Antenna project

Dual-Band Monopole Antenna

for RFID Applications

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3^{rd} year communication and Electronics

Sec : 8

Abstract

This report presents the design and evaluation of a **dual-band monopole antenna optimized for RFID systems** operating at **2.4 GHz and 5.8 GHz.** The proposed antenna is constructed on an FR-4 substrate and features a compact and cost-efficient design. Simulation results indicate excellent impedance matching, high radiation efficiency, and favorable gain in both frequency bands, making it a suitable candidate for modern RFID applications.

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1.Introduction

1.1 RFID Technology and Components

RFID (Radio Frequency Identification) is a wireless technology used to identify, track, and manage objects. Here's how it works:

1. **RFID Components:**
    - **Tags (Transponders):** These are attached to objects for identification. Tags can be *passive* (powered by the reader's signal), *active* (with an internal power source), or *semi-passive* (using both).
    - **Reader (Interrogator):** Sends radio frequency signals to communicate with tags and retrieves data.
    - **Data Processing System:** A computer or backend system processes and stores the data for applications such as inventory management or access control.
2. **Frequency Bands:** RFID systems operate across several frequency ranges:
    - **Low Frequency (LF):** 125-134 kHz, typically used in animal tracking or keyless entry.
    - **High Frequency (HF):** 13.56 MHz, commonly used in smart cards and ticketing systems.
    - **Ultra-High Frequency (UHF):** 860-960 MHz, suitable for supply chain and inventory management due to its longer range.
    - **Microwave Frequencies (e.g., 2.4 GHz, 5.8 GHz):** Ideal for high-speed, short-range applications.

1.2 RFID Applications

RFID is used in various industries due to its versatility:

- **Warehouses and Shops:** To track inventory and find items faster.
- **Hospitals:** To keep track of medical equipment or patient wristbands.
- **Transportation:** In toll systems or bus cards.
- **Retail Stores:** For faster checkouts or theft prevention.
- **Farming:** To track livestock or food products.

1.3 Advantages of the Antenna Design

- **Dual-Band Operation:** Covers 2.4 GHz and 5.8 GHz bands, suitable for common RFID frequencies.
- **Compact Size:** The small overall dimensions make it easy to integrate into various devices.
- **Omnidirectional Radiation Patterns:** Provides effective coverage and communication capability in multiple directions.
- **Good Impedance Matching:** Enhances efficiency and effectiveness in signal transmission and reception.

2.Antenna Design and Configuration

2.1 Substrate Selection

The proposed antenna features a modified F-shaped radiator, offering compactness and efficient performance.

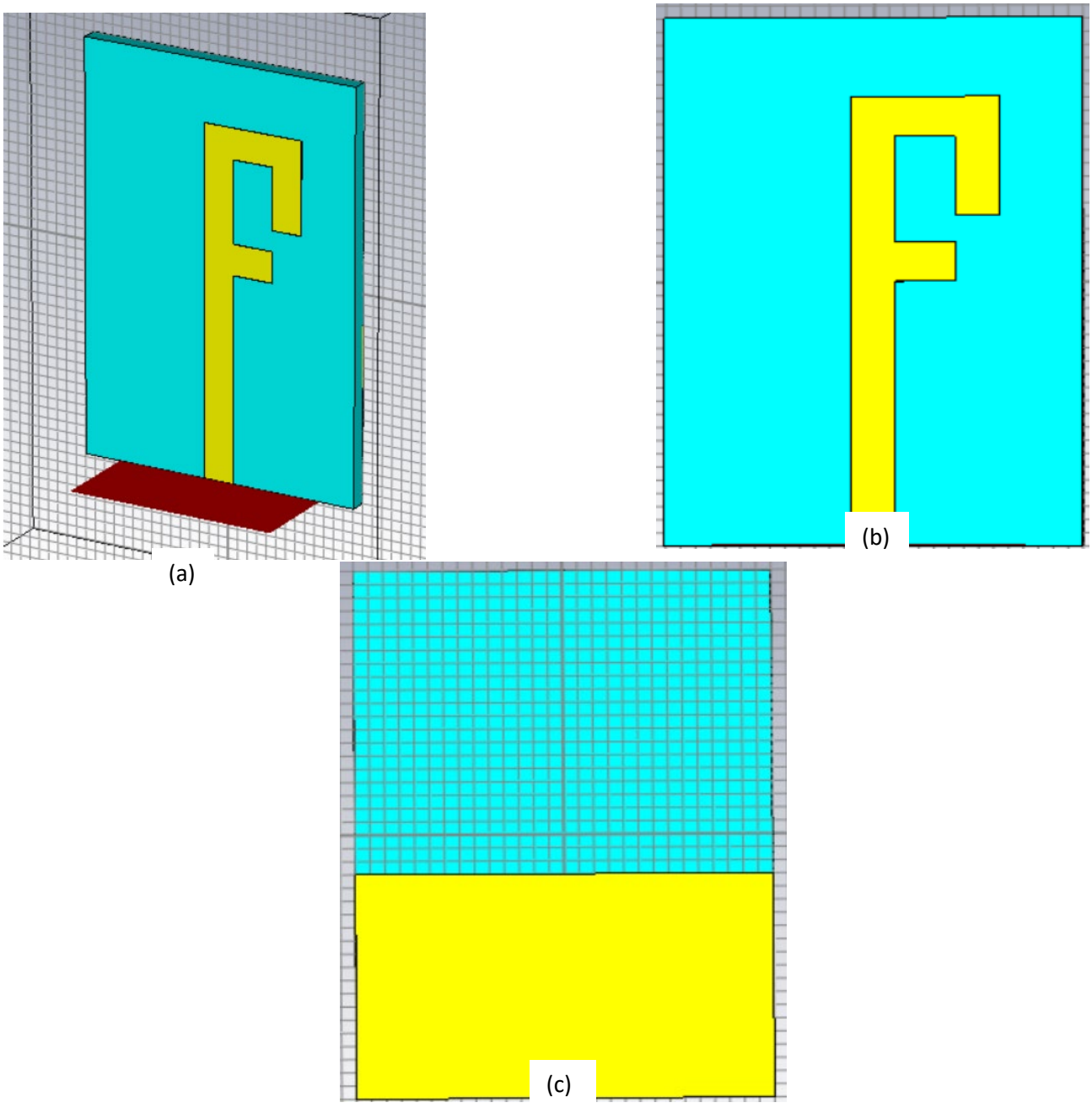


Figure 2.1 (a)side,(b)top,(c)bottom view of antenna

2.2Design Specifications

- **Frequency Ranges:** 2.2–2.6 GHz and 5.3–6.8 GHz
- **Substrate Material:** FR-4 with a thickness of 1.6 mm

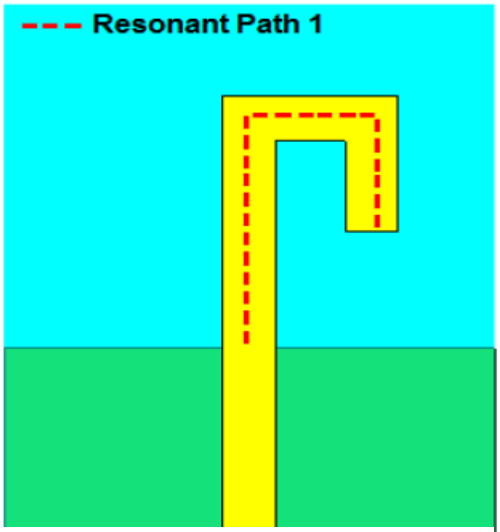


Figure 2.2 Response of 2.4 Frequency

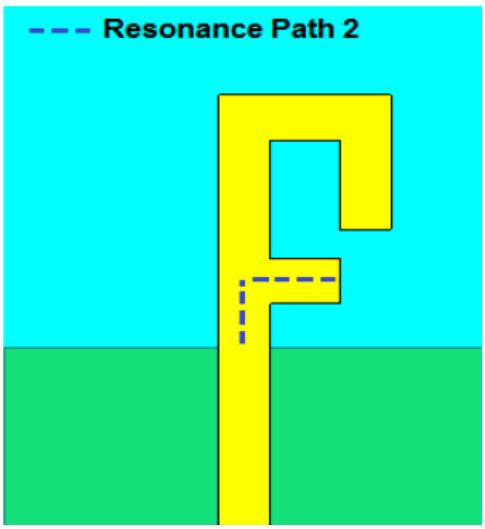


Figure 2.3 Response of 5.8 Frequency

2.3 Fabrication Process

The antenna is designed using computer simulation technology (CST), followed by the fabrication of a prototype for measurement.

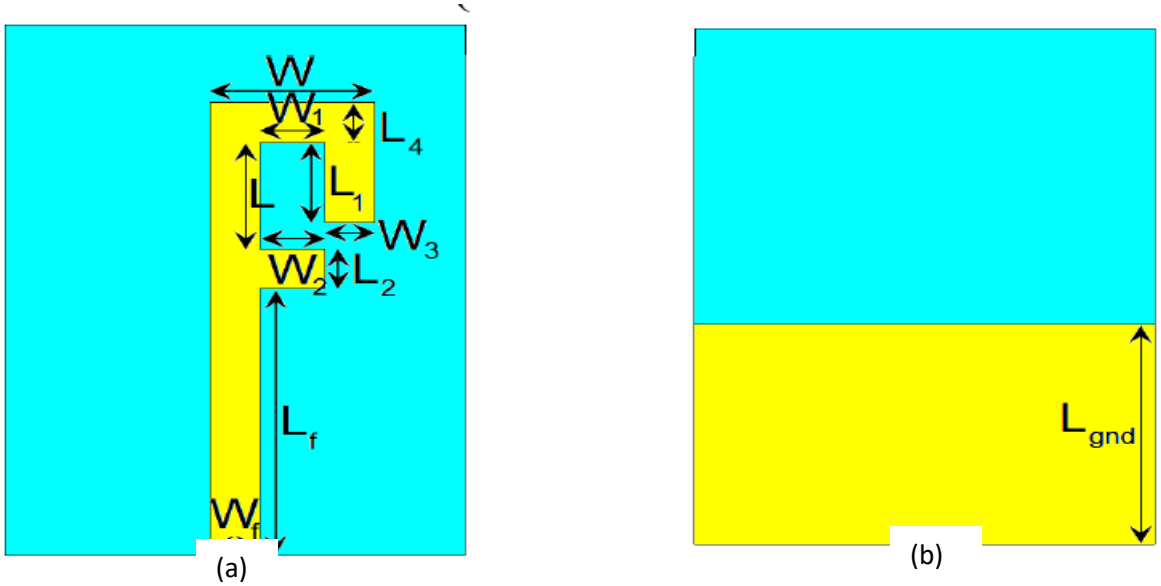


Figure2.4 the dimension of antenna in cst (a)F-shape,(b) Ground planer

Name	Expression	Value	Description
h	0.035	0.035	Thickness of the copper
hsub	1.6	1.6	Thickness of the substrate
L	8	8	Length of a particular segment of the radiation patch
l1	6	6	Length of a section
L2	3	3	
L4	3	3	
Lf	20	20	Length of the feed-line
Lgnd	17	17	Length of the ground plane
Lsub	40	40	Length of the substrate
w	10	10	
w1	4	4	
w3	3	3	
wf	3	3	Width of the microstrip feed-line
Wsub	28	28	Width of the substrate

Figure2.5 Table of dimension values of antenna at cst

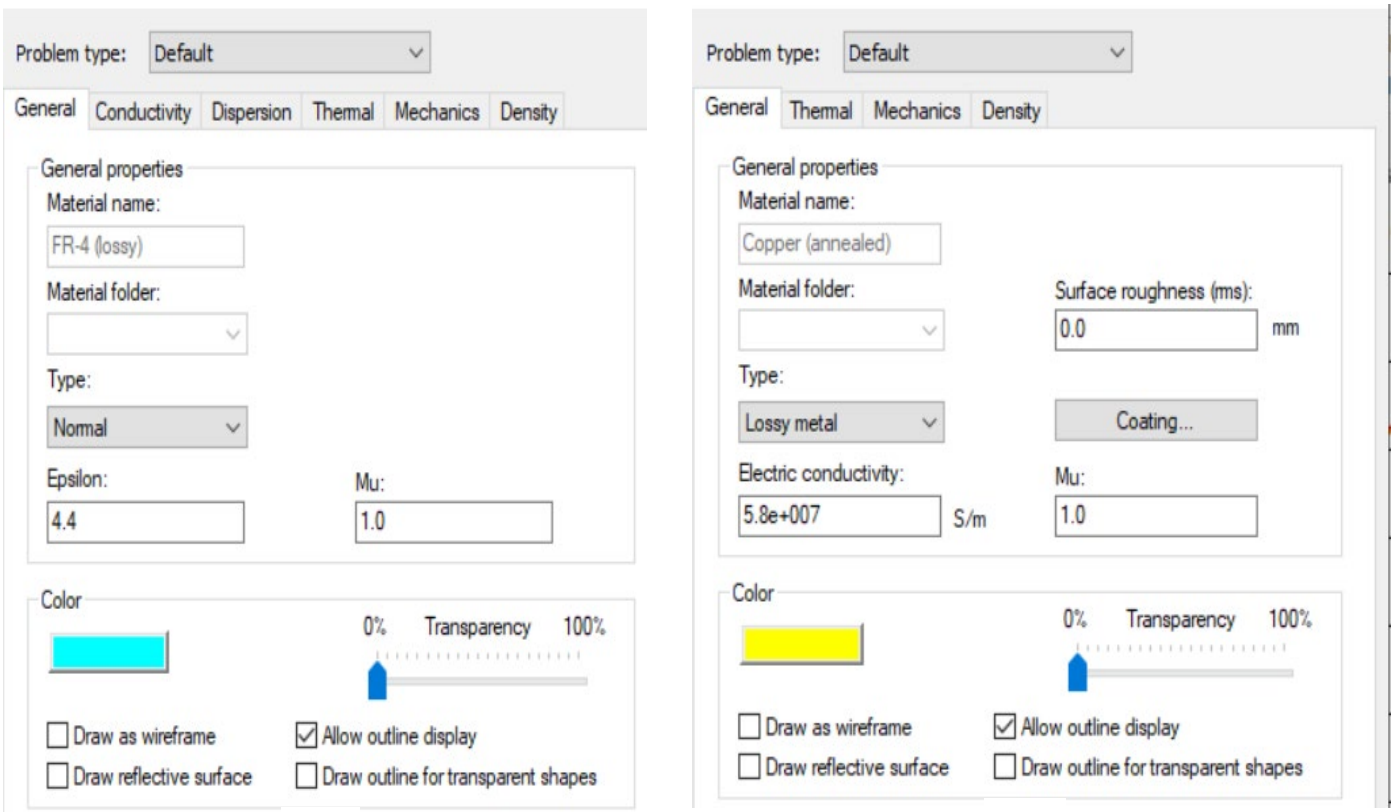
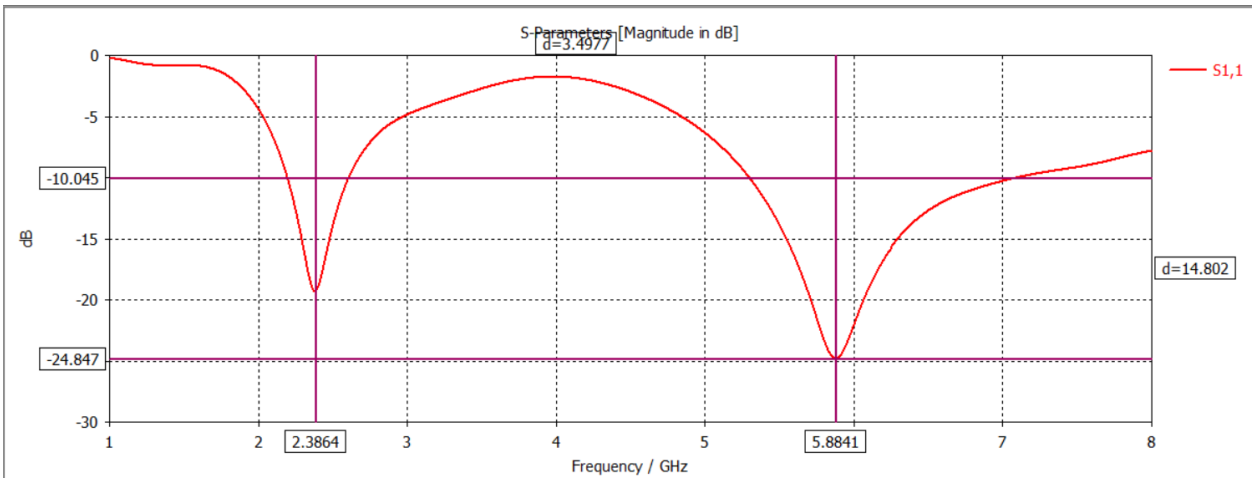


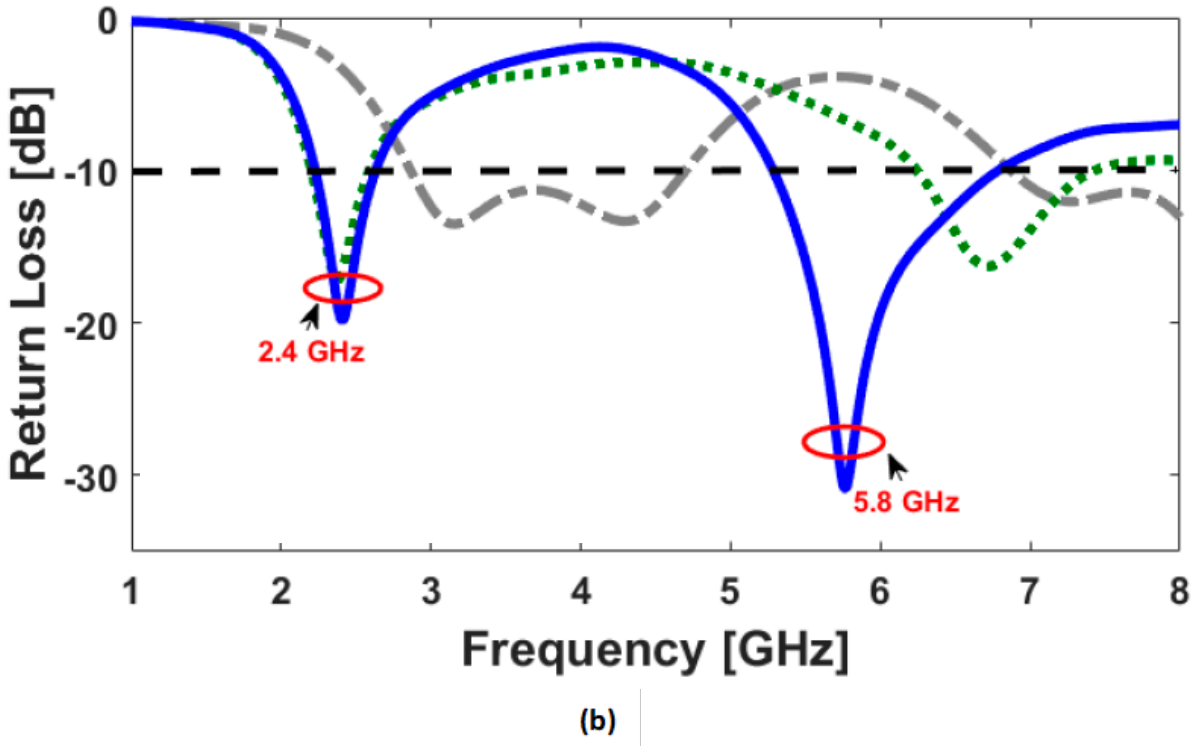
Figure 2.6 Material of antenna (a)substrate ,(b) GND and F-shape

3. Antenna Results

3.1 S-Parameter



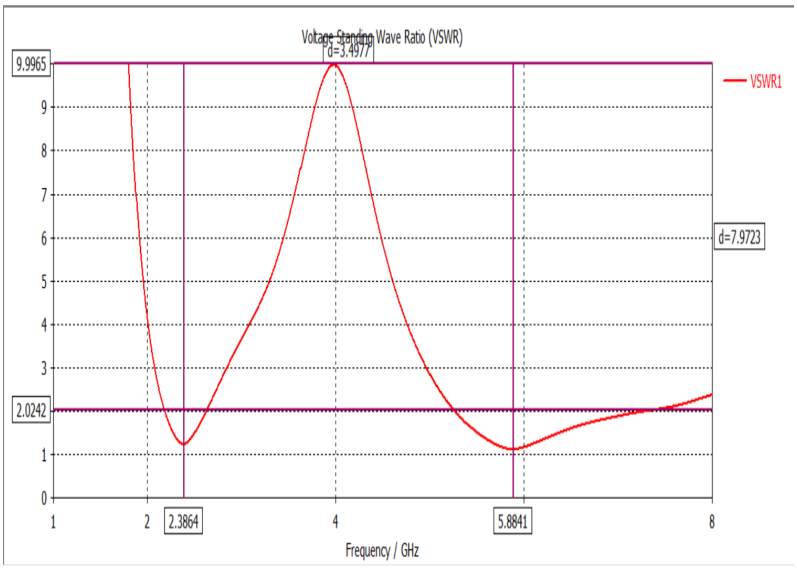
(a)

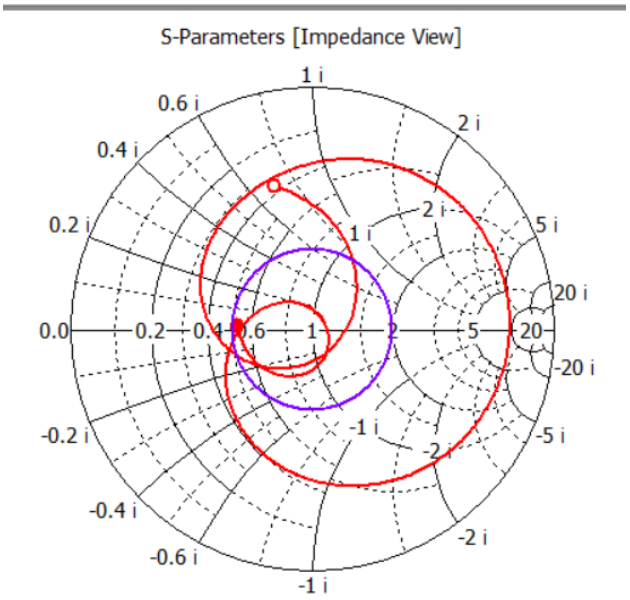


(b)

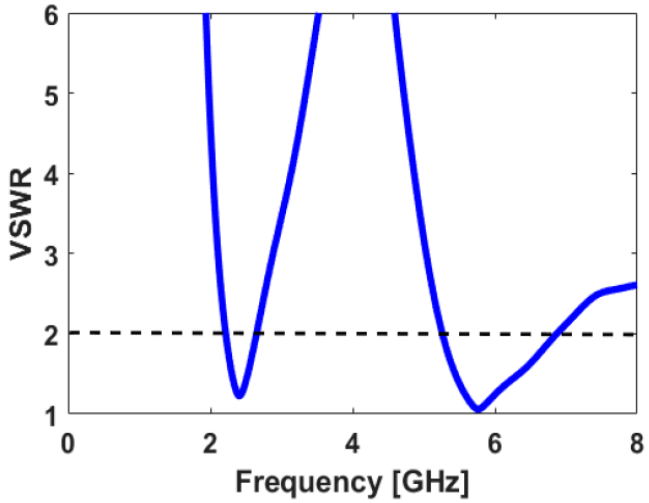
Figure 3.1 S-Parameter for antenna (a) my result (b) Research paper

3.2 Voltage Standard Wave Ratio (VSWR) and smith chart





(a)



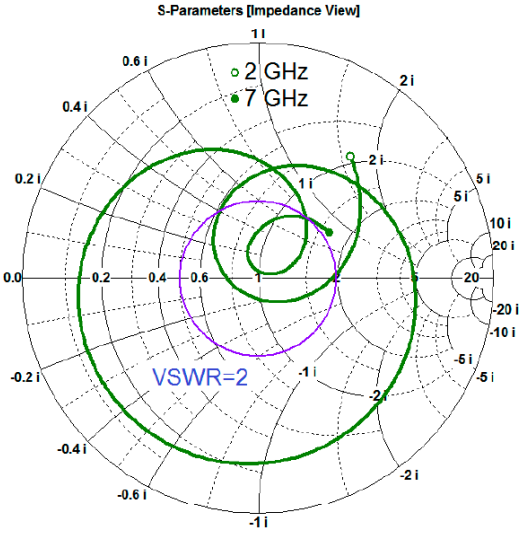


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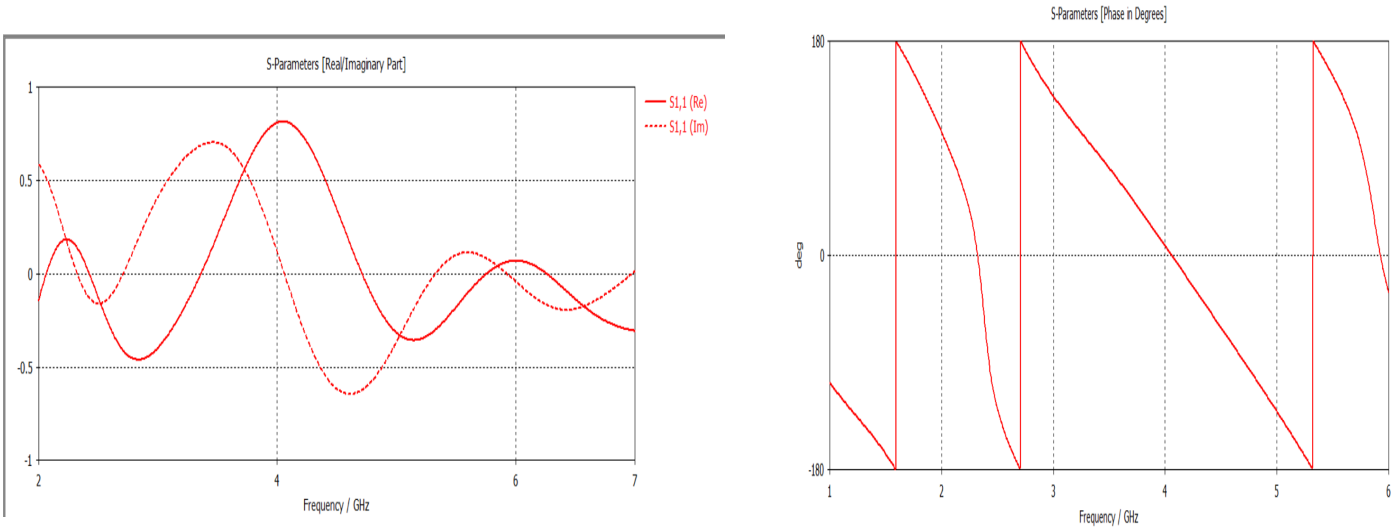
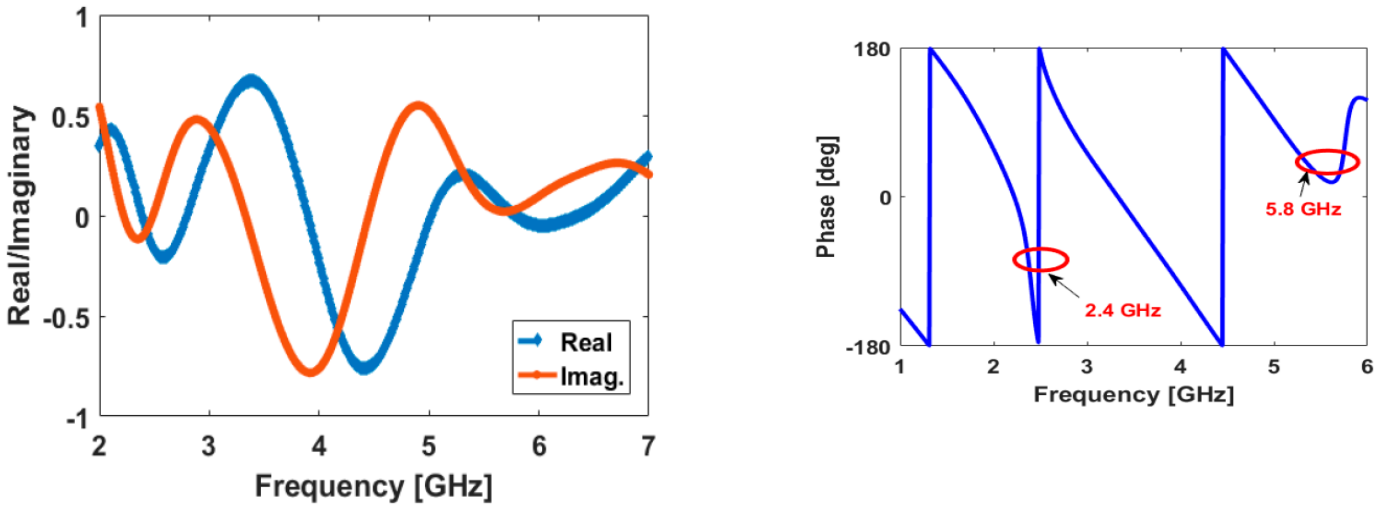
Figure 3.2 VSWR and smith chart for antenna (a) my result (b) Research paper

3.3 phase and Real & Imag in antenna



(a)

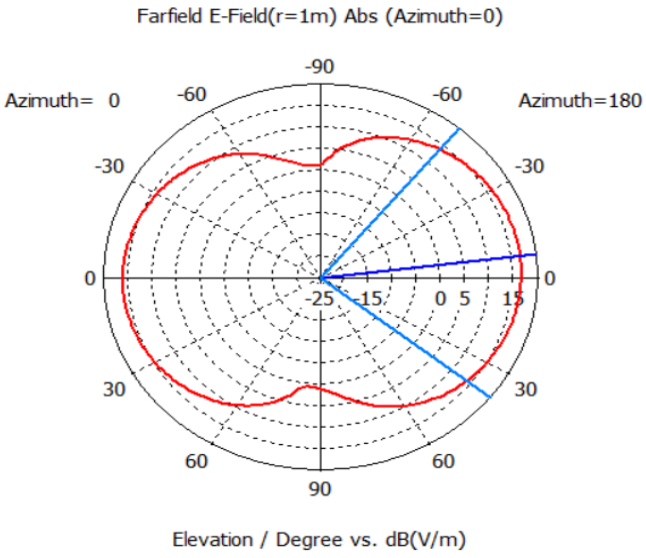


(b)

Figure 3.3 Phase and Real&Imag for antenna (a) my result (b) Research paper result

3.4 Farfield

- **E-plane**



(a)

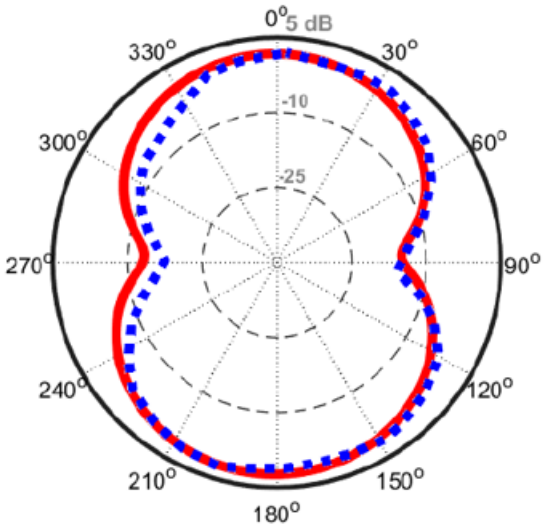


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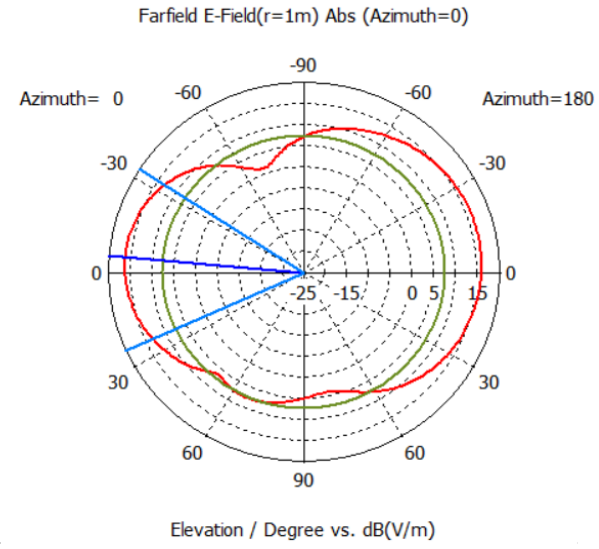
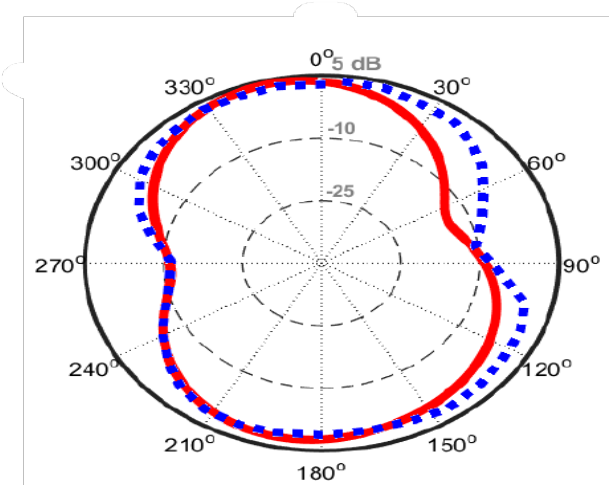
Figure 3.4 E-plane for 2.4 GHz (a) my result (b) Research paper result



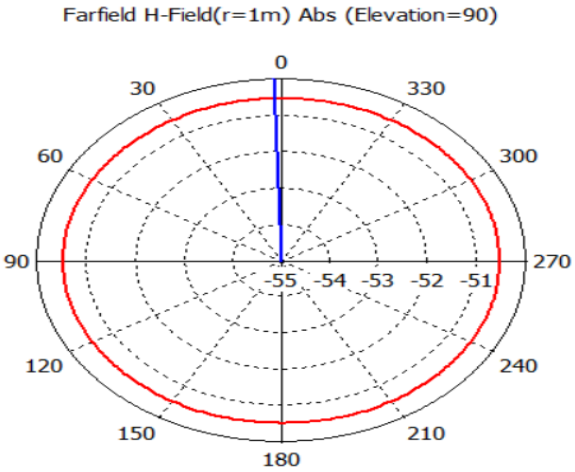
(a)



(b)

Figure 3.5 E-plane for 5.8 GHz (a) my result (b) Research paper result

- **H-plane**



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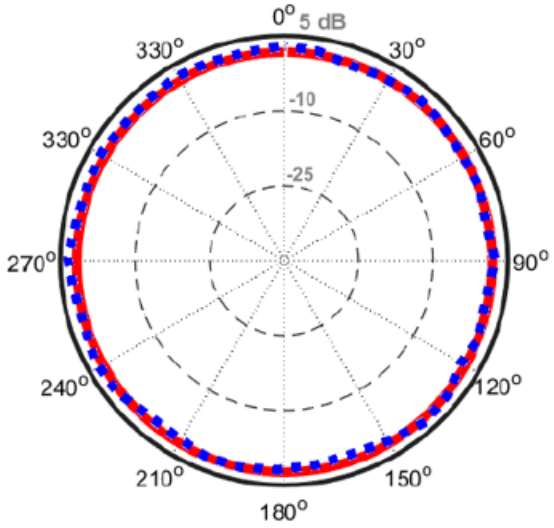
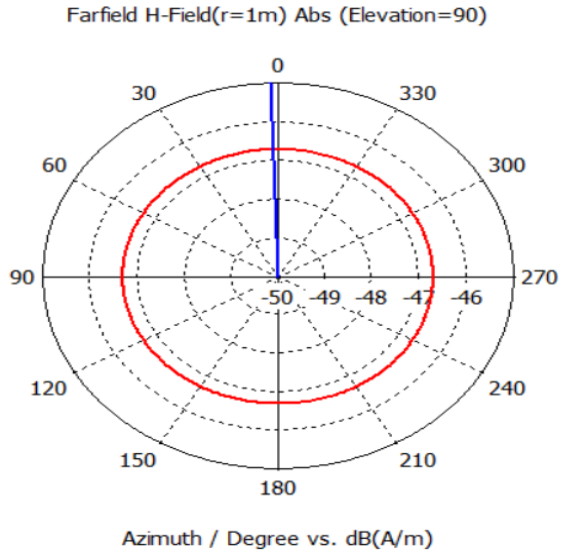


(b)

Figure 3.6 H-plane for 2.4 GHz (a) my result (b) Research paper result



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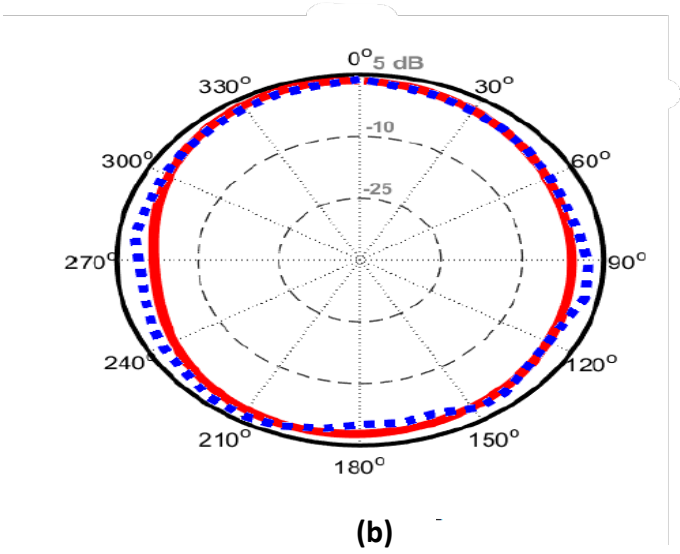
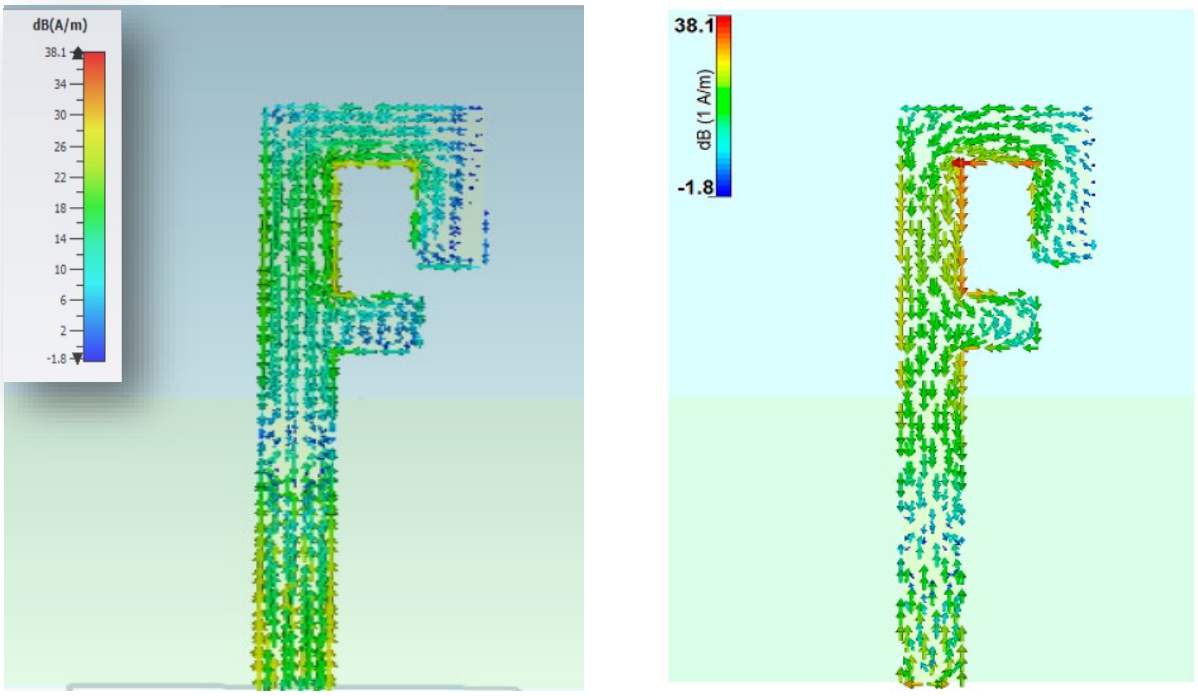


(b)

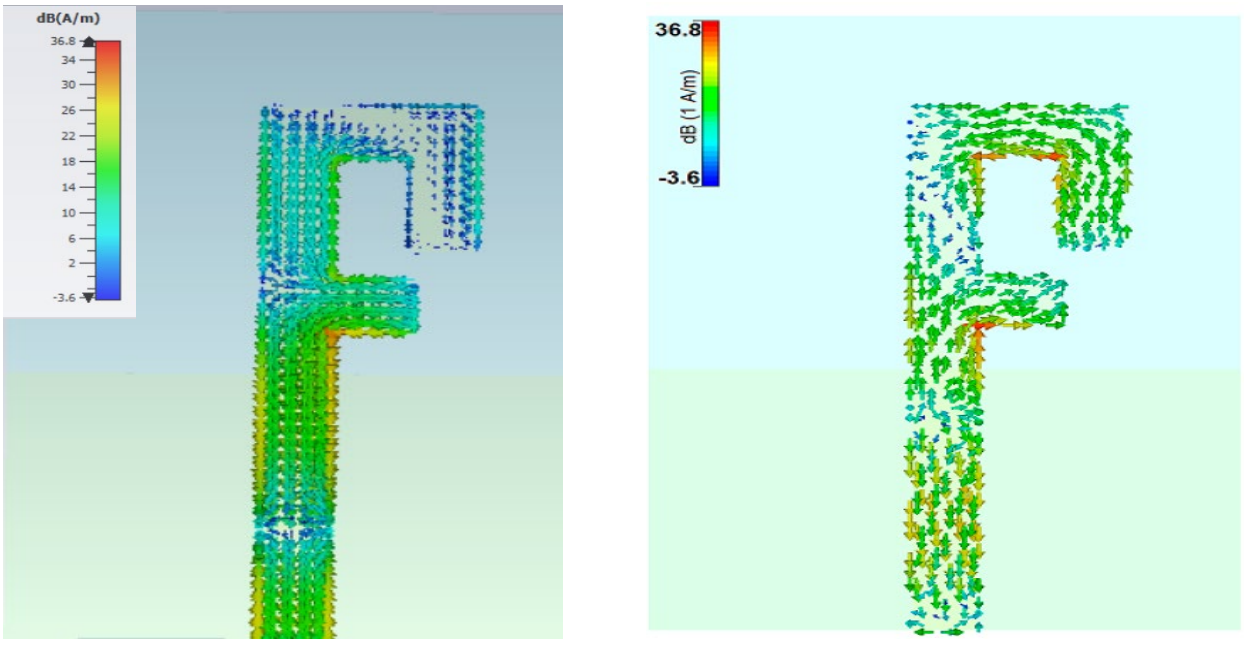
Figure 3.7 H-plane for 5.8 GHz (a) my result (b) Research paper result

3.5 Current distributions



(a) **(b)**

Figure 3.8 Current distributions for F-shape at 2.4 GHz (a) my result (b) Research paper result



(a) **(b)**

Figure 3.9 Current distributions for F-shape at 5.8 GHz (a) my result (b) Research paper result

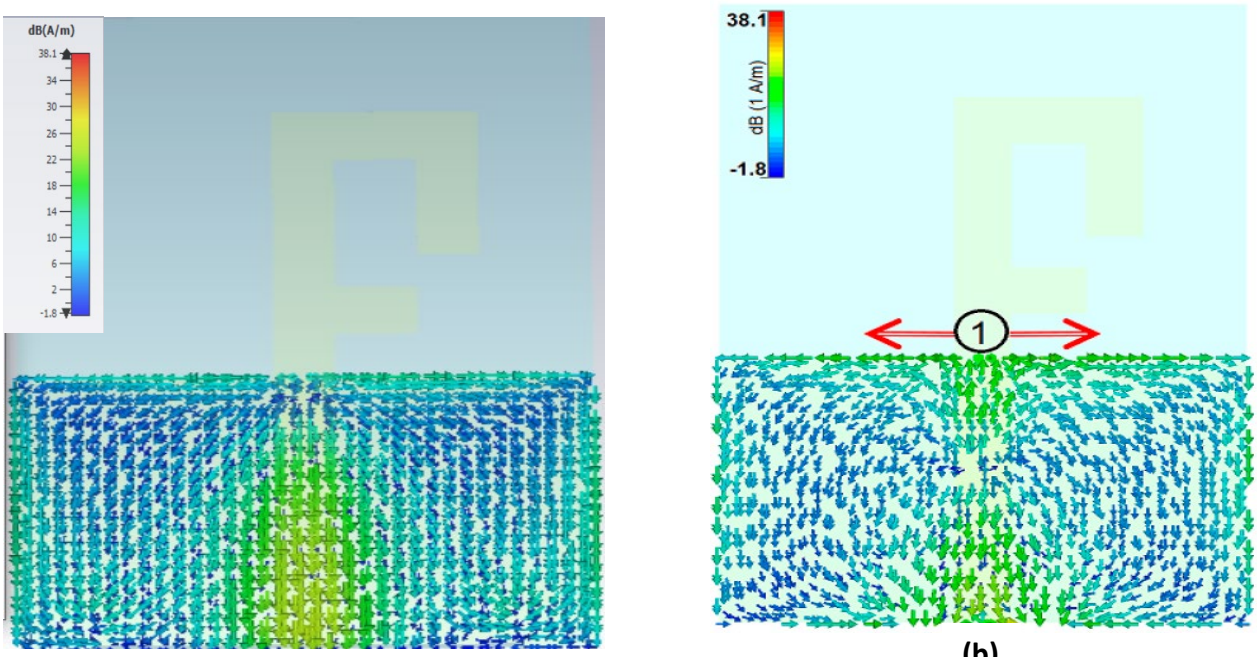


Figure 3.10 Current distributions for GND at 2.4 GHz (a) my result (b) Research paper result

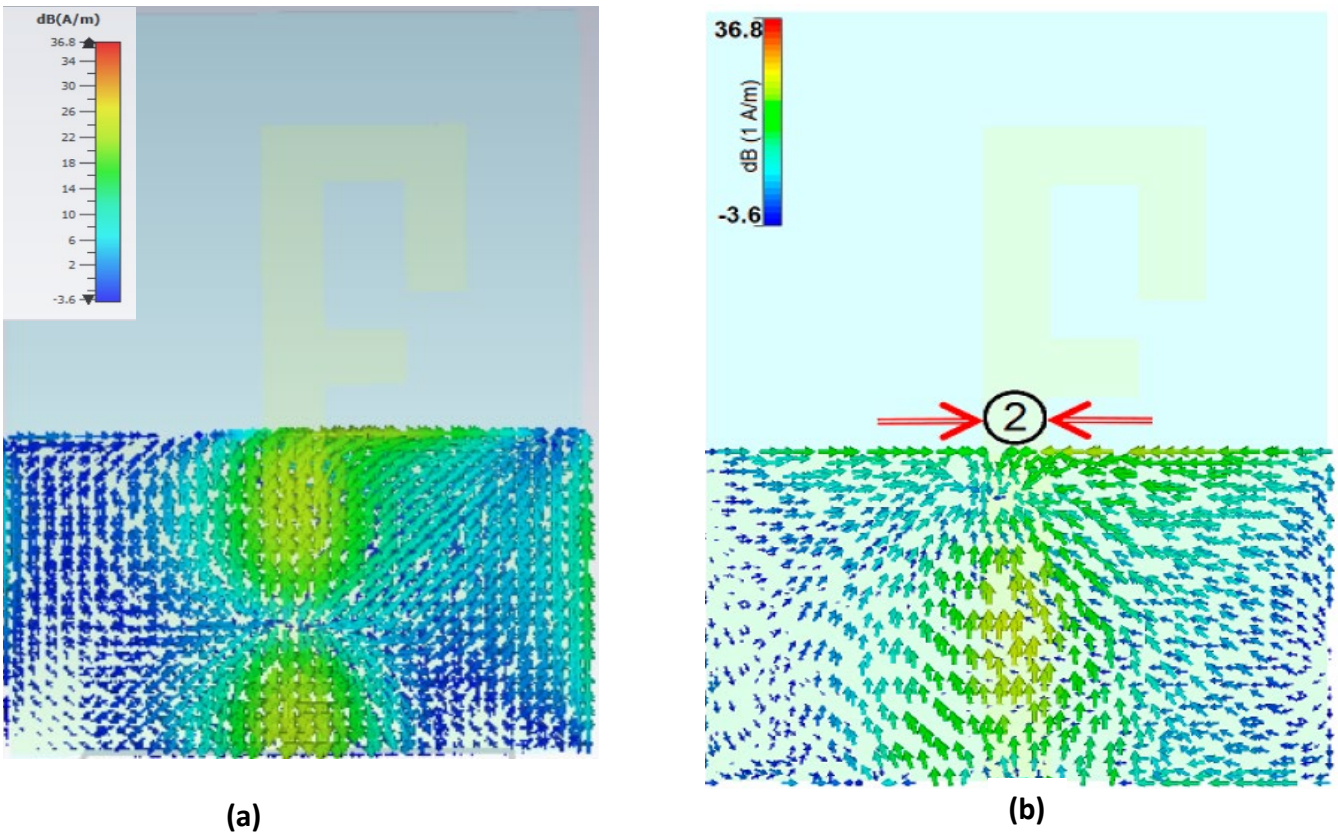
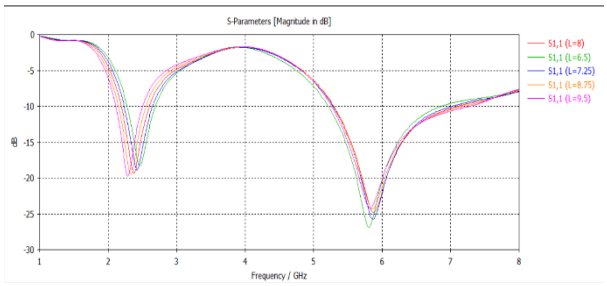


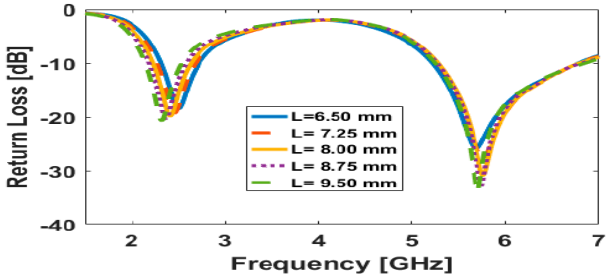
Figure 3.11 Current distributions for GND at 5.8 GHz (a) my result (b) Research paper result

4.parameter Sweep

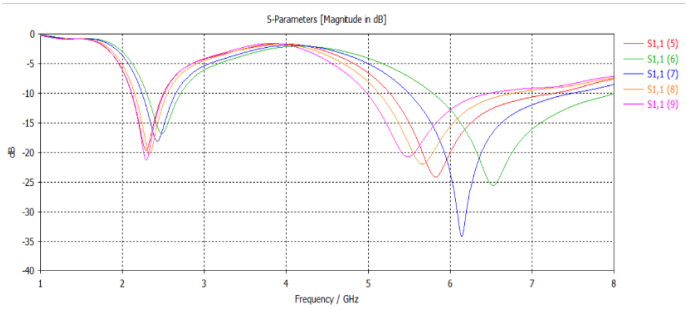
- L (from 6.5 to 9.5)



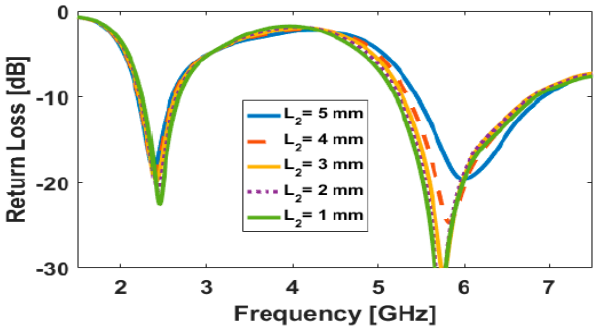
(a)



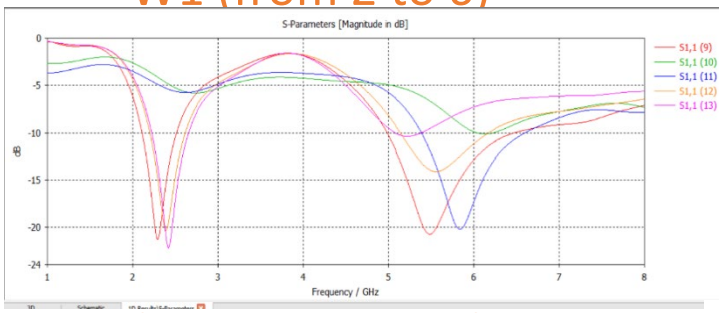
- L2 (from 1 to 5)



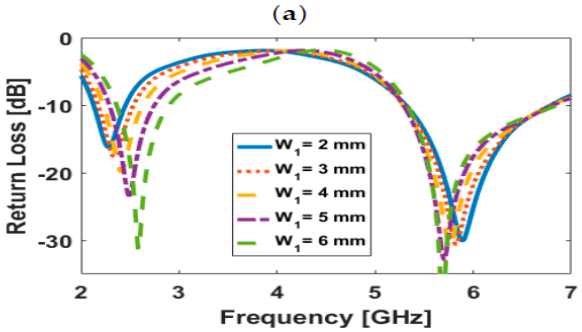
(b)



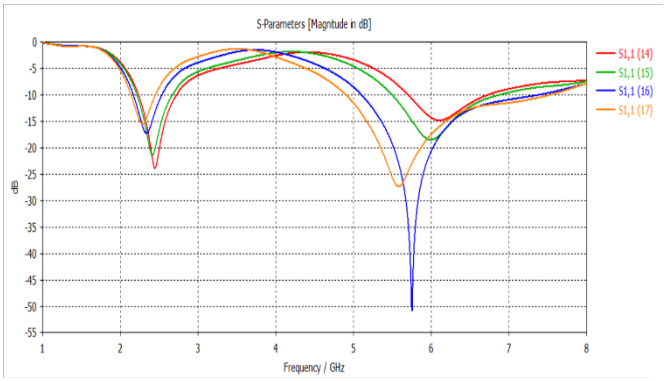
- W1 (from 2 to 6)



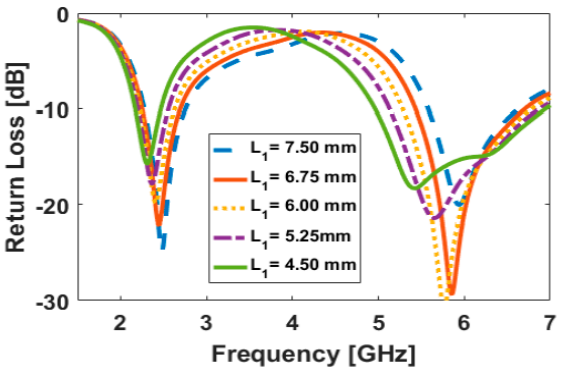
(c)



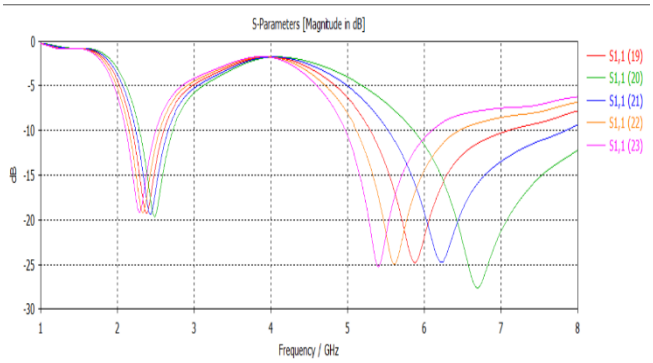
L1(from 4.5 to 7.5)



(d)



L3(from 1.5 to 4.5)



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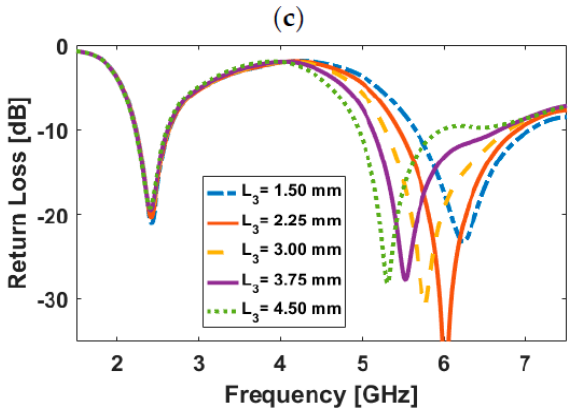
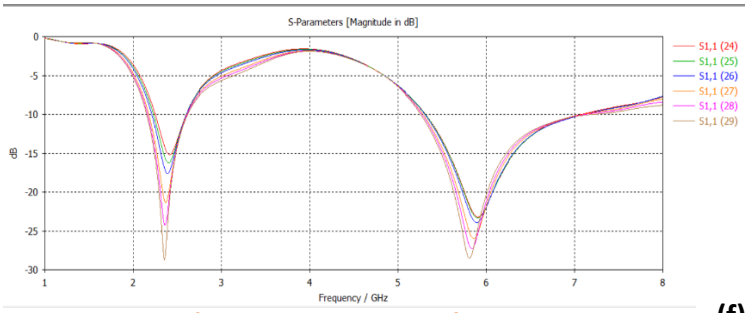


- lgnd(from 14 to 20)



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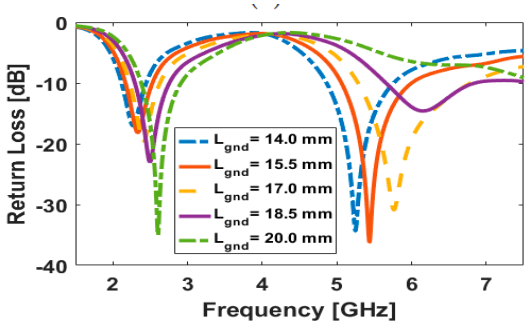
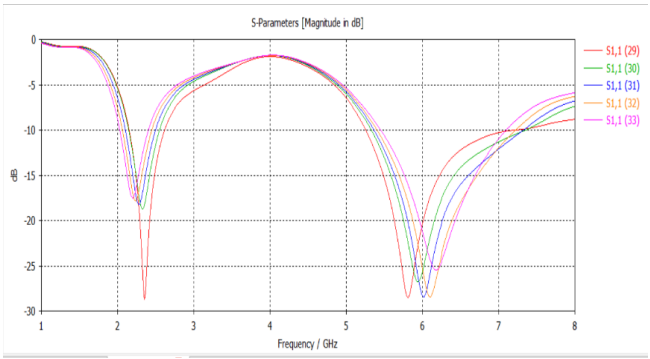
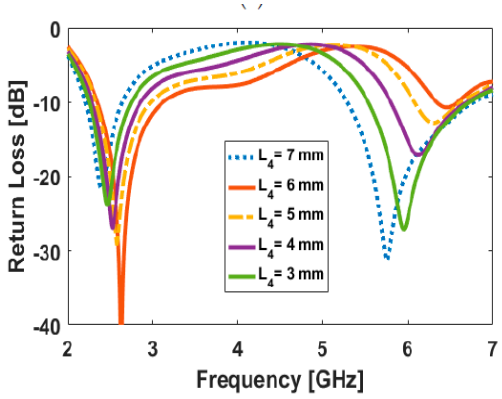


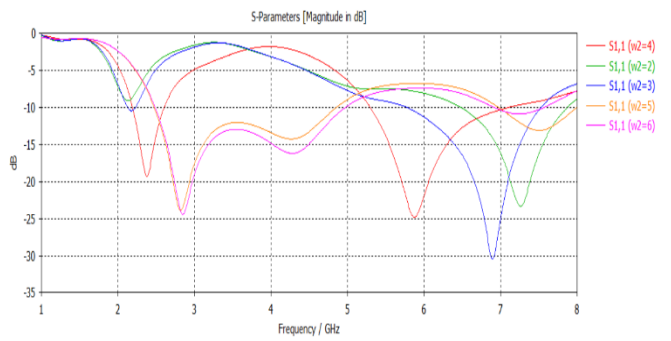
- L4 (fr om 3 to 7)



(g)



- w2 (from 2 to 6)



(h)

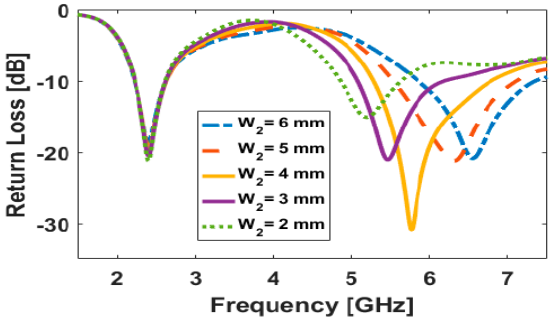
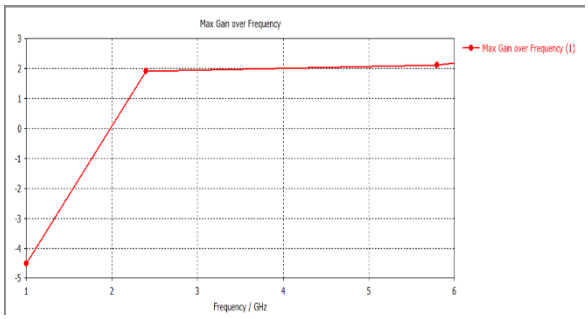


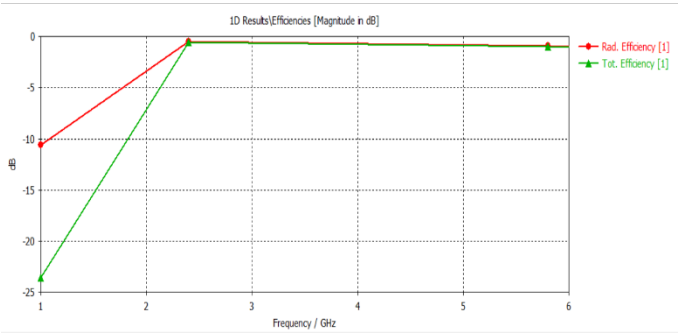
Figure 4.1 parameter Sweep (a) L(b) L2(c)w1(d)L1(e)L3(f)Lgnd(g)L4(h)W2

5.Additional Result

- Max Gain over frequency and Efficiency



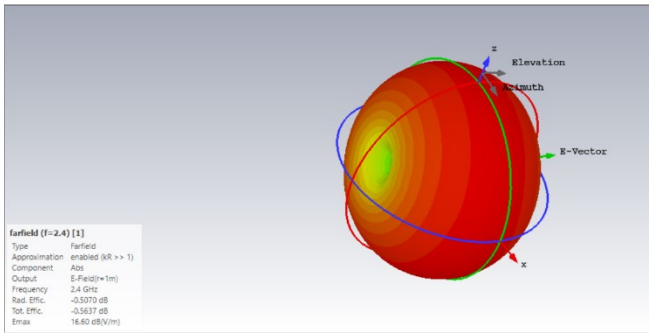
(a)

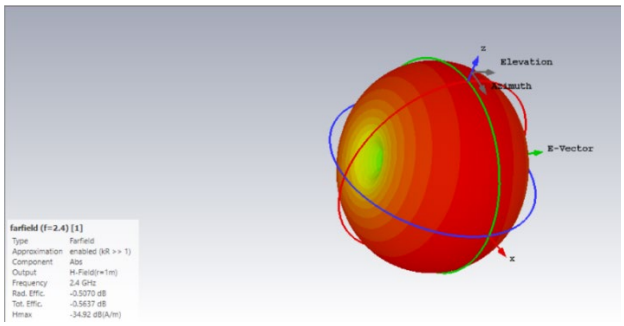


(b)

Figure 5.1 Max Gain over frequency and Efficiency (a) Max Gain over frequency (b) Efficiency

- **FARFIELD 3D PATTERN**





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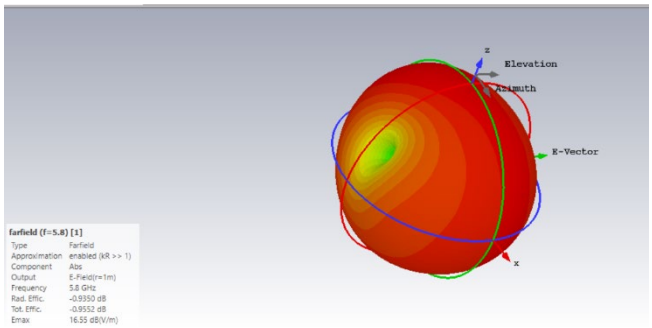

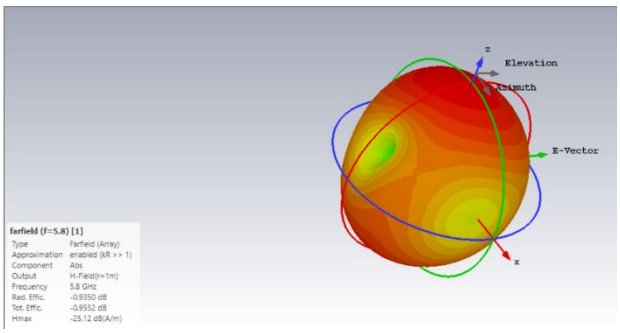

(b)

Figure 5.2 FARFIELD 3D PATTERN (a) for 2.4 GHz (b)for 5.8 GHz

6. conclusion

This dual-band monopole antenna is an efficient, compact, and low-cost solution for RFID applications. It achieves high impedance matching, favorable radiation characteristics, and adequate gain, making it suitable for modern RFID systems.

7.Reference

https://www.mdpi.com/1999-5903/11/2/31

https://youtu.be/eQ0-ugA0BcY?si=H1xTK9slUkjvJpAw