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Compact UWB Semi-Circular Microstrip Patch Antenna

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Abstract **- This paper presents the design, simulation, fabrication, and analysis of a compact Ultra-Wideband (UWB) semi-circular microstrip patch antenna for X-band wireless communication applications. The proposed antenna is designed on an FR4 substrate having dimensions of 40 mm × 30 mm × 1.6 mm and analyzed using ANSYS HFSS software. A semi-circular radiating patch combined with a modified feed structure is utilized to achieve improved impedance matching and stable resonance characteristics. Simulated results show a minimum return loss of approximately −40 dB at 7.8 GHz with a VSWR value close to unity, indicating excellent impedance matching. The fabricated antenna was experimentally tested using a Keysight FieldFox Microwave Analyzer and achieved a measured return loss of −9.714 dB at 8.257 GHz. The radiation pattern exhibits stable broadside directional characteristics with satisfactory gain performance. The obtained results demonstrate that the proposed antenna is suitable for ultra-wideband communication systems, radar applications, wireless sensing, microwave communication, and other high-frequency wireless devices.**

Keywords: UWB Antenna, Semi-Circular Patch Antenna, Microstrip Antenna, Return Loss, VSWR, Smith Chart, X-Band Communication.

I. INTRODUCTION

Ultra-Wideband (UWB) communication technology has attracted significant attention due to its high data transmission capability, low power consumption, and wide frequency bandwidth. UWB antennas play a crucial role in modern wireless communication systems, radar applications, remote sensing, satellite communication, and high-speed wireless networks. Among different antenna configurations, microstrip patch antennas are widely preferred because of their low profile, compact size, lightweight structure, ease of fabrication, and compatibility with integrated circuits.

Conventional microstrip antennas generally suffer from narrow bandwidth and limited impedance matching characteristics. To overcome these limitations, various patch geometries have been investigated. In this work, a compact semi-circular microstrip patch antenna is proposed to improve the electromagnetic performance while maintaining compact dimensions. The antenna is designed using an FR4 substrate and optimized using ANSYS HFSS simulation software. Both simulated and practical measurements are presented to validate the antenna performance.

II. ANTENNA DESIGN AND GEOMETRY

The proposed antenna consists of a semi-circular radiating patch connected to a microstrip feed line through a circular coupling section. Additional parasitic elements are incorporated near the feed region to improve impedance matching and resonance characteristics.

The antenna is fabricated on an FR4 substrate having a dielectric constant of 4.4 and thickness of 1.6 mm. The overall antenna dimensions are maintained compact to facilitate practical implementation in modern wireless communication systems.

2.1 Antenna Design Parameters

Parameter Description	Value
Antenna Type	UWB
Patch Shape	Semi Circular
Substrate Material	FR4
Substrate Thickness	1.6mm
Substrate Length	40mm
Substrate Width	30mm
Minimum Return Loss	-40dB
VSWR	Approx. 1
Resonant Frequency	7.8 GHz

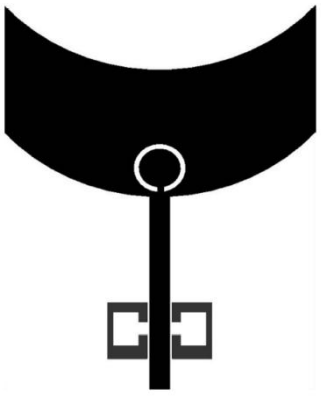

Figure 1: Geometry of Antenna (TOP VIEW)

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2.2 Fabrication of Antenna

After obtaining satisfactory simulation results, the antenna was fabricated on an FR4 substrate using standard PCB fabrication techniques. The copper radiating patch and feed structure were etched according to the optimized design dimensions. An SMA connector was soldered carefully to the feedline for experimental testing.

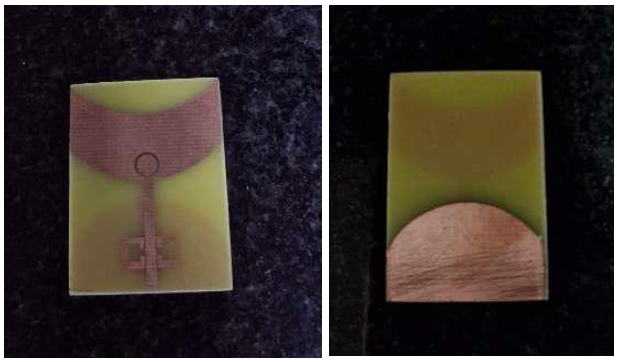

Figure 2: Fabricated Antenna a) Top View b) Bottom View

III. SIMULATED RESULTS

A. Return Loss (S11)

The S11 parameter is one of the most important characteristics used to evaluate the impedance matching and reflection performance of the proposed UWB semi-circular patch antenna. The antenna was simulated using ANSYS HFSS over the frequency range from 3 GHz to 11 GHz. The obtained S11 response exhibits a strong resonance near 7.8 GHz where the return loss reaches approximately −40 dB. Since the simulated return loss is significantly below the standard −10 dB criterion, the antenna demonstrates excellent impedance matching and minimum reflection loss at the resonant frequency.

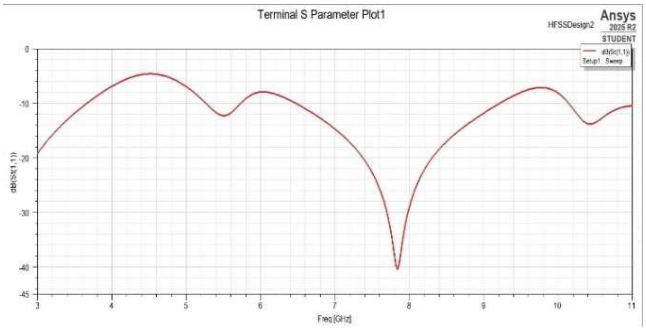

Figure 3: Return loss Vs Frequency Graph (S11)

B. VSWR Analysis

The Voltage Standing Wave Ratio (VSWR) is an important parameter used to evaluate the impedance matching of the proposed compact UWB antenna. The VSWR characteristics were analyzed using ANSYS HFSS over the frequency range from 3 GHz to 11 GHz. The obtained results show a minimum VSWR value close to 1 near 7.8 GHz, indicating excellent impedance matching and efficient power transfer with minimum reflection losses for ultra-wideband wireless communication applications.

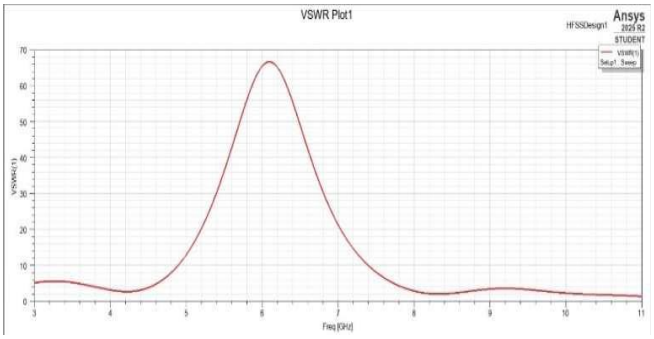

Figure 4: VSWR

C. Radiation Pattern and Gain Analysis

The radiation pattern of the proposed compact UWB antenna was analyzed using HFSS at the resonant frequency of 7.8 GHz. The obtained results show stable broadside directional radiation characteristics with low side lobes and efficient electromagnetic radiation. The semi-circular patch structure improves current distribution and radiation efficiency. The antenna provides stable directional performance suitable for ultra-wideband wireless communication, radar systems, microwave sensing, and modern high-frequency communication applications. The maximum simulated gain obtained from the analysis is approximately 2.25 dBi.

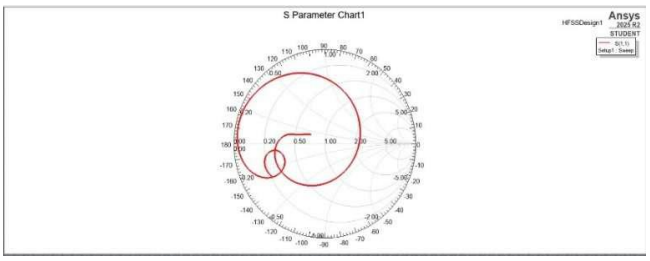

Figure 5: Radiation pattern

IV. PRACTICAL RESULTS AND DISCUSSION

Experimental measurements were carried out using a Keysight FieldFox Microwave Analyzer to validate the simulated results. The fabricated antenna achieved resonance at approximately 8.257 GHz with a measured return loss of −9.714 dB. The measured VSWR value was found to be approximately 1.94. A slight shift in resonant frequency was observed between simulation and measurement results, which may be attributed to fabrication tolerances, connector losses,

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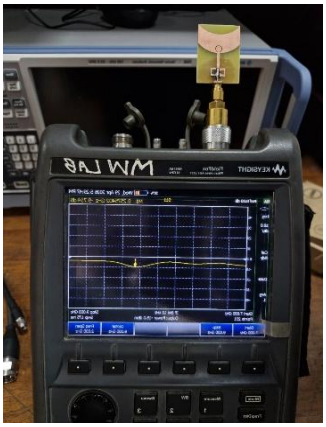
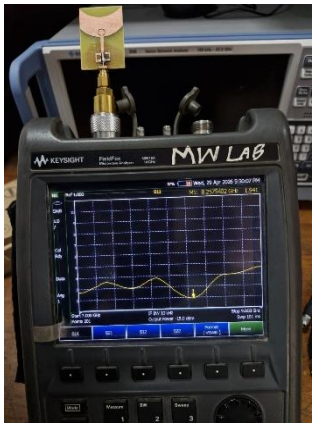
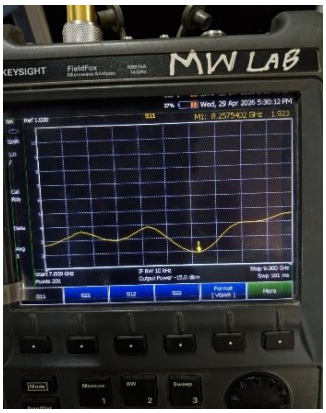
soldering effects, and practical variations in substrate properties.

The measured Smith chart response indicates an impedance value of approximately 81.2 + j30.5 Ω near the resonant frequency. Despite minor deviations from simulated results, the practical measurements confirm acceptable antenna performance and validate the effectiveness of the proposed design.

Parameter	Simulated	Practical
Resonant Frequency	7.8 GHz	8.257 GHz
Return Loss	-40 dB	-9.714 dB
VSWR	Approx 1	Approx 1.94
Gain	2.25 dBi	2.25 dBi
Impedance	Near 50ohm	81.2+j30.5ohm







V. CONCLUSION

In this work, a compact UWB semi-circular microstrip patch antenna was successfully designed, simulated, fabricated, and analyzed for ultra-wideband wireless communication applications around 7.8 GHz. The proposed antenna structure significantly improved the electromagnetic performance by enhancing impedance matching, reducing reflection losses, and stabilizing resonance characteristics. The simulated S11 results showed a minimum return loss of approximately −40 dB, while the obtained VSWR value close to unity confirmed efficient power transfer and excellent impedance matching near the resonant frequency. Practical measurements demonstrated a return loss of −9.714 dB at 8.257 GHz and a VSWR value of 1.94. The radiation pattern analysis confirmed stable broadside directional radiation characteristics with satisfactory gain performance. The overall results demonstrate that the proposed antenna provides stable electromagnetic characteristics while maintaining compact dimensions and low-profile structure. Therefore, the antenna is suitable for ultra-wideband wireless communication, radar systems, microwave sensing, WLAN systems, satellite communication, and modern high-frequency wireless devices.

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REFERENCES

[1] C. A. Balanis, Antenna Theory: Analysis and Design, *Wiley, 4th Edition*.

[2] K. F. Lee and W. Chen, Advances in Microstrip and Printed Antennas, *Wiley*.

[3] D. M. Pozar, “Microstrip Antennas,” *Proceedings of the IEEE*.

[4] ANSYS HFSS User Manual, *ANSYS Inc*.

[5] R. Garg, P. Bhartia, I. Bahl and A. Ittipiboon, Microstrip Antenna Design Handbook, *Artech House*.

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