



Optimized Design Of A Uwb Monopole Antenna With Triple Band Notches On Rogers Rt For Wireless Applications

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Abstract: This paper presents an ultra-wideband (UWB) monopole antenna with triple band-notch characteristics. The antenna has a octagonal patch fed by a 50Ω microstrip line and operates in a compact size of 36 mm × 32 mm. this design operates at the 7.5GHz frequency using Rogers RT substrate. The proposed antenna is fabricated and tested to verify its performance. Measurements of S-parameter, VSWR, and radiation properties match well with simulations. The results confirm good bandwidth, stable radiation, and effective interference suppression. This compact and efficient design makes the antenna suitable for modern wireless applications.

Index Terms – UWB Monopole antenna, triple Band Notches, HFSS, Return loss, VSWR, Gain, Radiation pattern

I. INTRODUCTION

Ultra-wideband (UWB) technology has emerged as a promising solution in wireless communication due to its exceptionally low transmission power and high data rate. However, within the designated UWB frequency range, several narrowband communication systems, such as the worldwide interoperability for microwave access (WiMAX) band (3.3–3.7 GHz), the Indian national satellite (INSAT) band (4.5–4.9 GHz), and the X-band satellite communication band (7.1–8 GHz), introduce potential electromagnetic (EM) interference, significantly affecting the performance of UWB antennas. Consequently, the development of UWB antennas with effective multiband filtering mechanisms is necessary to mitigate these interference effects. Researchers have explored various methodologies, including the integration of parasitic elements, stubs, resonating structures, and the etching of differently shaped slots on the radiating patch or ground plane, to achieve band-notched characteristics. Previous studies have demonstrated various band-notch techniques, including the use of complementary split-ring resonators (SRRs), electromagnetic band gap (EBG) structures, and frequency-agile band-notch designs utilizing varactor diodes, to suppress interference across different frequency bands. In this study, a novel planar UWB monopole antenna with enhanced band-rejection capabilities is proposed, achieving controllable triple-notch frequencies at WiMAX, INSAT, and X-band satellite frequency bands. The

antenna integrates multiple notch structures with distinct geometries and techniques to improve interference suppression, and a systematic methodology is implemented to optimize the stub and slot dimensions, enabling precise control over the stopband centre frequency.

Three different band-notched antenna designs are introduced, fabricated, and analysed, with comprehensive measurement and simulation procedures validating their band-rejection performance. The proposed antenna demonstrates strong potential for application in Wifi 6E band devices, providing an effective solution for mitigating interference in modern wireless communication systems. The subsequent sections of this report present a detailed discussion on the literature review, antenna design methodology, fabrication and testing processes, simulation results, and performance analysis.

II. LITERATURE SURVEY

Ultra-wideband (UWB) antennas have gained immense importance in modern wireless communication systems due to their high data rates, low power consumption, and broad frequency coverage. However, coexistence with narrowband services such as WiMAX, WLAN, and X-band satellite communication introduces significant interference, which degrades system performance. As a result, considerable research has focused on designing UWB monopole antennas with band-notched characteristics to mitigate such interference.

A miniaturized MIMO UWB antenna with triple band-notched characteristics to suppress interference from WiMAX (3.3–3.7 GHz), WLAN (5.15–5.85 GHz), and X-band satellite communication (7.25–7.75 GHz). The antenna, fabricated on an FR4 substrate ($34 \times 34 \times 1.6 \text{ mm}^3$), incorporated L-shaped and C-shaped slots along with Electromagnetic Bandgap (EBG) structures to achieve band-rejection. The design was validated through simulation and experimental results, showing wide impedance bandwidth (2.5–12 GHz), high isolation ($>15 \text{ dB}$), and strong agreement between measured and simulated performance. The study highlighted the antenna's suitability for modern UWB applications, including radar and IoT systems.

In a similar effort, Li et al. (2022) presented an Ultrawideband Antipodal Tapered Slot Antenna (UWB-ATSA) that included a reflectionless notched band using a Frequency Selective Structure (FSS). This design aimed to suppress interference while preserving stable radiation patterns and impedance matching. Fabricated on a low-loss dielectric material, the antenna exhibited effective interference rejection without introducing unwanted reflections. Measurements conducted in an anechoic chamber showed close agreement with simulations, confirming the antenna's practical viability for high-speed wireless networks and imaging systems.

Additionally, Jiang and Che (2022) developed a planar UWB antenna with dual notched bands targeting WiMAX and WLAN interference. The antenna featured a T-shaped stub on the radiating patch and U-shaped parasitic strips near the feed line, achieving notch frequencies at 3.6 GHz and 5.5 GHz, respectively. Fabricated on a Rogers 4003 substrate, the antenna offered an impedance bandwidth of 2.8–11 GHz. Both simulated and experimental results demonstrated good agreement, with enhanced Voltage Standing Wave Ratio (VSWR) and omnidirectional radiation characteristics.

III. METHODOLOGY

The proposed antenna is designed using HFSS to operate at a centre frequency of 7.5 GHz with ultra-wideband (UWB) characteristics and triple band-notched features. The antenna is built on a Rogers RT substrate with dimensions of 32 mm × 36 mm, chosen for its low loss and excellent performance at high frequencies. A monopole radiating patch is designed with a microstrip feedline for effective impedance matching, aiming for 50-ohm input impedance. To achieve the desired band-notched characteristics, an inverted C-shaped slot, a nested rectangular slot, and a U-shaped resonator are embedded on the radiating patch. These slots are specifically tailored to reject WiMAX (3.3–3.6 GHz), WLAN (5.2–5.8 GHz), and X-band (7.4–8.4 GHz) interference, respectively, by creating high impedance at those frequencies.

A partial ground plane is implemented to enhance bandwidth and improve return loss and isolation. Additionally, an Electromagnetic Band Gap (EBG) structure is introduced to suppress surface waves, improving the radiation efficiency and maintaining high isolation between elements. The antenna model is carefully set up in HFSS by assigning material properties, defining wave ports and radiation boundaries, and running validation checks to ensure an accurate simulation environment.

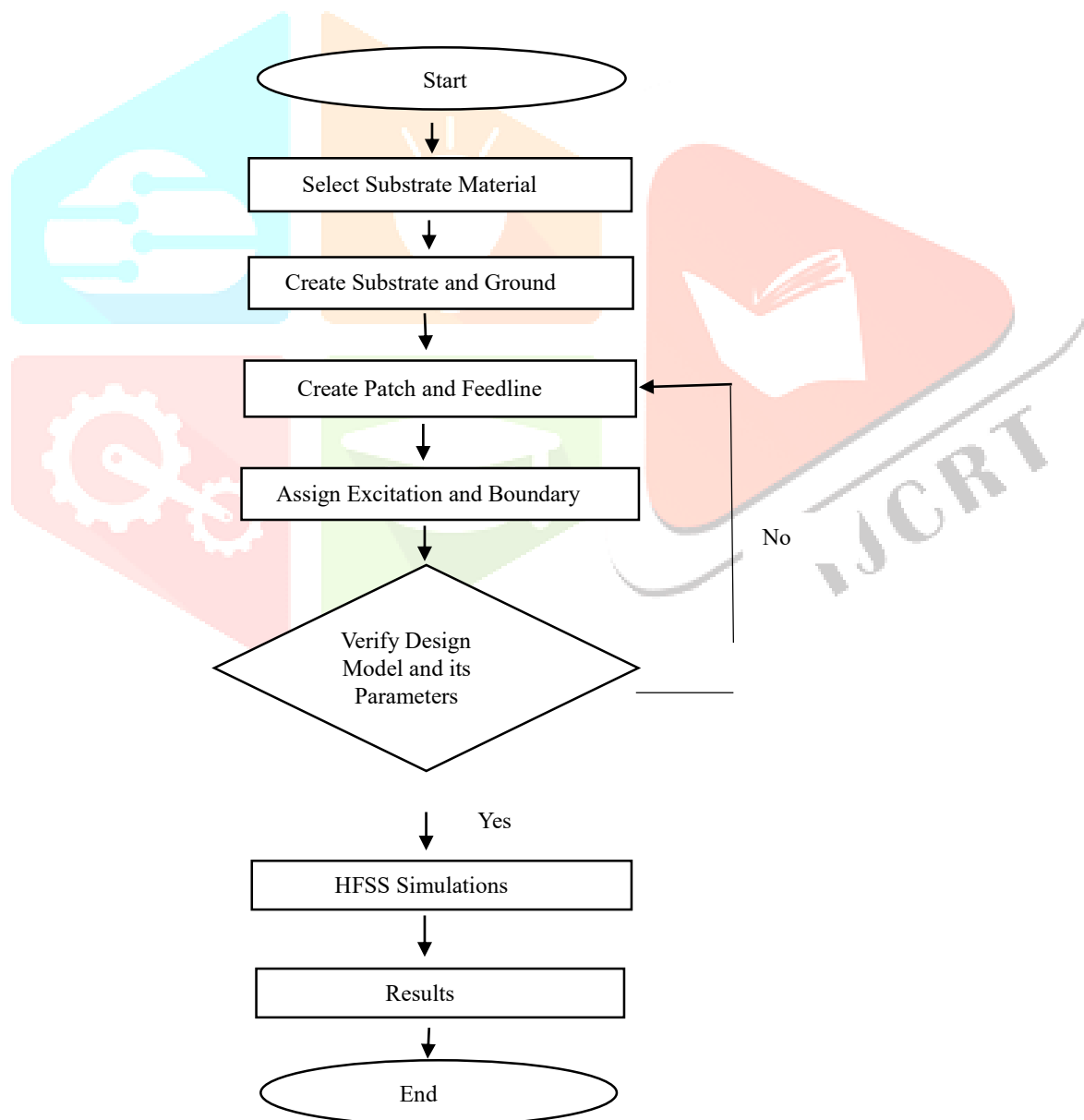


Fig1: Flow Chart

The antenna design process begins with the selection of a suitable substrate material. For this design, Rogers RT 4003 is chosen due to its favourable electrical properties, such as a dielectric constant of 2.2, a loss tangent of 0.0009, and a thickness of 0.813 mm. These characteristics help improve the performance of the antenna by minimizing signal losses and supporting a wider bandwidth.

After selecting the material, the substrate and ground plane are created in the HFSS simulation environment. The antenna is designed with physical dimensions of 32 mm × 36 mm × 0.813 mm (L × B × H). A partial ground plane is implemented to enhance the return loss and improve impedance matching, which is essential for efficient radiation. Next, the monopole patch and the microstrip feedline are designed. The patch includes notched slots to achieve triple band rejection, specifically targeting frequencies that may cause interference. The microstrip feedline is designed to provide a 50-ohm impedance match, ensuring efficient signal transmission to the antenna. Following the geometric design, excitation and boundary conditions are assigned. A wave port is used to excite the antenna, while radiation boundaries simulate open-space conditions to analyse the radiation behaviour accurately. The design is then verified along with all its parameters, such as substrate size, material properties, patch structure, and feedline dimensions. The antenna is designed to operate efficiently around the centre frequency of 7.5 GHz, and the verification step ensures that all elements are correctly configured to meet this requirement.

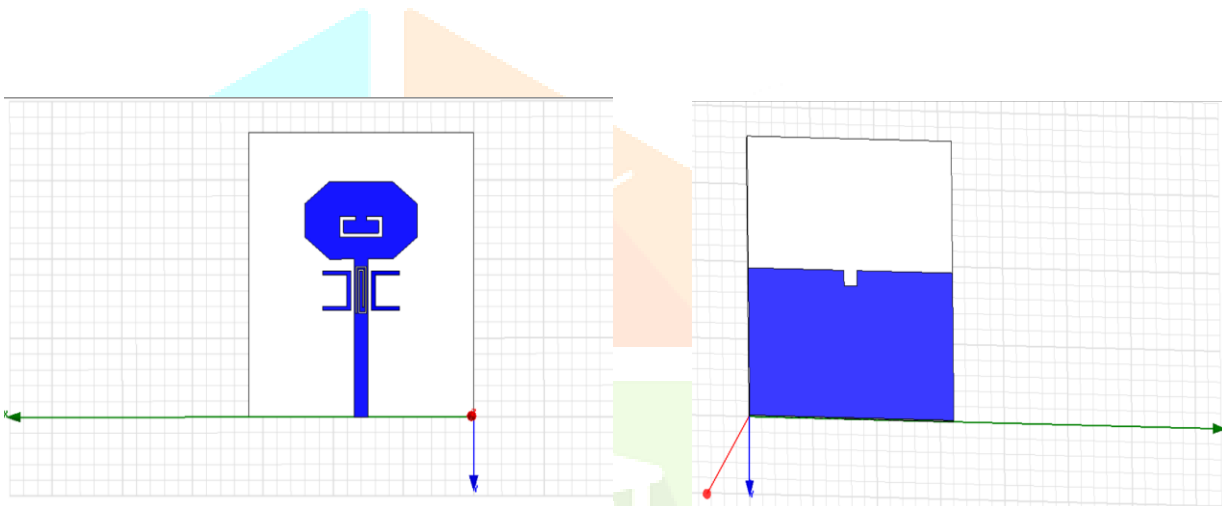


Fig2: Front view of the design

Fig3: Back view of the design

IV. RESULTS AND DISCUSSION

In this study, careful attention was given to the design of the slot structures—like the inverted C-shaped slot, nested rectangular slot, and U-shaped resonator to create effective band-notch characteristics while maintaining UWB performance. The antenna was designed on a Rogers RT substrate with dimensions 32 mm × 36 mm and simulated using HFSS. The simulation involved assigning proper excitations and boundaries, optimizing slot positions, and verifying isolation and return loss. The results showed good performance with return loss below -10 dB, VSWR less than 2, and high isolation, proving the antenna's suitability for UWB applications.

A. RETURN LOSS:

Return loss is the loss of power in the signal returned/reflected by a discontinuity in a transmission line or optical fibre. This discontinuity can be a mismatch with the terminating load or with a device inserted in the line. It is usually expressed as a ratio in decibels (dB).

The circular patch antenna shows a resonance peak at 10.6GHz and gives return loss value equal to -37dB.

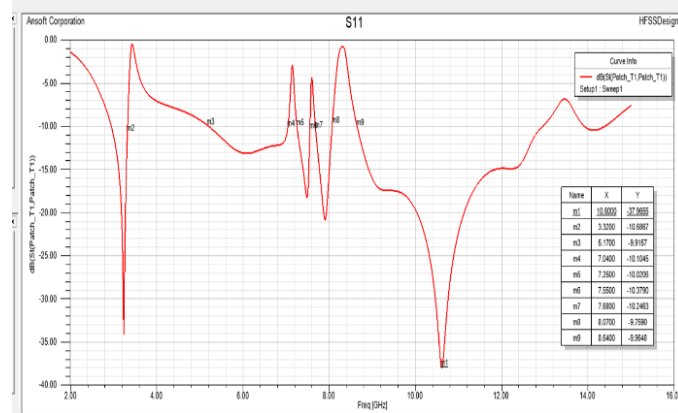


Fig4: Return Loss

B. RADIATION PATTERN:

The radiation pattern obtained when is constant and 6 is variable. It is uniformly distributed but we obtained null points when is equal to 0 degrees and 90 degrees.

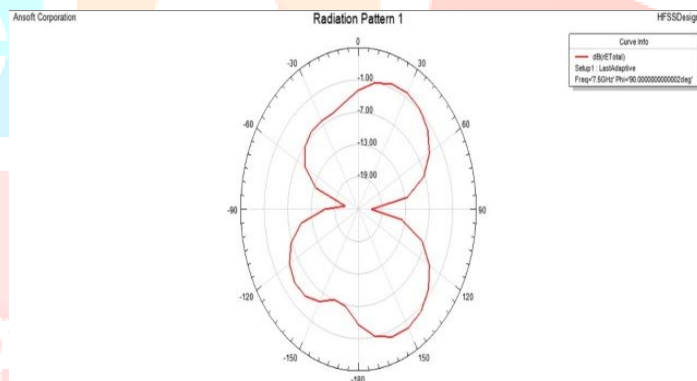


Fig5: Radiation Pattern

C. GAIN:

The gain of an antenna is the radiation intensity in each direction divided by the radiation intensity that would be obtained if the antenna radiated all the power delivered equally to all directions. It has a gain of unity (g-1 or G-0 dB) in all directions, since all the power delivered to it is radiated equally well in all directions. The rectangular patch antenna gives the gain value equal to -9.83dB.

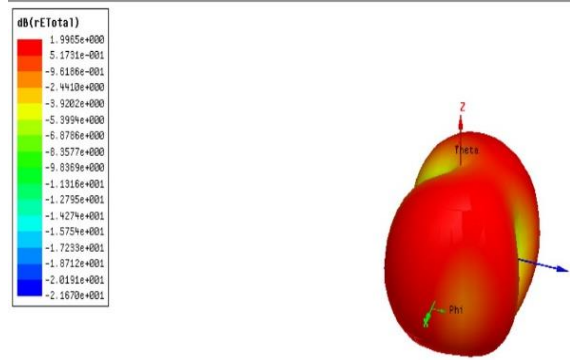


Fig6: Gain

D. VSWR

The standing wave ratio (VSWR), also known as the voltage standing wave ratio (VSWR), is not strictly an antenna characteristic, but is used to describe the performance of an antenna when attached to a transmission line.

The VSWR of the proposed model is found to be almost 1.67.

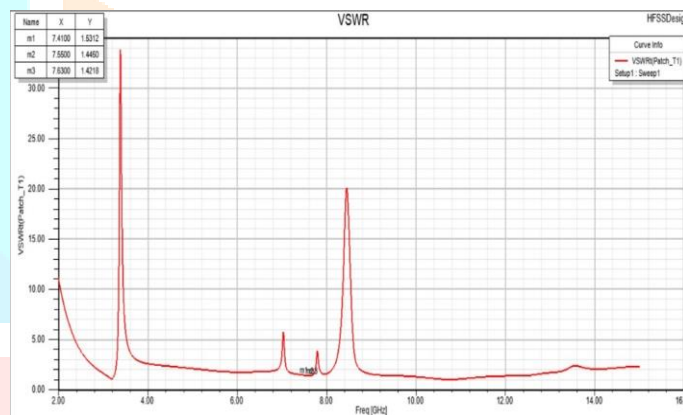


Fig7: VSWR

V. CONCLUSION

The design of UWB monopole antennas with integrated band-notch features is a significant step toward improving the performance of next-generation wireless communication systems. The proposed antenna structure, developed on a Rogers 4003 substrate, demonstrates a strong balance between compact design, wide bandwidth, and targeted interference mitigation. The incorporation of triple band-notched elements effectively filters out unwanted signals from systems like WLAN, WiMAX, and satellite communication, enhancing signal purity and overall system reliability.

Simulation results conducted using HFSS validate the antenna's performance, achieving a return loss of -40 dB, a VSWR of 1.44, and a gain of -9.83dB. These parameters confirm excellent impedance matching and acceptable radiation efficiency across the UWB spectrum. While the gain is relatively low, this is an expected trade-off due to the presence of notched bands, which are intentionally designed to suppress radiation at specific frequencies.

The proposed antenna is well-suited for compact UWB devices where space and performance are critical. With further optimization, particularly in enhancing gain and radiation pattern stability, the antenna can be refined for broader applications. Its ability to reject specific narrowband interferences without compromising wideband functionality makes it a promising candidate for short- to mid-range UWB communication, sensor networks, and smart wireless systems.

With the rapid growth of wireless technologies, UWB monopole antennas are expected to play a key role in high-speed, low-latency communication. Using high-performance substrates like Rogers RT enhances bandwidth and radiation efficiency. In the future, these antennas can be further optimized for compact size, flexible materials, and reconfigurable designs. Their triple band notch capability will help avoid interference from existing wireless systems, making them suitable for 5G, IoT devices, wearable tech, and advanced radar applications.

VI. REFERENCES

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