Compact, printed, UWB, fiberglass textile antenna with quadruple band-notched characteristics for WLAN/WiMAX

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Abstract

- Herein, a printed Ultra-Wideband (UWB) monopole antenna possessing quadruple band-notched characteristics has been investigated.
- A fiberglass textile composite laminate has been used as the substrate material.
- Complementary Split Ring Resonating Structures, ‘C-shaped’ parasitic structures and ‘L-shaped’ slits have been introduced near the edges of the fractional ground plane to produce band notches for WLAN/WiMAX.
- The proposed fractal monopole antenna shows UWB response from 02.7 – 11.5 GHz along with quadruple band-notched features.

Introduction

- Here, we have designed and investigated a UWB antenna with quadruple band-notched features.
- A fiberglass composite laminate G-10 has been used as the substrate material.
- Complementary Split Ring Resonating Structures have been introduced at the centre of the snowflake radiator to create band notches for the 03.5/05.2 GHz WiMAX/WLAN bands.
- Two ‘C-shaped’ parasitic structures have been placed alongside the feed line to generate a notched band for 05.5 GHz WiMAX band.
- Two ‘L-shaped’ slits have been introduced near the edges of the slotted ground plane to produce notch for the 05.8 GHz WLAN band.
- The proposed fractal monopole antenna shows UWB response from 02.7 – 11.5 GHz along with quadruple band-notched features.
- Antenna responses, both simulated as well as measured, showed a good agreement.

- The proposed antenna has been compared with notable UWB band-notched antennas in Table 1, based on compactness i.e. size/area and features.

Table 1: Comparison of notable band-notched UWB antennas

Ref. No.	Size [mm²]	Area [mm²]	BW [GHz]	Notched Bands
[2]	20 × 27	540	2.89 - 11.52	Two
[3]	34 × 26	884	2.80 - 10.70	Two
[4]	21 × 28	588	3.10 - 10.60	Two
[5]	24 × 28	672	2.91 - 11.40	Two
[6]	23 × 28	644	3.10 - 11.00	Two
[7]	24 × 25	600	3.05 - 14.20	Two
[8]	30 × 30	900	3.01 - 12.00	Three
[9]	28 × 32	896	2.90 - 13.40	Three
[10]	20 × 30	600	2.68 - 13.00	Four
Prop	15 × 32	480	2.70 - 11.50	Four

Antenna design and simulation

- Koch Snowflake Fractal Geometry has been incorporated in the Patch of the proposed radiating structure. This geometry is generated by an Iterative-Function-System (IFS). It is obtained by a group of overlapping equilateral triangles.

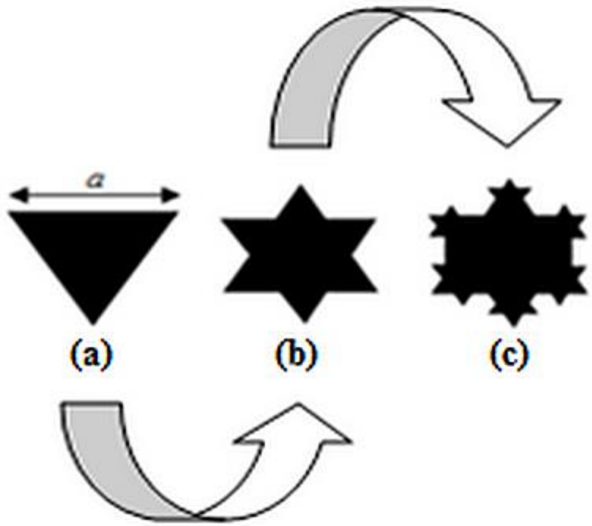
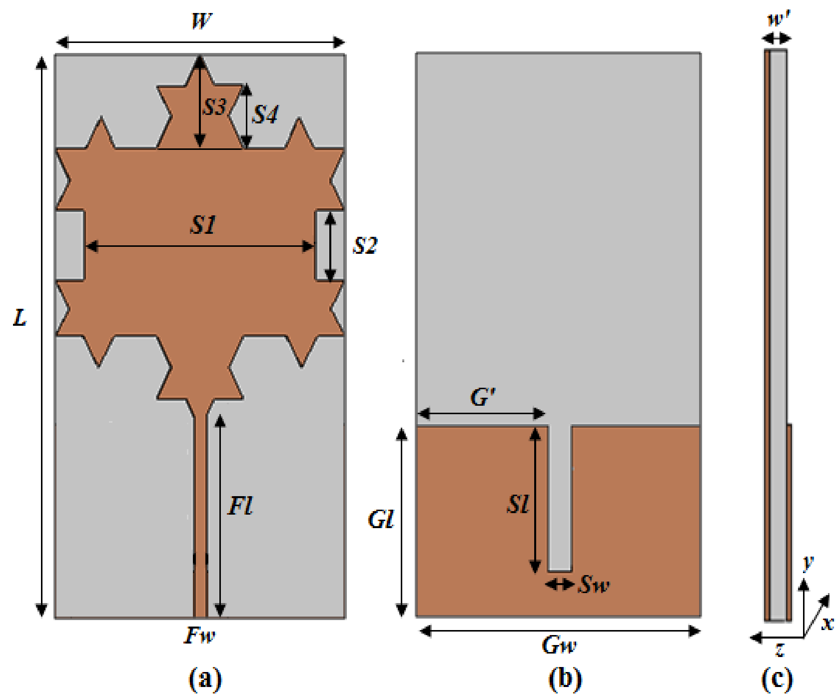
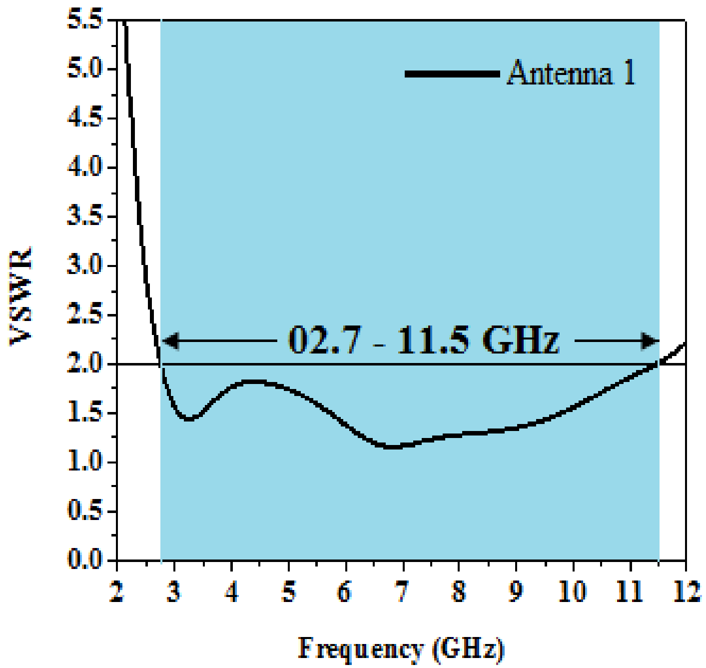


Fig.: Koch fractal geometry in successive iterations: (a) basic geometry, (b) First iteration, and (c) Second iteration

Antenna 1

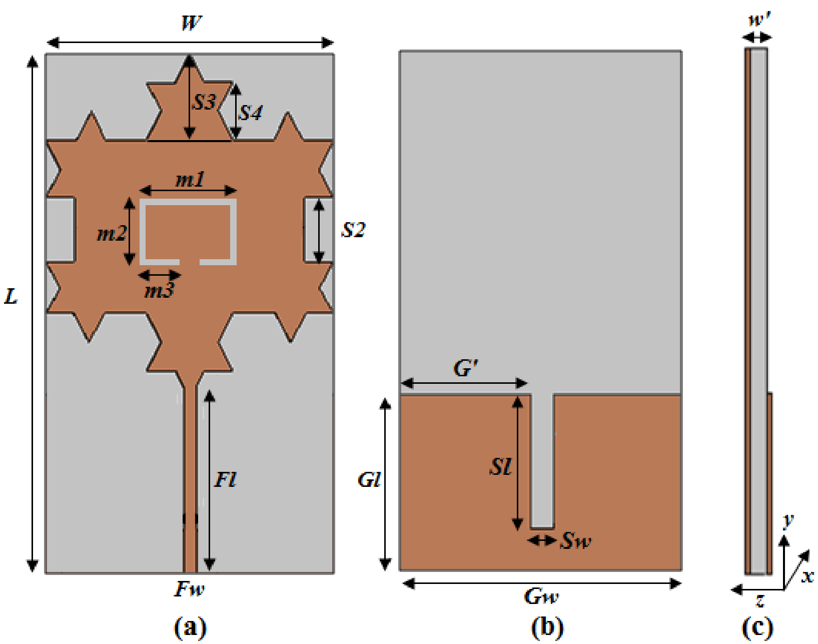
For Antenna 1, substrate dielectric constant, ε_r= 4.8 (G-10) and substrate height, *h* = 0.75 mm. As observed from Figure , the VSWR is less than 2 starting from 02.7 GHz and continuing till 11.5 GHz.

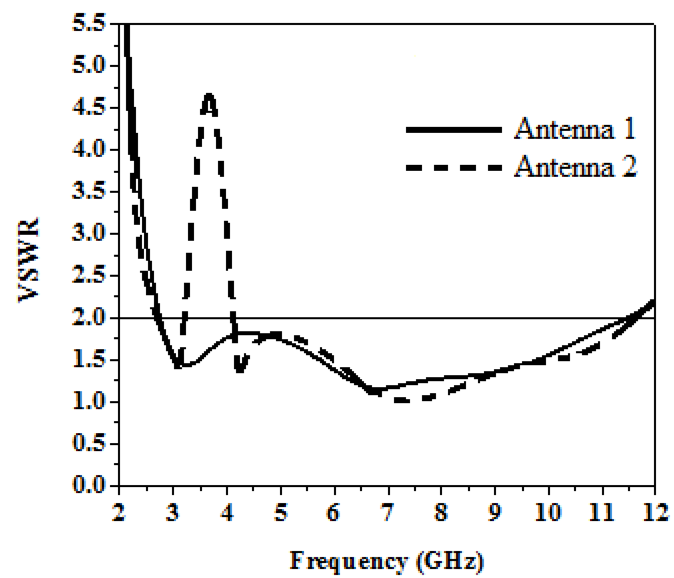




Antenna 2

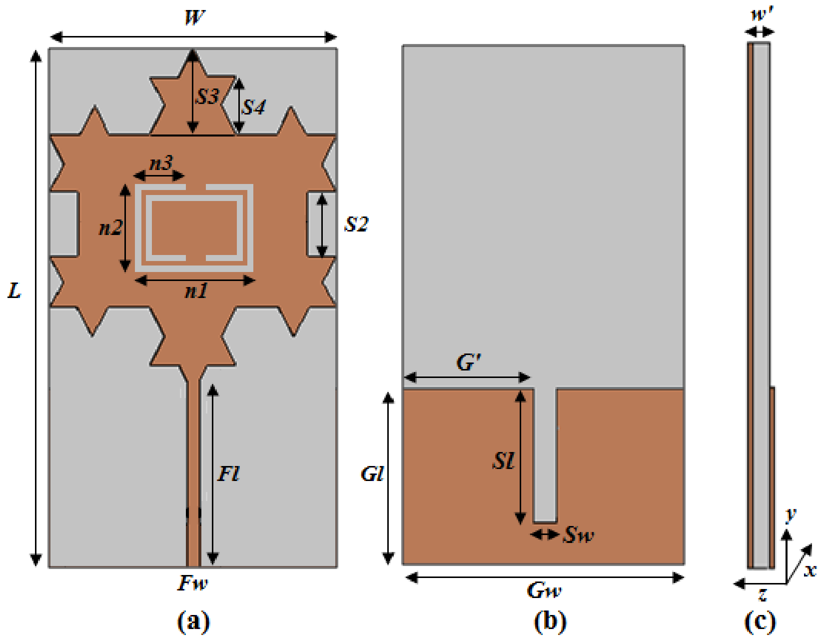
The structure of the modified antenna i.e. Antenna 2 has been displayed in Figure, which consists of a CSRR structure at the centre of the radiator. Figure shows VSWR vs. Frequency response of Antenna 2. By appropriate choice of dimensions of CSRR structure the centre-freq. of the band-notch is finely tuned to 3.5 GHz.

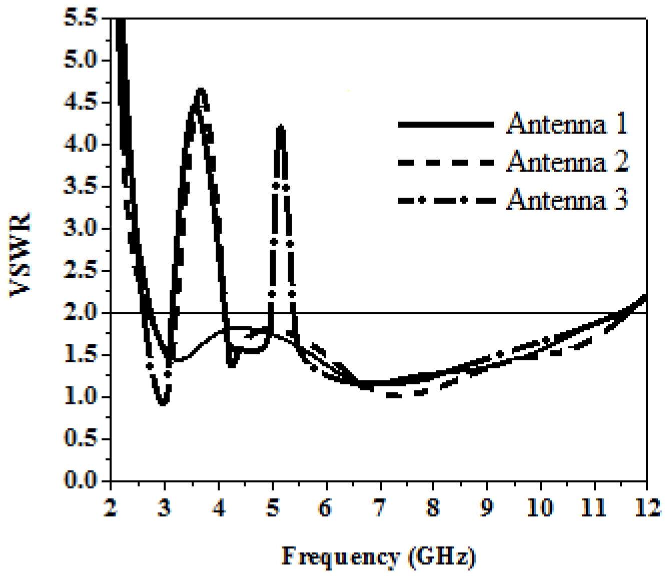




Antenna 3

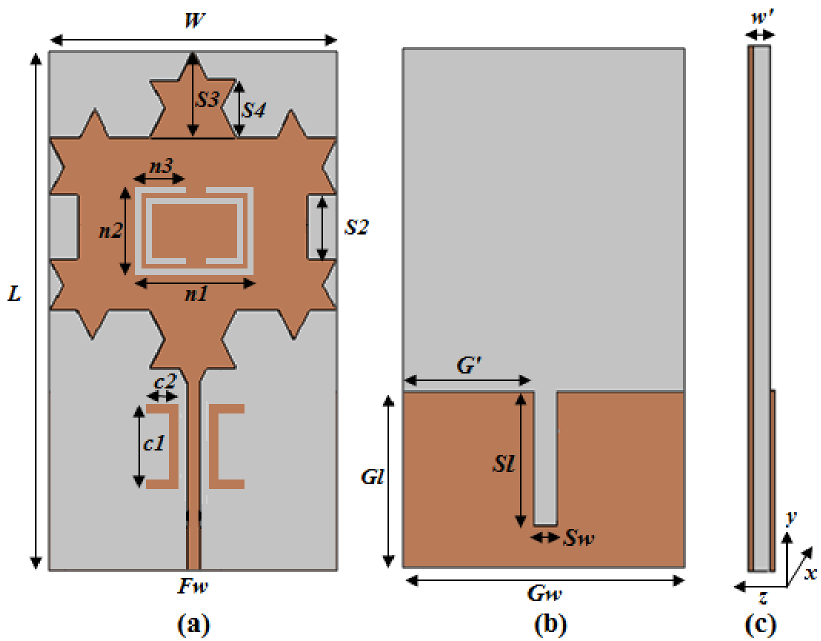
For generating a notch for the 05.19-5.21 GHz WLAN band. For this purpose we have introduced another CSRR structure as displayed in Figure (Antenna 3). By appropriate choice of dimensions we have been successful in generating a notch centred at 05.2 GHz.

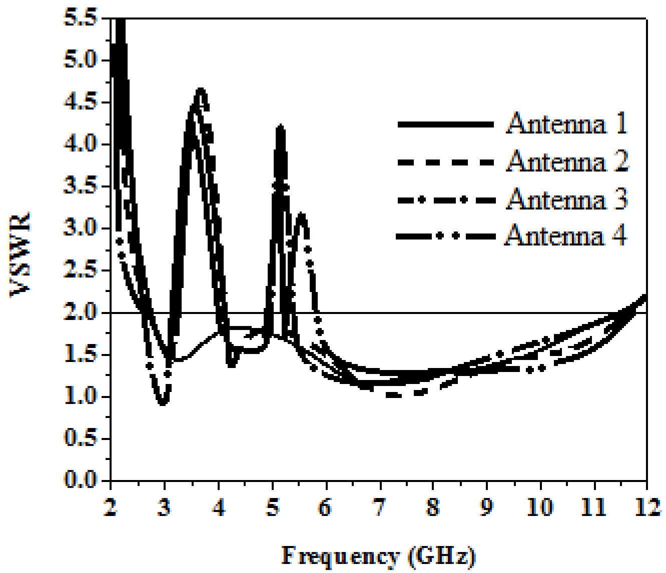




Antenna 4

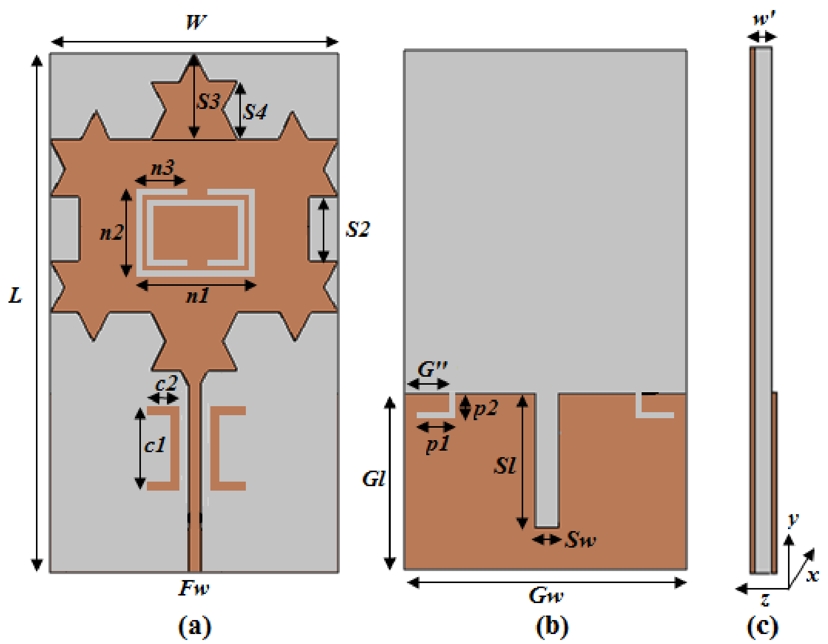
The modified antenna (Antenna 4) with open-circuited stubs located at both sides of the feeding segment has been depicted in Figure. The VSWR characteristic of Antenna 4 has been depicted in Figure.

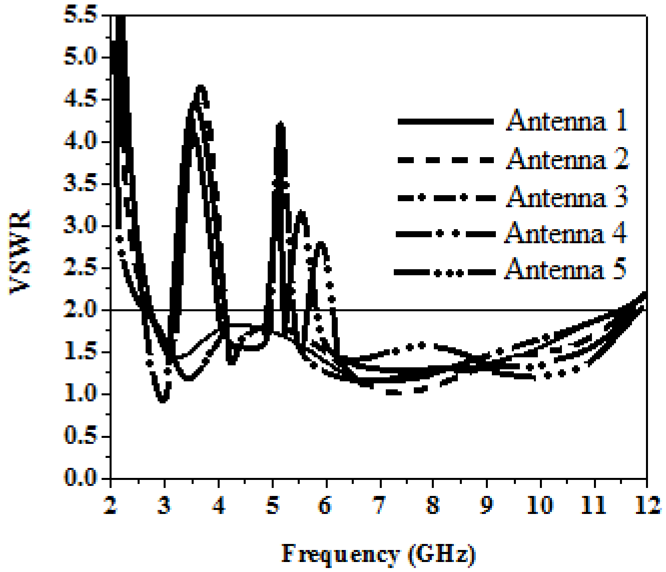




Antenna 5 (Proposed antenna)

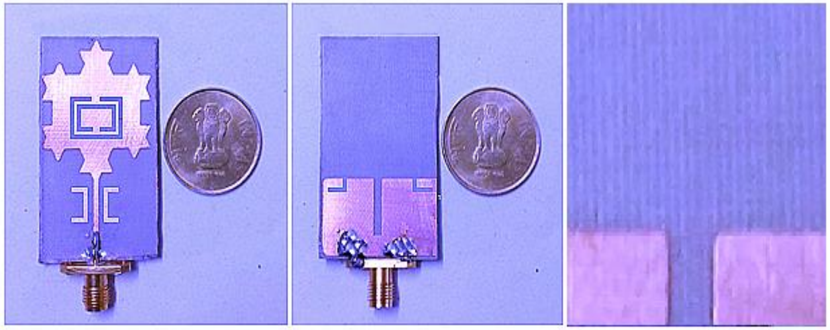
The proposed antenna structure (Antenna 5), with slits in the ground plane has been depicted in Figure. The VSWR vs. Frequency response of Antenna 5 has been shown in Figure. Antenna 5 shows a wide frequency response ranging from 02.7 – 11.5 GHz along with four notched-bands centred at 03.5 GHz, 05.2 GHz, 05.5 GHz and 05.8 GHz respectively.



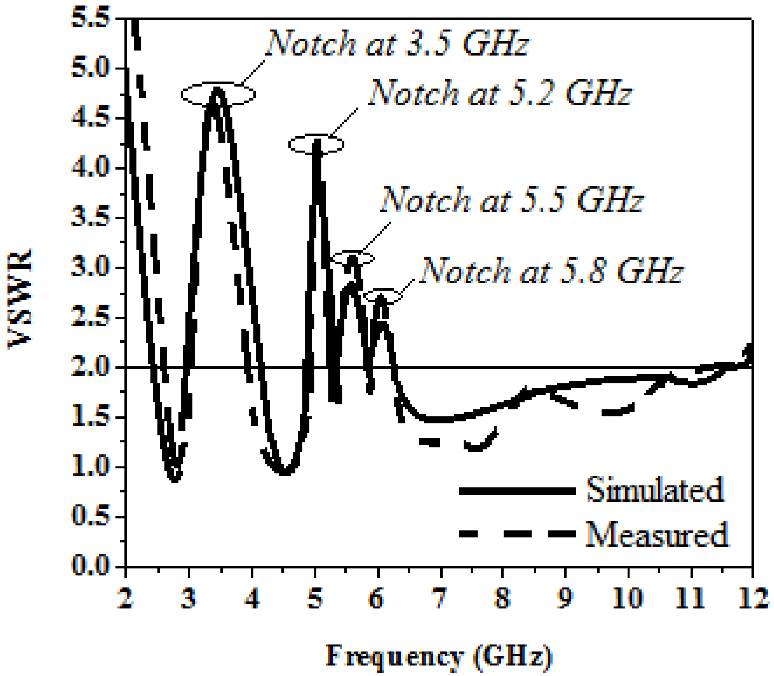


Fabrication, measurement and analysis

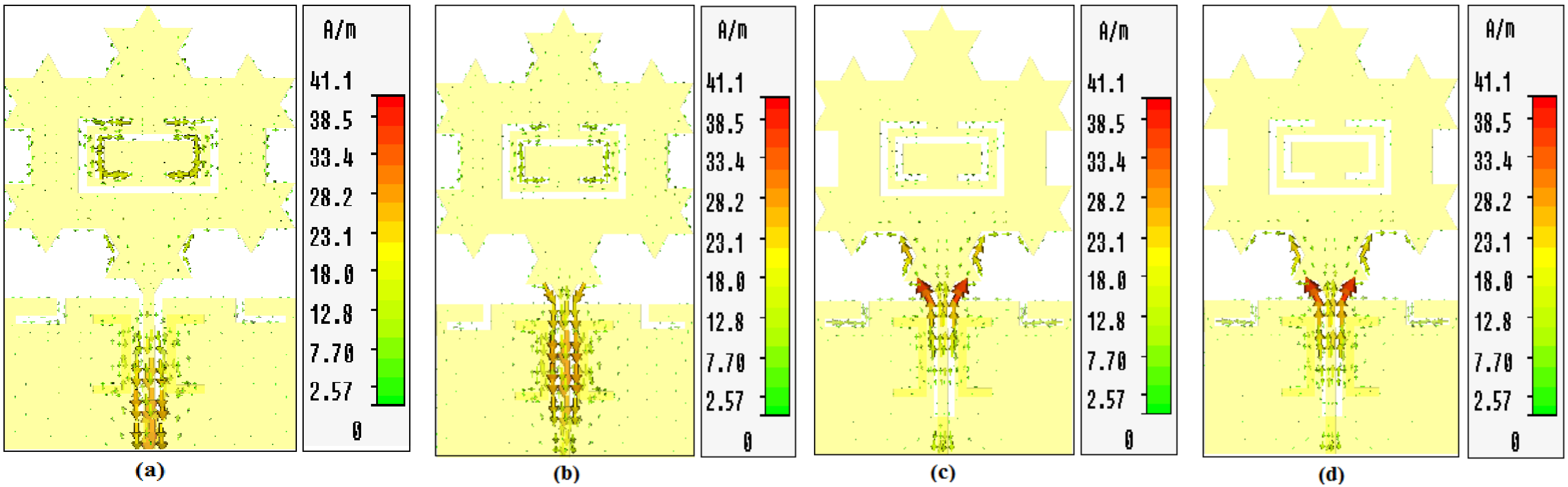
- The proposed antenna i.e. Antenna 5 has been fabricated in order to compare the simulated values with those obtained from measurement. Figure 14.shows the foremost, rearmost and magnified view of the antenna fabricated with fiberglass substrate.



(a) (b) (c)



Surface Current Distribution Pattern of proposed Antenna at (a) 03.5 GHz, (b) 05.2 GHz, (c) 05.5 GHz and, (d) 05.8 GHz



Antenna Gain vs. Frequency.

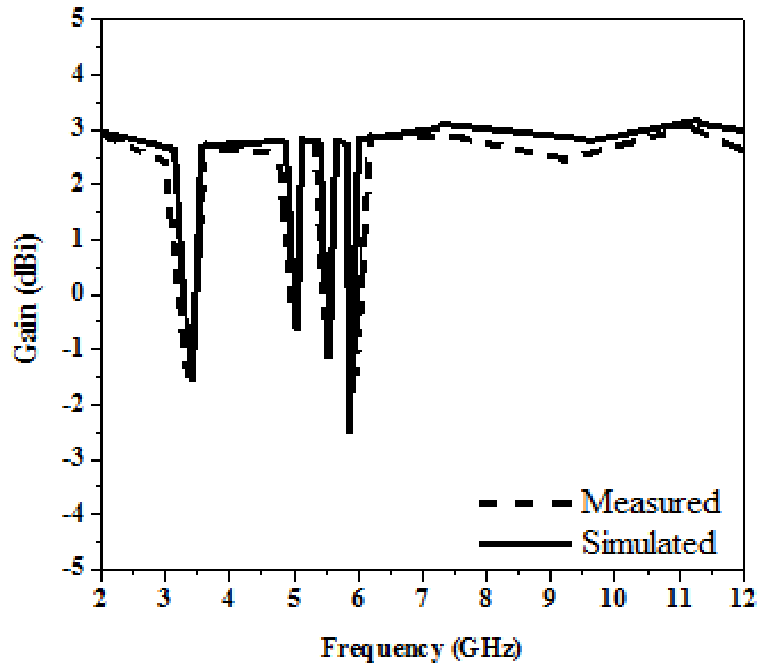
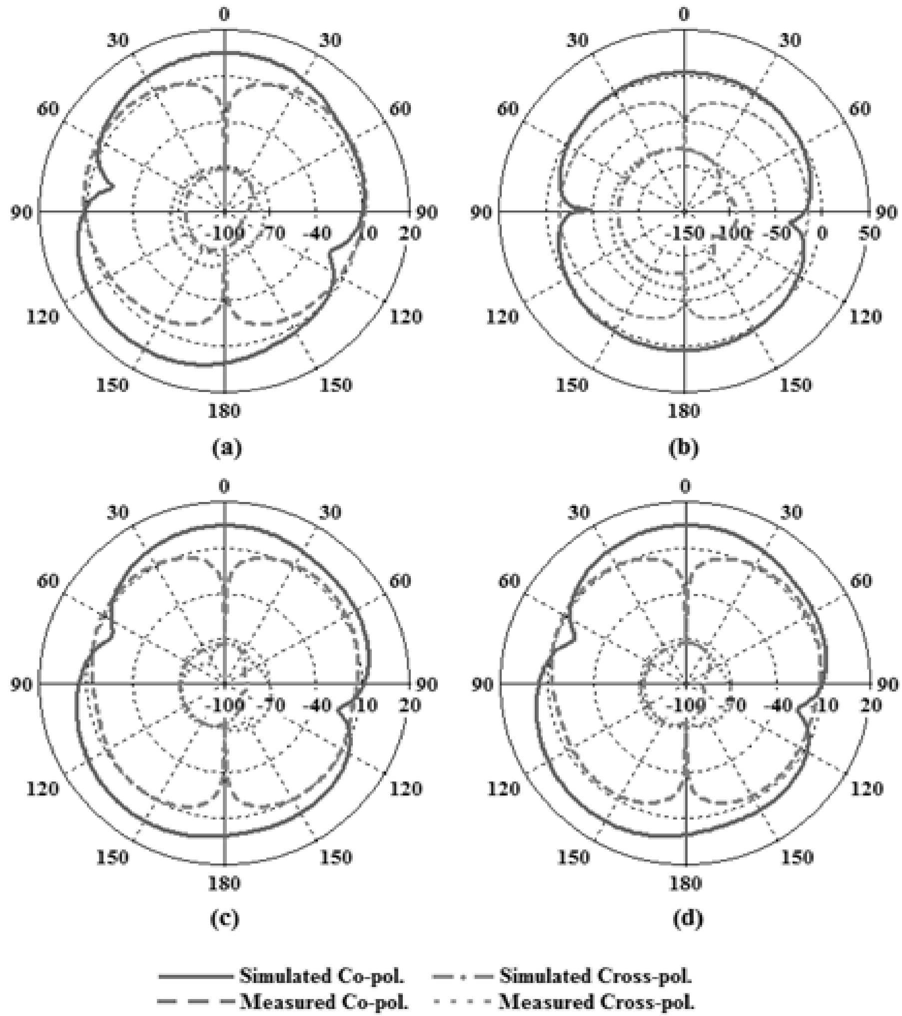
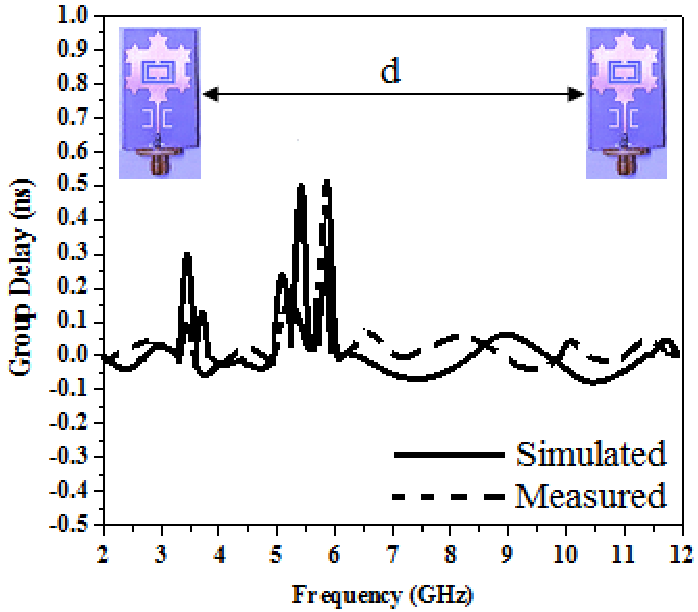


Figure shows simulated vs. measured gain in dBi vs. Frequency. It can be observed that there is an abrupt fall in antenna gain at the band-notched frequency point(s). The band-notching structures are responsible for this drastic reduction of gain below the 0 dBi level.

Radiation pattern of proposed antenna: (a) 03.5 GHz, (b) 05.2 GHz, (c) 05.5 GHz, and (d) 05.8 GHz.



Time Domain analysis of proposed antenna.



•The change in group delay accounts for the distortion in signal. As noticed from Figure, the group delay pattern is similar all through with some ripples ≤ 0.15 ns.

•The Tx and the Rx had been placed at a gap of d = 25 cm. Group delay response of proposed antenna obeys the considerable limits throughout the whole impedance-bandwidth with an exception at the notched-frequency bands.

•One can observe the presence of undesired oscillations in the antenna time domain analysis. These unwanted fluctuations occur due to the presence of noise.

Conclusions

- The antenna we have designed and investigated here, is an UWB antenna with quadruple band notches.
- A fiberglass composite laminate G-10 fabric has been used as the substrate material, which makes it wearable.
- Complementary Split Ring Resonating Structures have been introduced at the centre of the radiator to generate band notches for the 03.5/05.2 GHz WiMAX/WLAN bands.
- Two ‘C-shaped’ parasitic structures have been placed by both sides of the feed line to generate a notched band for 05.5 GHz WiMAX band.
- Two ‘L-shaped’ open-ended slits have been introduced in the ground plane to produce a notch at 05.8 GHz for bypassing the WLAN band.
- The proposed fractal monopole antenna shows UWB response from 02.7 – 11.5 GHz excepting the four notched bands.
- Compactness, high durability, minimal moisture absorption, high resistance to chemicals along with multiple frequency eliminating technique account for the novelty of the proposed structure.

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Thank You!