Design of Quasi Modified Rectangular Patch Antenna by using Ultra Wideband (UWB) Frequency for Radar Communications

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Abstract— Ultra wideband (UWB) antennas are made specifically to send and receive electromagnetic energy at extremely short wavelengths. It is commonly recognized that the advancement of UWB technology is mostly attributed to the creation of UWB antennas. The Ultra-Wideband Microstrip Printed Antenna for Radar Communications is presented in this paper. A micro-strip line feeds the antenna and is flushed with the ground plane. The substrate is made of inexpensive FR4 material, and the patch is a quasi-modified rectangular radiating patch. The dimensions of the suggested antenna are 37 × 26 × 1.2 mm. The high-frequency structures simulator, or HFSS, was used to construct and improve this antenna. The antenna's VSWR, radiation patterns, input impedance, gain, and return loss are all shown. The FCC has granted authorization for the proposed UWB antenna's bandwidth.

Keywords — Ultra wide band Frequency, Printed Antenna, Radar Communications, FR-4,

I. Overview

Today's world makes extensive use of microstrip patch antennas due to its numerous attractive and distinctive features, including as their low profile, light weight, compact and conformable construction, ease of fabrication, and ability to be integrated with solid-state electronics. Nonetheless, the low strength and limited bandwidth of the micro-strip patch antenna are its primary disadvantages. Ultra-wide-band antennas have proven to be fascinating topics for antenna designers and have significant uses in both military and commercial systems. The bandwidth used by UWB applications is in GHz ranges. High data rates, high levels of security, and great reliability of communication are the major benefits of UWB applications. Thus, the Federal Communication Commission (FCC) approved the use of ultra-wideband systems in the 3.1GHz–10.6GHz band in the United States in 2002. A small number of other nations have set aside specific frequency bands for UWB use.

The UWB spectrum is essentially split into six band groups, each of which is further subdivided into fourteen bands. For UWB applications, printed antennas are usually selected because of their various advantages, which include ease of fabrication, low cost, small size, and light weight. On the other hand, planar antennas can achieve ultra-wideband behavior by incorporating ground planes with slots that are specifically built, as well as partial ground planes with round forms and edges. Additionally, it is possible to get ultra-wideband features devoid of partial ground, round borders, and round forms. However, these designs produce strong UWB performance.

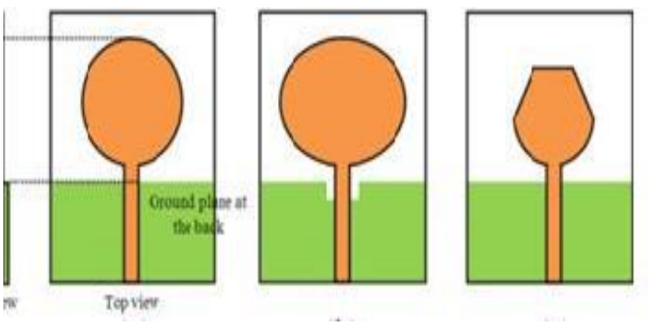


Figure 1: UWB Antenna Models

II. Antenna Design

With a partial ground plane and a quasi-modified rectangular radiating patch, the antenna configuration is depicted in Figure 1 with its dimensions. The partial ground plane is 26 mm in width and 8.9 mm in length. The suggested rectangular antenna feed is an 8.9mm-long and 1.2mm-wide microstrip line. To improve antenna performance, a meander line of 0.94 mm in thickness and 11.92 mm in length is included into the radiating patch, as shown in figure 1. The suggested quasi-modified rectangular is printed with a permittivity of 4 and measures 37 x 26 x 1.2 mm on a 1.2 mm thick FR4 epoxy material substrate. To increase the antenna's bandwidth, a tiny 17.34 x 1.7 mm gap is cut out of the partially ground. In addition to the radiating patch, two parasitic patches with the dimensions shown in Figure 1 are added to improve the antenna's performance. The antenna model design and all of its dimensions are shown in Figure 1.

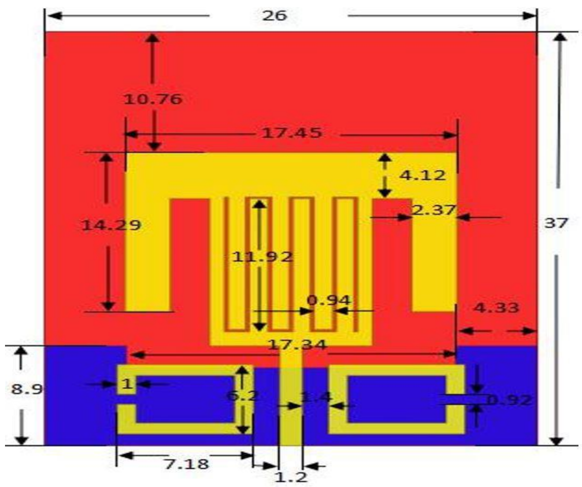
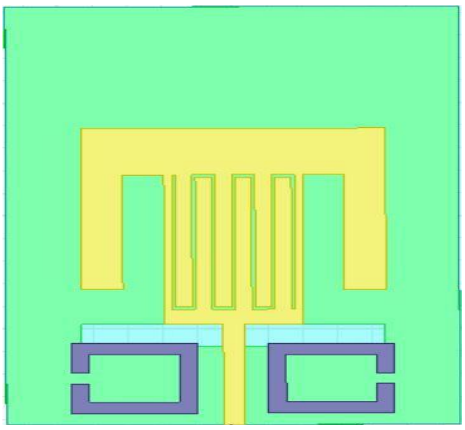
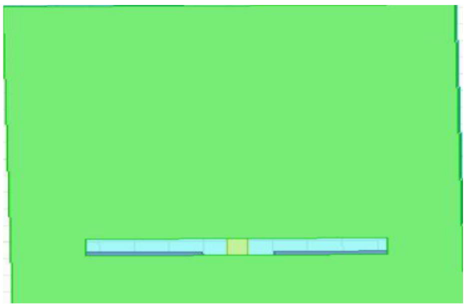


Figure 2: Geometry of Ultra wide Band Antenna

a) Simulation Using HFSS



(a)



(b)

Figure 3: HFSS Design of Proposed Model
a) Top View **b)** Back View

Version 13.0 of the HFSS (High-Frequency Simulation Software) is used to model and analyze the aforementioned antenna design, as stated in Figure 2.

III. Fabrication Model of Proposed Antenna

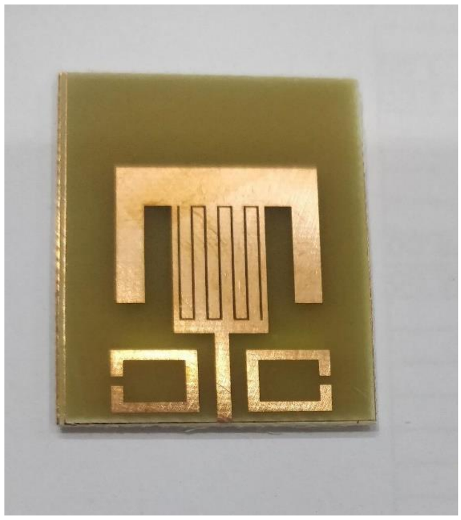


Figure 4: Fabricated Ultra wide Band Antenna
a) Top View b**)** Back View

The construction of the proposed ultra-wideband antenna is shown in figure 3 above. Its dielectric constant is 4.4 and its substrate is composed of FR-4 epoxy.

IV. Experimental Results

a) S11

S11 between the port impedance and the input impedance of the network is known as S11. The S11 acquired for the quasi-modified rectangular patch constructed in HFSS corresponding to Figure 3's Ultra Wideband Microstrip patch antenna is shown in Figure 5. This chart shows that the return loss fluctuates between the 11 GHz and 12 GHz bandwidth, with values falling below -10dB at 11.32 GHz and 19.59 at 11.80 GHz.

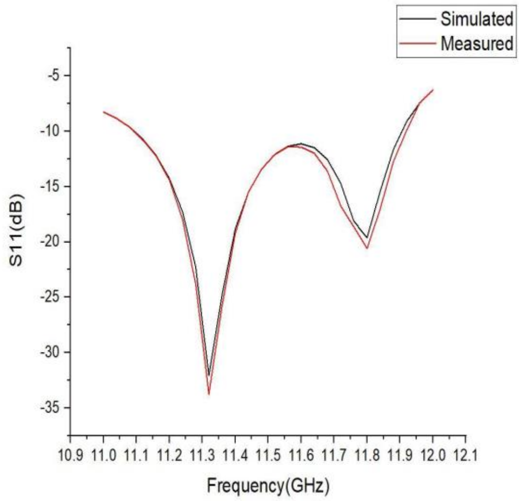
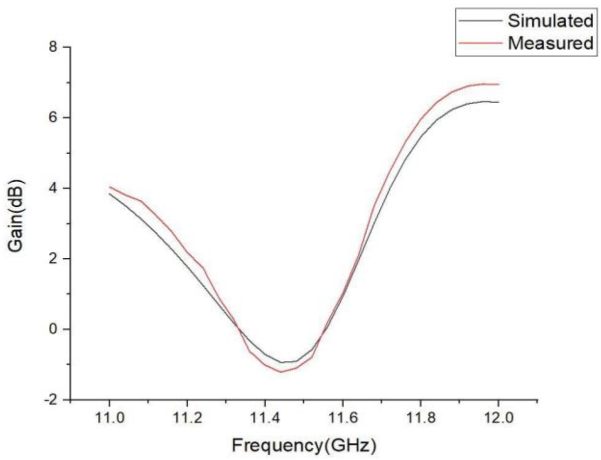


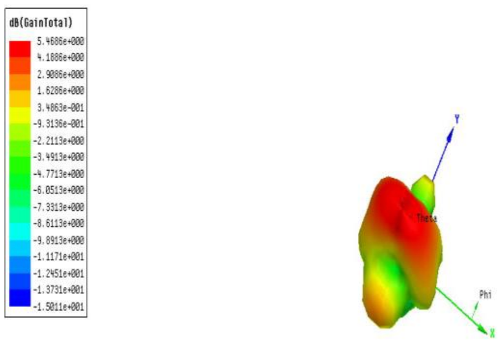
Figure 5: Simulated & Measured S11 of UWB Antenna

b) Antenna Gain

The amount of radiation that an antenna concentrates in a certain direction or absorbs incident radiation from that direction in relation to a reference antenna is known as gain. Figures 6(a) and 6(b) display the 5.46dB gain of the ultra wideband microstrip patch antenna. In terms of HFSS matching, this antenna, which is a quasi-modified rectangular patch, matches figure 3.



(a) Graphical



(b)Polar

Figure 6: Simulated & Measured Gain of UWB Antenna

c) VSWR

The Voltage Standing Wave Ratio (VSWR) is a measurement of the degree of mismatch between an antenna and the feed line that connects to it. A perfect match is indicated by a minimum VSWR of unity. Figure 7 displays the VSWR of the quasi-modified rectangular patch Ultra wideband Microstrip patch antenna built in HFSS equivalent to figure 3. In real-world scenarios, it needs to be between 1 and 2. The VSWR at 11.8GHz is found to be 1.2339.

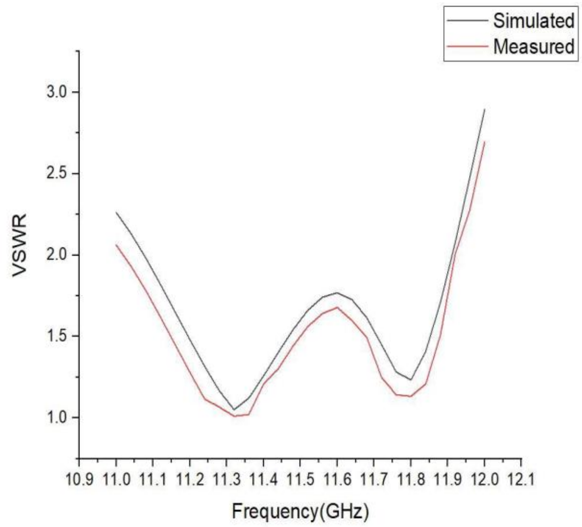


Figure 7: Simulated & Measured VSWR of UWB Antenna

Using HFSS and a network analyzer, the Ultra Wide Band (UWB) Printed Antenna's measured and simulated results are acquired, and the S11 and gain parameters are checked.

V. Analysis of the Outcome

Ref	Dimensions of an Antenna	S11	Gain
1	29 × 35 × 0.764 mm3	-10 dB	3.6 dB
2	28 × 28 × 1.6 mm3	-10 dB	4.5 dB
3	30 × 30 × 1 mm3	-10 dB	4.8 dB
4	30 × 22 mm2	-10 dB	3.62 dB
5	25 ×24 mm	-10 dB	4.9 dB
Proposed Work	**37 ×26 × 1.2 mm**	**33 dB**	**5.46 dB**

The reference papers compare antenna size, S11, and gain in relation to UWB antennas for radar applications. The antenna gain of the proposed work is higher than that of the UWB antennas utilized as a benchmark.

VI. CONCLUSION

This paper designs and simulates a quasi-modified rectangular ultra wideband patch antenna over HFSS. The obtained results demonstrate good performances with respect to size, gain, radiation patterns, and bandwidth & where the simulation's results are presented and discussed. With a VSWR of less than 2 and a return loss of less than -10dB, the antenna performs best around 11.8GHz. It operates in the frequency range of 11GHz to more than 12GHz. As a result, the antenna can be used for radar applications and satisfies the FCC and UWB standards.

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