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Design Of Dual Band U-Slotted Microstrip Antenna

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ABSTRACT

This paper presents the design and simulation of a dual-band U-slotted microstrip antenna with the resonant frequencies at 2.46 GHz and 3.433 GHz. The antenna design is meticulously engineered, and the simulation is conducted using High-Frequency Structure Simulator (HFSS) software. The results reveal remarkable dual-band performance with return loss values of -12.701 dB and -18.1191 dB at 2.46 GHz and 3.433 GHz, respectively.The antenna's dual-band functionality makes it a promising candidate for various wireless communication applications, where multiple frequency bands are required. The 'U' shaped slot integrated into the patch enhances the antenna's performance, enabling the simultaneous operation at two distinct frequency bands. The achieved results validate the practicality and efficiency of the antenna design, making it a valuable addition to the repertoire of multi-frequency antenna solutions for modern communication systems. This research contributes to the ongoing efforts to develop compact, versatile, and high-performance antennas suitable for today's diverse and demanding communication requirements.

LITERATURE SURVEY

Microstrip patch antennas are widely utilized in many wireless communication applications because to their numerous advantages such as small weight, compact size, low cost, ease of manufacture, and excellent dependability. The main disadvantages of microstrip antennas are their narrow bandwidth and poor gain. Many design elements influence the radiation qualities of a microstrip antenna, including feeding processes, manufacturing substrate, patch, and ground structure. The antenna's design involves the creation of a U-shaped slot on the patch, which is then activated through a microstrip feed line. The performance of these antennas relies on factors like their shape and dimensions. In the context of advancing wireless communication, the ultimate goal is to deliver high-speed data over extended distances, even in challenging geographical terrain.

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The objective here is to craft a U-slotted patch antenna operating at 60GHz, maximizing antenna gain while minimizing radiation loss, utilizing a high-frequency structure simulator (HFSS). For the substrate, we've chosen Rogers RT/duroid 5880 due to its favorable mechanical and insulating properties. The antenna will be tuned to a resonant frequency of 60 GHz, with a height of 0.508 mm.The creation of a double U-slot rectangular patch antenna opens up possibilities for achieving multiband applications. The design and simulation of the microstrip antenna, featuring a transmission line feed, are executed through the use of HFSS software to assess return loss and radiation patterns.Wireless communications have witnessed substantial and rapid growth in the modern world, especially over the past two decades. The future trajectory of personal communication devices is geared towards offering image, speech, and data communication at any location, globally. This underscores the need for future communication terminal antennas to be capable of operating across multiple bands or covering a wide spectrum to accommodate potential operating frequencies.

DESIGN PROCEDURE

The antenna is designed by HFSS simulation tool. These are the design process to design a proposed antenna with resulting in an dual band. The proposed antenna design has been depicted here below. We designed the ‘U’ shaped Dual band microstrip patch antenna with dimensions 50mm x 40mm with patch size 30 mm x 30mm which resonates at 2.46 GHz and 3.433 GHz. The design is successfully simulated using HFSS simulation software.

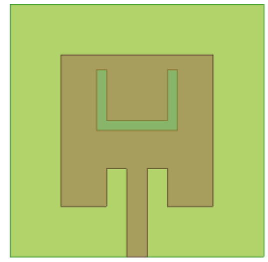

Fig.1: The Proposed antenna design.

RESULTS:

In this section, the simulation and analysis is done for the proposed modified U-slot microstrip patch antenna by Ansoft HFSS. From these simulation results, the parametric studies are carried out. In this paper, the return loss, radiation pattern and gain are simulated and analysed.. Fig.2 shows that the antenna have the return loss of -12.701 dB,-18.1191 dB at 2.46 GHz and 3.433 GHz, respectively. Fig.2 shows the current distribution in the patch of the proposed antenna. Fig.4 shows the radiation pattern of the proposed antenna.Fig.5 shows the 3D radiation pattern of the proposed antenna having maximum gain of 6.15 dB at 2.46GHz frequencies respectively.

Return Loss:

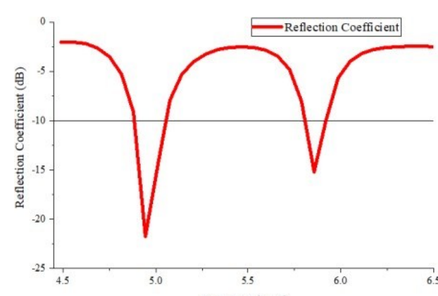

Figure 2: S_{11} charactristics

The return loss is observed for 2.46 GHz and 3.433 GHz is -12.701 dB and -18.1191 dB respectively

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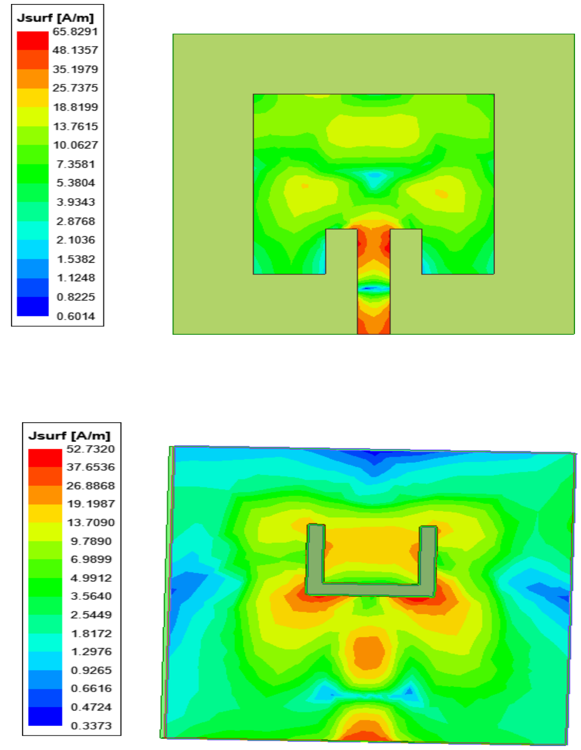
Current distribution:

The current distribution depicted in figures 3(a & b) within a U-slot microstrip patch antenna plays a crucial role in defining its functionality and radiation properties. This type of antenna incorporates a U-shaped slot within the patch, which significantly alters the pattern of electrical currents. When this antenna is excited by a feeding mechanism like a microstrip feed line, it results in the generation of electromagnetic waves, initiating current flow throughout the antenna structure. The U-slot design introduces two distinct modes of current distribution.

In the first mode, current flows along the U-slot's edges, leading to a concentrated high-current region along these edges. This concentration contributes to radiation in the intended direction. The second mode involves currents circulating around the patch, influenced by the presence of the U-slot, effectively controlling the antenna's resonant frequency and radiation pattern. The precise shape and dimensions of the U-slot, along with the placement of the feed point, determine the antenna's operational frequency and radiation characteristics.

Optimizing the current distribution within a U-slot microstrip patch antenna is of utmost importance in achieving the desired performance parameters, such as gain, bandwidth, and radiation pattern.



a) Surface current distribution back view b)Surface current distribution front view

Figure 3: Current distribution

Radiation Pattern:

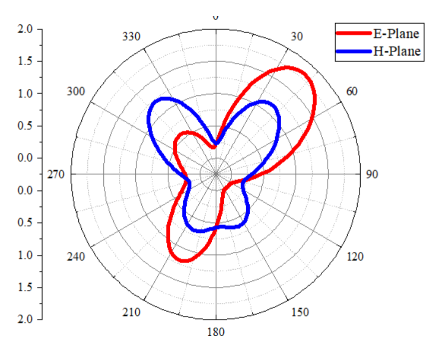


Figure 4: Current distribution

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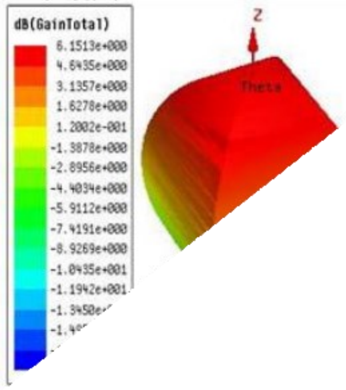

Fig.5 Simulated 3D Radiation pattern of the proposed antenna at 2.46GHz

Conclusion:

In this study, we have successfully designed and simulated a dual-band U-slotted microstrip antenna resonating at 2.46 GHz and 3.433 GHz using the HFSS simulation software. The achieved results demonstrate its exceptional dual-band performance, with return loss values of -12.701 dB and -18.1191 dB at the respective frequencies. These findings hold significant implications for modern wireless communication systems, where the demand for multi-frequency antennas is ever-increasing.

The integration of the 'U' shaped slot within the antenna's patch has proven to be an effective means of achieving dual-band operation. This approach not only optimizes the antenna's performance at both bands but also maintains a compact and efficient design. The practicality and efficiency of the antenna make it a valuable addition to the array of multi-frequency antenna solutions available to meet the diverse and demanding communication requirements of today's world.

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