	w1	3.7mm
k.	w2	0.2mm
l.	w3	3.3mm
m.	w4	6.202mm

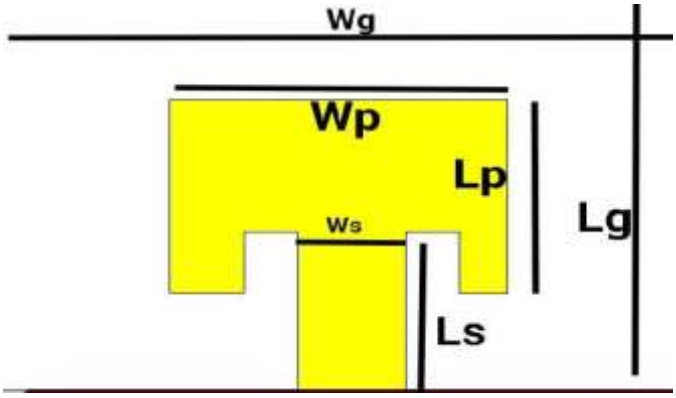

Figure 1. Microstrip patch antenna without half rectangular cut ….

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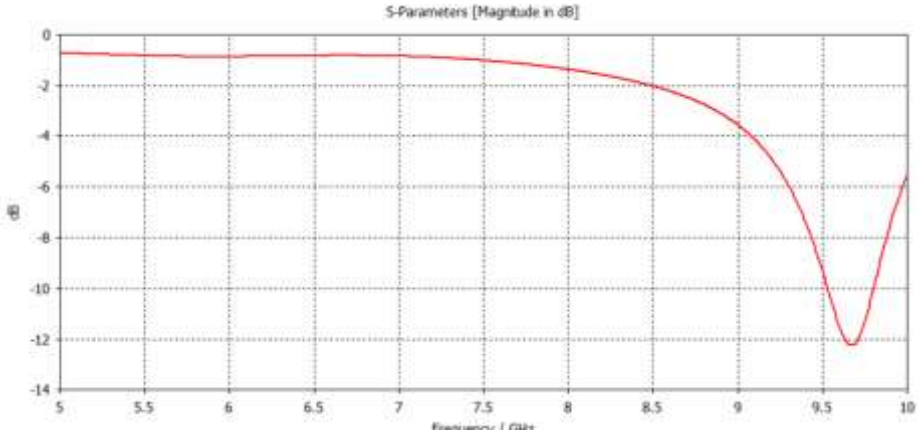

Figure 2. S-parameter of microstrip patch antenna without half rectangular cut.

3. MICRO STRIP PATCH ANTENNA DESIGN WITH HALF RECTANGULAR CUT:-

Patch antennas are widely used in wireless communication systems due to their versatility and unique advantages. When we introduce specific design modification like a half rectangular cut, it can impact to the antenna's performance and broaden its applications here are some key points:-

Frequency band adjustment*:*

- The half rectangular cut in the radiator (patch) allows for fine tuning the frequency band.
- By strategically placing the cut we can adjust the projected direction of higher frequencies.

. For instance, this notification can amplify both lower and upper frequencies, enabling the antenna to operate within a specific frequency range. An example scenario covers the frequency band between 2.9 Ghz and 4.6 Ghz.

Improved performance:-

- A half rectangular shaped cut can make better the performance of a impedance matched rectangular microstrip patch antenna.
- This improvement is particularly relevant for antenna's operating in 2.4Ghz and above frequencies.

Compact design*:-*

- The half rectangular cut allows more efficient use of space while maintaining performance.
- Compact antennas are desirable for applications where size constraints exist such as in mobile devices, aircraft and spacecraft.

Diverse applications*:-*.

- **Satellite communication** - they are used in satellite communication systems for data transmission and remote sensing.
- **Radar system** - patch antennas are employed in radar systems for target detection and tracking.
- **RFID (radio frequency identification)** - they play a role in RFID tags for inventory management and access control..

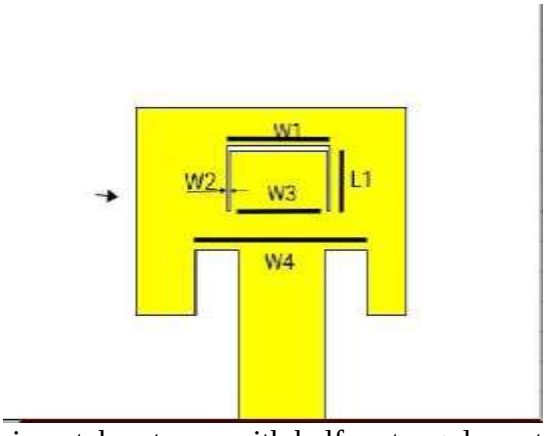

Figure 3. Microstrip patch antenna with half rectangular cut on patch surface.

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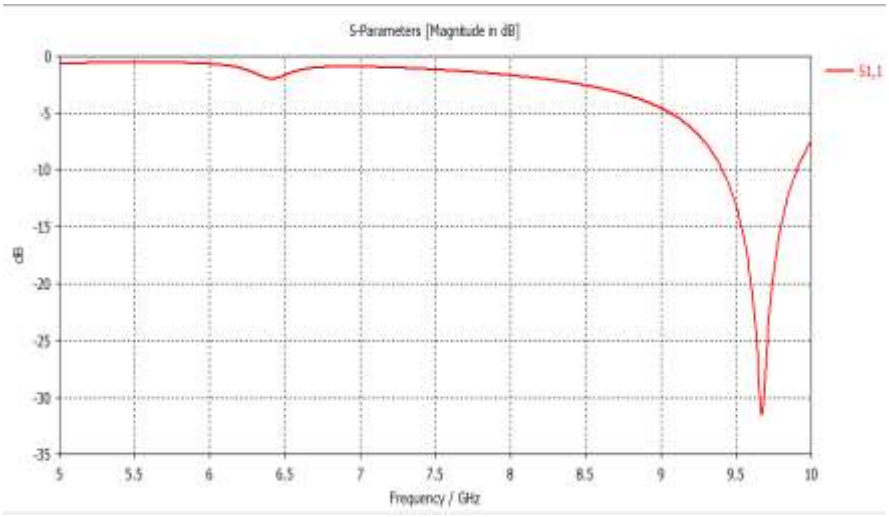

Figure 4. S-parameter of Painted antenna with half rectangular cut on patch surface.

4. SQUARE SPLIT RING RESONATOR:-

The integration of square ring resonators with patch antennas has been a fascinating area of research. Traditional patch antennas often suffer from narrow bandwidth. By embedding SRR material structures within the patch antenna, subwavelength modes are introduced in the patch cavity. The result is a broadband patch antenna with improved performance characteristics.

The process involves designing and optimizing SRRmaterial based on the reference patch antenna. The SRR metamaterial is then strategically set between the patch and the ground plane of the proposed antenna. Experiment results align well with simulations validating the effectiveness of the approach.

Square split ring resonator- enhances patch antennas, finds applications in various wireless communication systems like LTE, GSM, WiMAX, Bluetooth and more.

5. ANALYZATION OF SQUARE SPLIT RING RESONATOR :-

The design Presented in the figure 5 is used as metamaterial structure to design Unit cells. This structure is shaped in the borderline Box with length U width V and height W is equal to 2.78 mm and the measurement for the various variables are written down below. All dimensions are in Millimeters. Length of the larger rectangular ring of the cell is 2.60 mm. Length of the smaller ring of the cell is 1.70 mm. Width of the unit cells(Rw) are 0.20 mm. Space between two rings is 0.25 mm. Width of cuts inside and outside rings of the unit cell is 0.3mm. The length and width of the substrate is 2.78 mm, and thickness of the substrate is 0.25 mm. The width of the strip line, applied on the substrate of the unit cell is 1.228 mm.

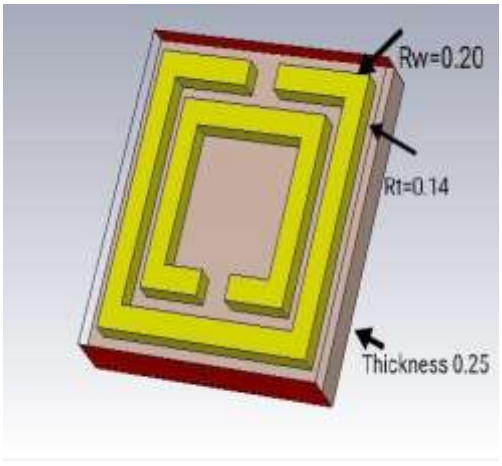

Figure 5. Square split ring resonator

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6. SIMULATION RESULTS

When simulating a microstrip patch antenna using CST (computer simulation technology) we can obtain various valuable results. Let's explore these results:-

RETURN LOSS

Return loss qualifies how much power is given back from the antenna due to mismatch of Impedance ; a lower comeback loss designate better impedance matching and efficient power transfer.The presented antenna has a return loss of -42.93dB which indicates the antenna works perfectly on a 9.59 gigahertz resonant frequency.

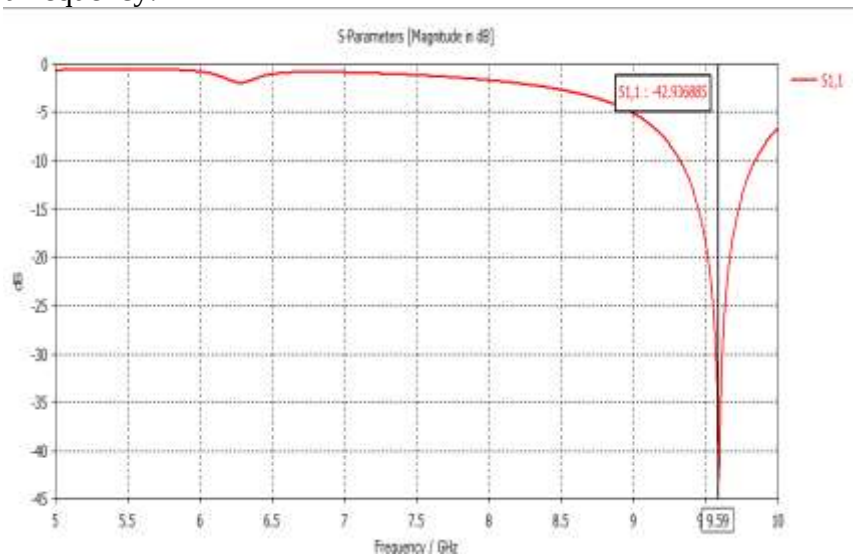

Figure 6. Return loss of micro strip patch antenna

B. GAIN:-

The lower gain antenna such as 3 or 8 dBi would provide better signal quantity and coverage. The proposed antenna has a gain of 3.742dBi.

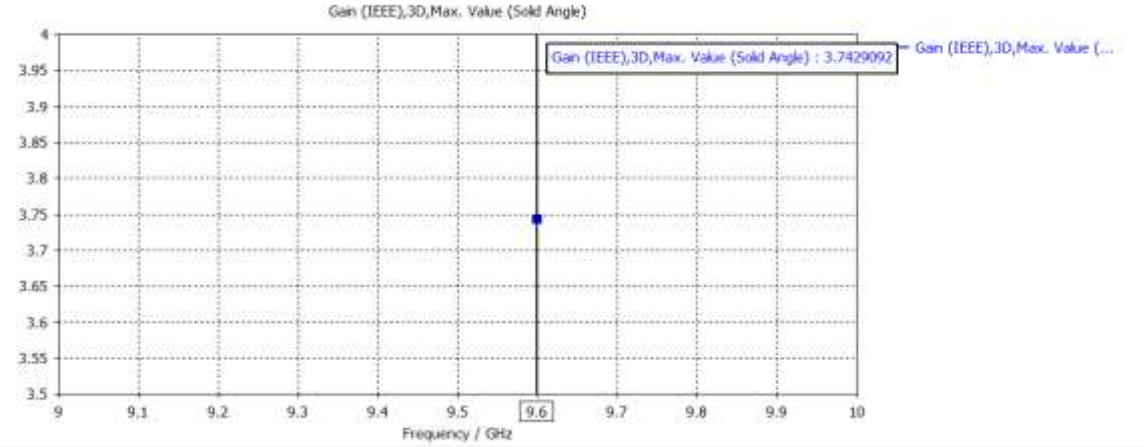

Figure 7. Gain of microstrip patch antenna

C. VSWR:-

Voltage Standing Wave Ratio is used to measure how an antenna matches its transmission line. A low VSWR designate good impedance matching while a high VSWR shows poor matching.The VSWR is explained as the ratio of maximum voltage (or current) to the minimum voltage (or current) along the transmission line.The proposed paper shows the 1.014 VSWR which shows perfect impedance match.

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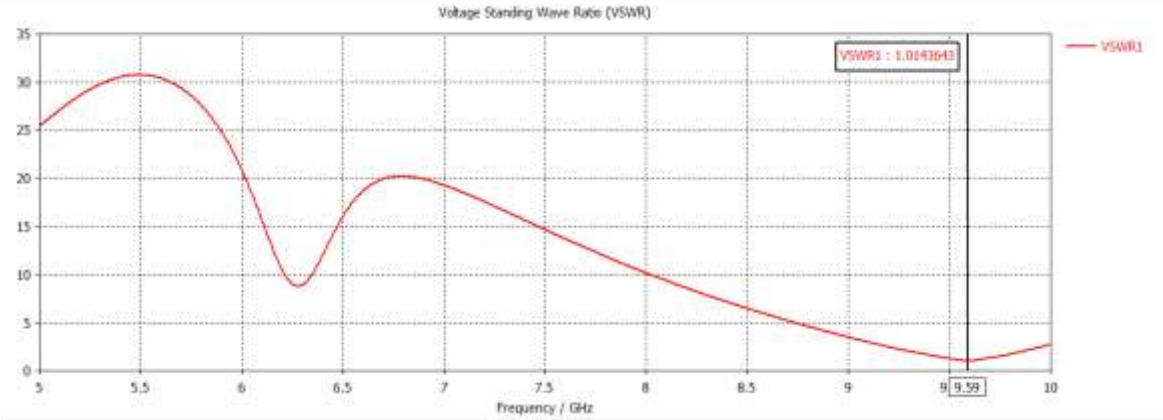


Figure 8. Voltage Standing Wave Ratio of Presented antenna

D. BANDWIDTH:-

The bandwidth of an antenna Indicates the range of frequency on which the antenna can efficiently transmit or receive signals.The bandwidth of the introduced antenna is shown below. This antenna resonates at 9.59ghz frequency.

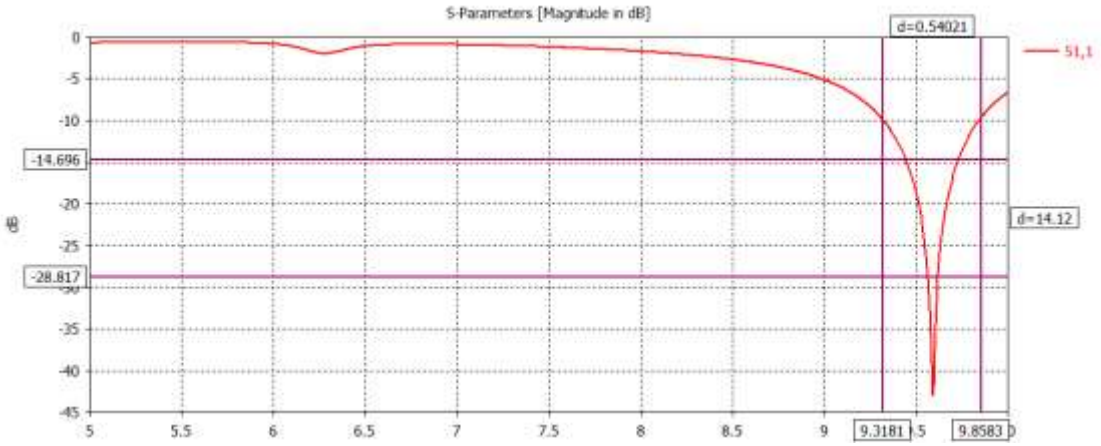
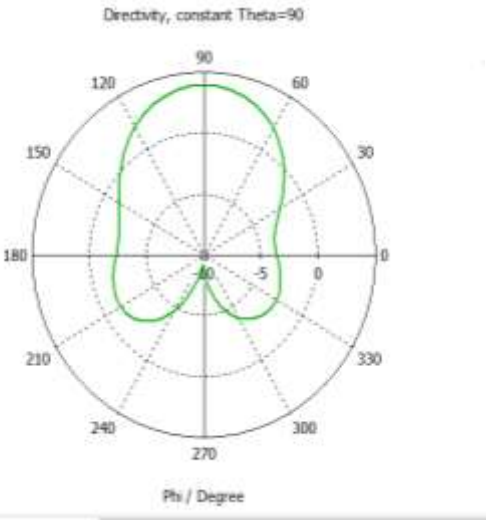


Figure 9. Bandwidth graph of antenna

E. DIRECTIVITY:-

Directivity is a key parameter that characterizes the antenna's ability to focus its radiation in a particular direction. It qualifies how much power the antenna radiates in all directions.



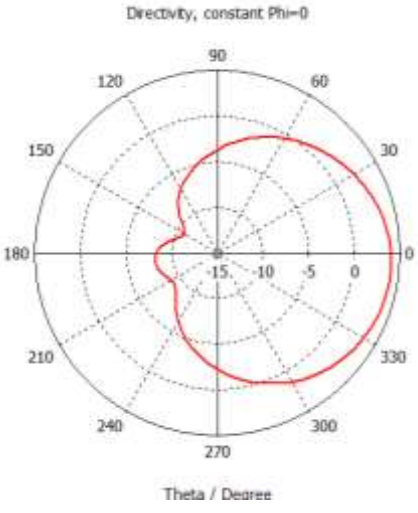


Figure 10. and 11. shows the directivity of the proposed antenna.

F. EFFICIENCY:-

Efficiency computes how successfully the antenna converts input power into radiator power. The efficiency of 9.59 GHz resonant frequency is mentioned in figure 12.

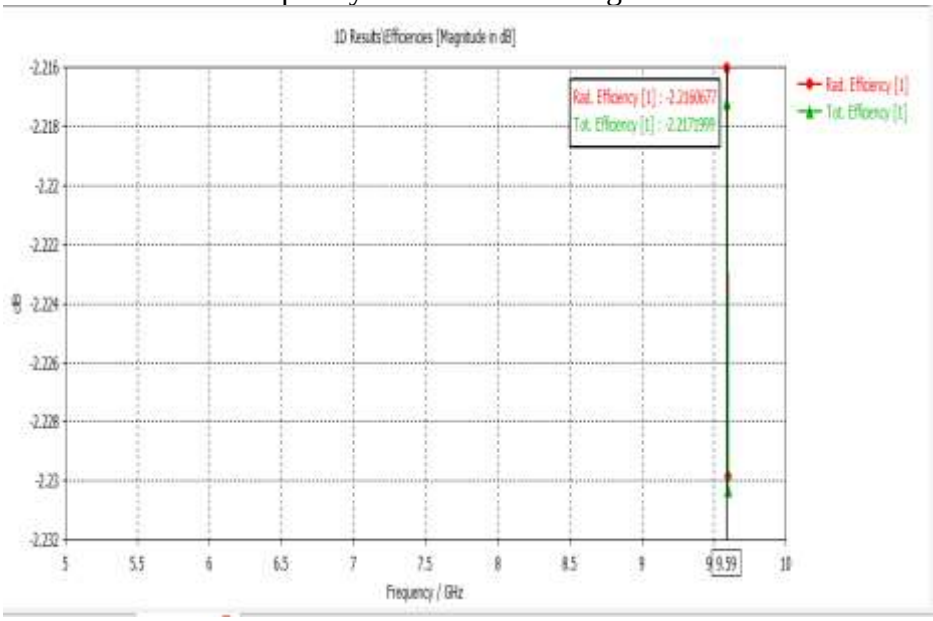


Figure 12. Efficiency graph of the introduced antenna.

***G.* RADIATION PATTERN**

The firefield radiation pattern shows how the antenna radiates energy in different directions; it provides insight into the antenna's coverage area.

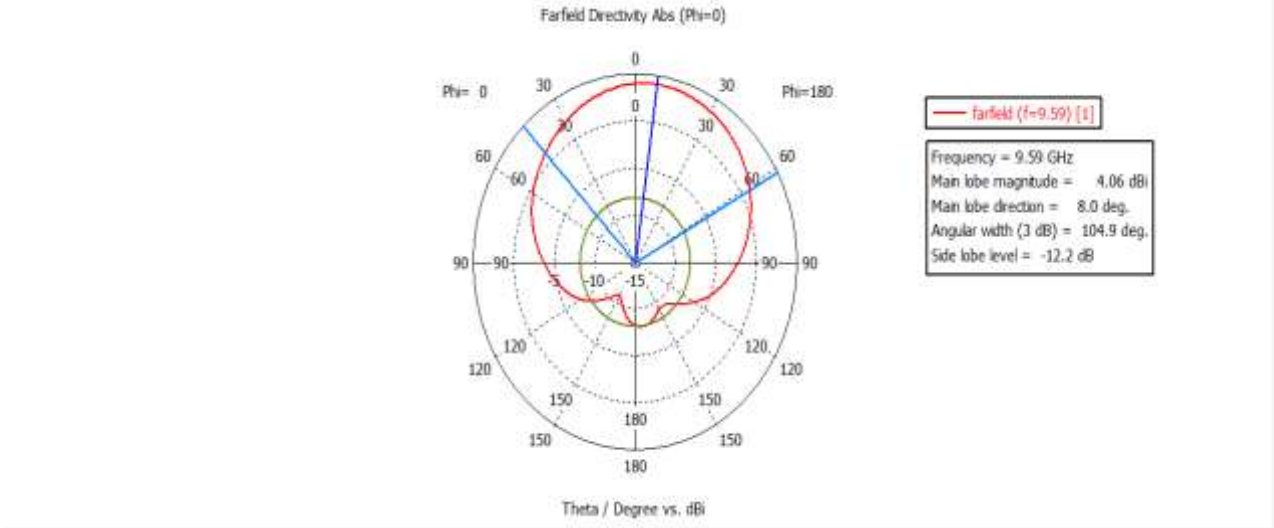


Figure 13. Radiation pattern of the antenna .

Depending on the specific simulation setup, we can also analyze the parameters like polarization, sidelobe levels, smith chart and surface current distribution.

7. CONCLUSION

A compact square split ring resonator added antenna is proposed in this research.. The Split Ring Resonator is made known so the antenna can toil on 9.59 gigahertz resonant frequency. The comeback loss at 9.59 resonant frequency is -42.93dB which presents better antenna performance. The Introduced

antenna is purposely used in civil and military uses for Maritime navigation radar systems, Bluetooth, WLAN, WiMAX. The antenna parameters like come back loss, Voltage Standing Wave ratio, radiation patterns, smith charts,surface current at 9.59ghz are also discussed.

8. APPLICATIONS AND USES OF ANTENNA

1.Bluetooth:-The presented patch antenna can be utilized in Bluetooth 2.0 and Bluetooth low energy.
2.WiFi:- It can also be employed for wireless fidelity connectivity.
3.Zigbee:-The antenna is suitable for Zigbee IEEE 802.15.4 communication.
4. Cellular networks:- it can resonate at different frequencies within the 2G /3G /4G LTE- A bands.
5.Military and aerospace:- patch antennas are crucial in military applications such as rockets, radar and aircraft missiles; they are also used in satellite communication systems.
The 9.59 GHz patch antenna can serve a wide range of purposes, from wireless communication to medical diagnostic and beyond. Its versatility makes it a valuable component in modern technology.

9. ACKNOWLEDGEMENT

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