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Design and Development of Integrated Patch Microstrip Antenna for Wideband Operation

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Abstract: ***A novel geometry of integrated truncated coupled monopole microstrip antenna (ITCMMA) has been designed for the resonant frequency of 3.5 GHz. The rectangular and triangular patches are designed for the same resonant frequency. The triangular patch is placed along the radiating edge gap coupled to the rectangular patch in order to make the antenna resonate repetitively for wide bandwidth. The truncation is made along the edge of the patch for compactization. Microstrip line feed is used to excite the antenna. The monopole technique is used in the construction of proposed antenna. The antenna gives a bandwidth of 110.8% with a gain of 8.69dB. The radiation patterns are omni directional in both E and H plane. The simulation and experimental results of return loss is in good agreement with each other. The antenna may be useful for WLAN microwave communication applications***

Keywords: Rectangular, Bandwidth, WLAN, Monopole, Compact

1. Introduction

In the recent past microstrip antennas are widely used for many industrial and defence applications. These antennas are mainly compact, planar, lightweight and low cost. Among the various parameters of an antenna: bandwidth, radiation pattern and gain are the important parameters because many applications of the antenna are decided by these parameters only. Numbers of efforts have been made by the various researchers to enhance the bandwidth, gain and to improve the radiation patterns of microstrip antenna. The methods used by them are use of corporate feed network, aperture - coupled technique, thick dielectric substrate, matching networks, series capacitance in the probe fed circuit, electromagnetic coupling, stacked technique, proximity coupled technique, series capacitance in the probe fed circuit, use of combination of dissimilar elements, use of additional resonators to the radiating edges, use of parasitic patches in the form of gap - coupling to the driven elements, slot loading, stub loading, monopole technique, meandered slot on the ground plane, defected ground plane etc [1 - 8]. However, the use of conventional dissimilar patchelements fed through microstrip line with monopole technique designed on low cost substrate material for enhancing the bandwidth is found rare in the literature. The proposed antenna shows wide bandwidth, high gain and omni directional radiation patterns which are essential for many wireless local area network (WLAN) microwave communication applications.

ANTENNA GEOMETRY AND DESIGN:

The top and side view geometry of ITCMMA is as shown in Fig 1. The antenna consists of a radiating patch of width Wp and length Lp. The antenna patch is bifurcated at the top radiating edge with a gap of1mm. A parasitic patch is truncated at left and right top corner forming a triangular shape parasitic patch. The radiating patch is also truncated at the left and right bottom corners. The antenna is fed using a single 50Ω microstrip line feed which is connected to 50 Ω SMA connector for excitation. The length of feed is L_f and width is W_f. A partial copper ground plane of height Lg is placed below the microstrip line feed on the bottom layer of the substrate. The gap between the partial ground plane and radiating patch is g. The antenna is fabricated on low cost glass epoxy dielectric substrate material with a thickness of h and size Ws x Ls having relative permittivity (εr) 4.2 and loss tangent (δ) 0.05. The antenna design model and dimensions have been optimized to achieve wider bandwidth by using ANSYS HFSS simulation software. The optimized design dimensions of ITCMMA are given in Table 1. The photograph of fabricated antenna is shown in Fig.2. The proposed antenna is consisting of two different patches rectangular and triangular. In the present case the antenna is fed at the centre point of rectangular patch. In a similar way study may also be extended by feeding the same antenna at the different locations of triangular patch that may result and work like multi input multi output antenna (MIMO).

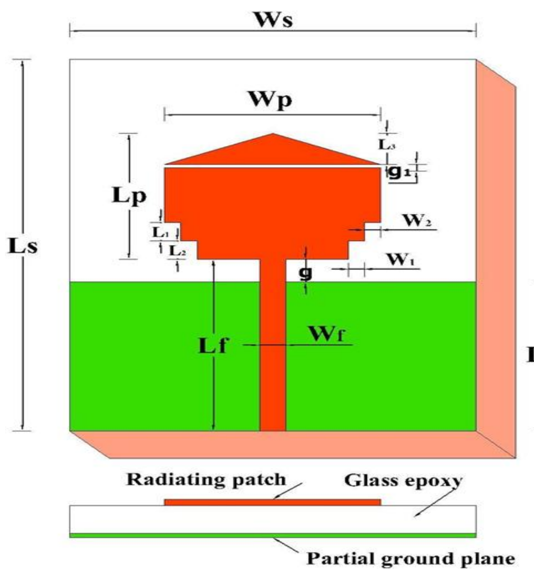
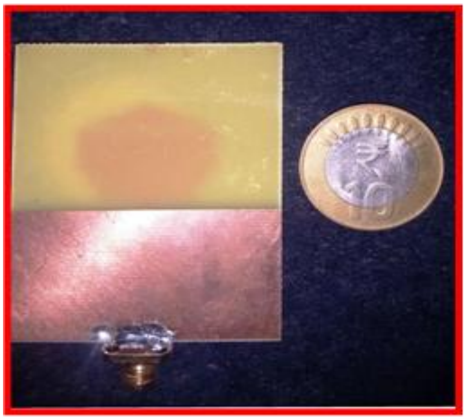


Figure 1: Top view geometry of ITCMMA

Table 1: Optimized design dimensions of ITCMMA

Antenna parameter	Dimensions (in mm)
Substrate width (Ws)	50
Substrate length (Ls)	60
Patch width (Wp)	26.6
Patch length (Lp)	20.4
Width of feed line (W_f)	3.2
Length of feed line (L_f)	27.7
Gap between the radiating patch and ground plane (g)	1.7
Substrate thickness (h)	1.6
Height of top parasitic patch (L_3)	4.8
Length of the ground plane (Lg)	26
Width of truncation slot W_1	2.0
Length of truncation slot L_1	3.0
W_2	4.0
L_2	6.0
L_3	4.6
Gap g_1	1.0

(a) Top view



(b) Bottom view

Figure 2: Photograph of fabricated ITCMMA (a) Top view and (b) Bottom view

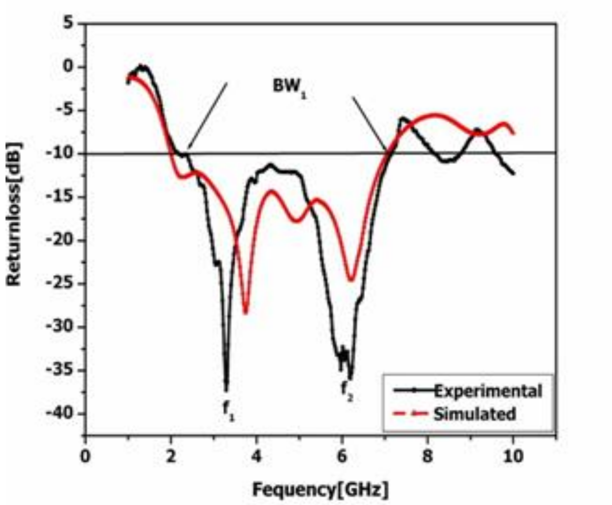


Figure 3: Variation of return loss verses frequency plot of ITCMM

Figure 5 shows the simulated frequency versus VSWR plot of the ITCMM. This figure is also useful to measure and for validating the impedance bandwidth of an antenna using VSWR instead of return loss as shown in Fig.3. From this figure, itis also clear that, the variation of VSWR of ITCMM lies well below ≤2 from the frequency of 2.19 to 7.05 GHz which gives the bandwidth of110.8%. The wide bandwidth is mainly due to nearby combined resonance of dissimilar patches gap coupled with each other. Further, the antenna also shows the property of compactness i.e. physical size reduction which is 19.6 % due to the use of truncation at the edges of the patch compared with conventional rectangular microstrip antenna designed for same frequency.

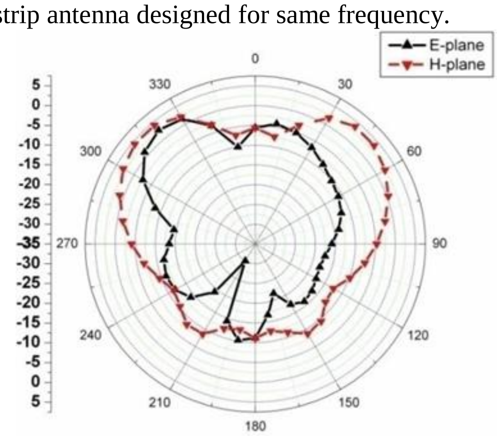


Figure 4: Typical radiation pattern of ITCMMA measured at (a) 3.295 GHz and (b) 6.175 GHz.

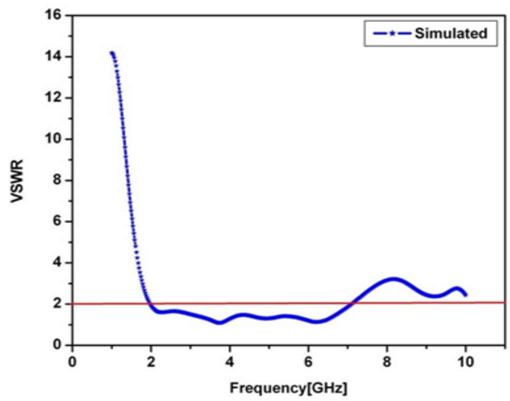


Figure 5: Simulated VSWR plot of ITCMMA

2. Conclusion

From the detailed experimental and simulation study it is observed that, the proposed antenna gives a bandwidth of 110.8% with a gain of 8.69dB. The radiation patterns are omni directional in both E and H plane. The antenna is simple in its structure and easy to fabricate. The antenna uses commercially available low cost substrate material. The simulation and experimental results of return loss is in good agreement with each other. The antenna may be useful for WLAN microwave communication applications. The present study may also be extended to construct MIMO antenna.

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