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Impedance Bandwidth Enhancement of UWB Monopole Rectangular Microstrip Patch Antenna using New Slots and EBG Structures

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***Abstract:** This paper presents a new design of a wide band monopole antenna with excellent impedance matching to enhancement the impedance bandwidth of rectangular patch microstrip antenna design by using slots and conventional mushroom-type electromagnetic band-gap (CMT-EBG). Designed on FR4 substrate with dielectric constant of 4.4 loss tangent 0.02 and 1.6-mm thickness. Slots and CMT-EBG structures are intended for impedance bandwidth enhancement. By using the Ansys hfss simulator, the structure has been designed on 32x32 mm2 substrate for rectangular patch microstrip antenna working at UWB range (3.1-10.6GHZ). Based on simulation results, the use of slots and CMT-EBG structures are able to extend bandwidth up to 455 MHz with bandwidth enhancement reaching 124% larger than without Slots and EBG.*
***Keywords**: Monopole antenna, Bandwidth, Ultra-wide Bandwidth, Bandwidth Enhancement*

I. INTRODUCTION

There is huge demand for communication and information sharing from one device to another in a wireless medium. Wireless transmissions are comparatively more reliable than wired transmissions due to their long range transmission and cost. An antenna is a transducer that coverts guided electromagnetic energy from an incoming source to an electromagnetic energy that can be radiated in the free space. Antennas play a crucial role in a transmitting device, so it is very important and necessary that antennas are designed efficiently. Till today PIFAS (planar inverted f antennas) have been proven efficient for wireless devices. Monopole antennas have received enough attention in the world of communication system. Monopole antennas are a class of radio antennas that have a straight rod shaped conductor placed over a surface which is conductive. Monopole antennas are mostly used in ground based communication systems. The geometry of the monopole element and the ground plane decides the electric properties, in other words the electric properties depend on the above two factors. The two main examples of monopole antennas are whip antenna and radiomast. The bandwidth of monopole antennas ranges from to 10.6 GHz certain mobile terminal applications such as ultra-wideband, WIMAX, Bluetooth, TD-SCDMA, UTMS2000, PCS900, GPS, DVB-H. UWB antennas are classified into directional and non-directional. The ultra-wide bandwidth is based on few principles such as frequency-independent antennas, self-complementary antennas, multi-resonance antenna and electrically small antennas. Since ultra-wide-band is an emerging technology, it is important that we have thorough knowledge on time, frequency and spatial domain for antenna characterization. Certain classes of antenna can be defined based on their radiation characteristics.UWB technology can easily receive and transmit pulses based on waveform compressed in time. The bandwidth of a place is very high in a frequency domain. The data rate is very high because the power of the pulse is transmitted or spread over a large frequency band .This is the reason why there is very less level of noise interference. This paper describes the design of an antenna that is less in cost, light in weight and small in size making it one of the efficient antennas for huge bandwidth. The inherent characteristics of dielectric material are very helpful in improving the impedance bandwidth.

II. DESIGN OF ANTENNA

We used ANSYS HFSS software that allows calculation of finite-sized phased-array antennas with all electromagnetic effects that includes element-to-element coupling and also critical array edge effects. The traditional approach for simulating large phased-array antennas is to approximate antenna behavior by assuming an infinitely large array. In this technique, one or more antenna elements are placed within a unit cell with a periodic boundary condition on the surrounding walls that mirror the fields and allows you to create infinite number of images in two directions.

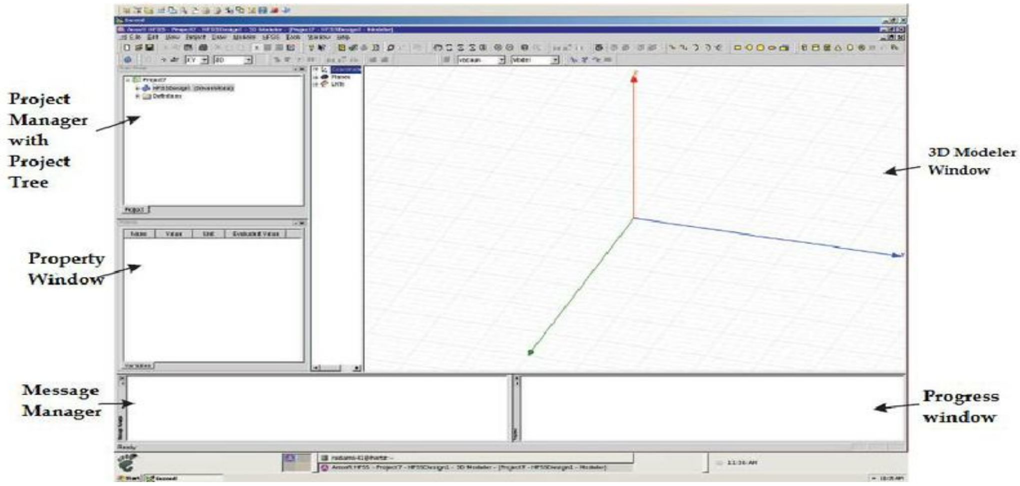

Fig1: ANSYS HFSS

III. DESIGNED ANTENNA.

The geometry of this proposed antenna is shown in fig3.. It consists of printed rectangular patch antenna on FR4 substrate of thickness h = 1.6mm and relative permittivity 4.4 with relative permittivity 0.02. The substrate has a length of L1 = 32mm and the width of W1 = 32mm. The dimension of the conducting ground plane 32mm × 10mm. Also Antenna is feed with a 50Ω microstrip feed line which has length 10.7mm and width 2. 8mm.The radiating rectangular patch has a length of L2=20mm and the width of w2=17mm.

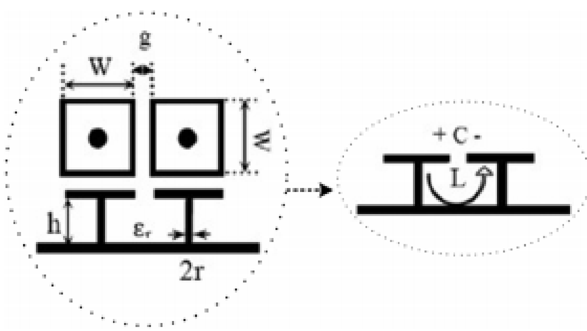

Fig2: structure of CMT-EBG

To broaden the antenna bandwidth, two different methods are applied to antenna design as shown in Fig. 2. The antennas are named as antenna 2, the elliptical shape slot has the major axis A=12mm & A1=10 and the minor axis B=6mm & B1=5mm located at a=2.5mm and b=6.3mm position on the rectangular radiating patch. The rectangular radiating patch located Ld=10mm away from the left side edge of the substrate. The feed is located Ld1=4.555mm away from the position of the radiating rectangular patch.

The dimensions of the CMT-EBG are w=5.3mm and the center located via with r=0.3mm and the gap between the two EBGs is g=0.3mm and the CMT-EBG are placed ata gap of G=2.7mm

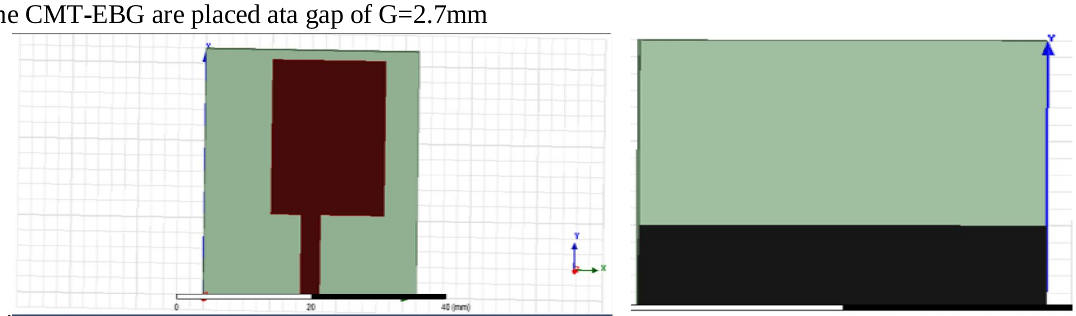

Fig3: antenna 1 top and bottom view without slots

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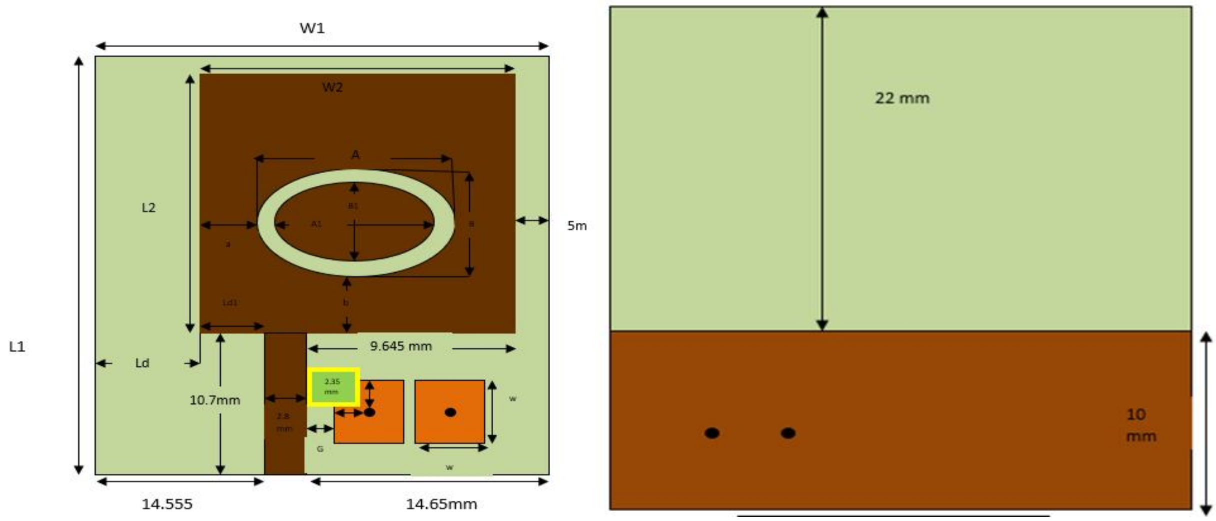


Fig3: configuration of antenna2 top view and bottom with slots

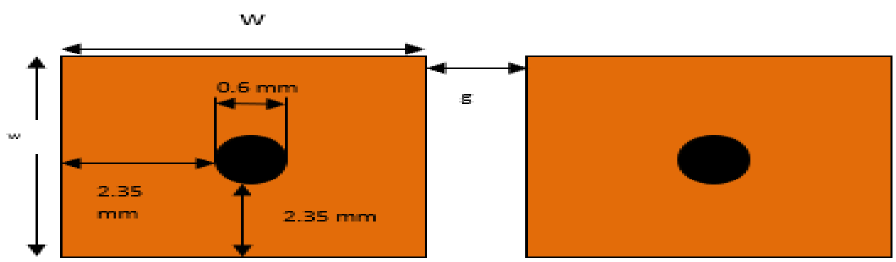


Fig4: periodic CMT-EBG

IV. SIMULATION

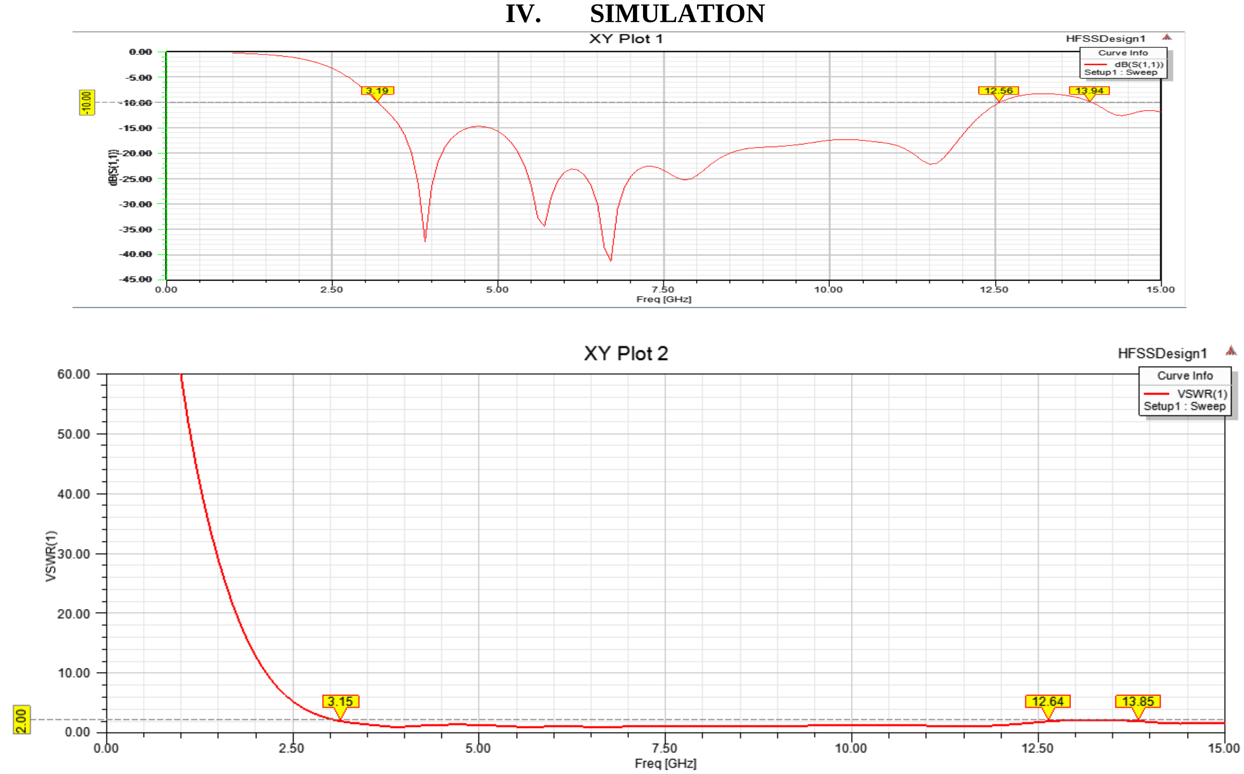
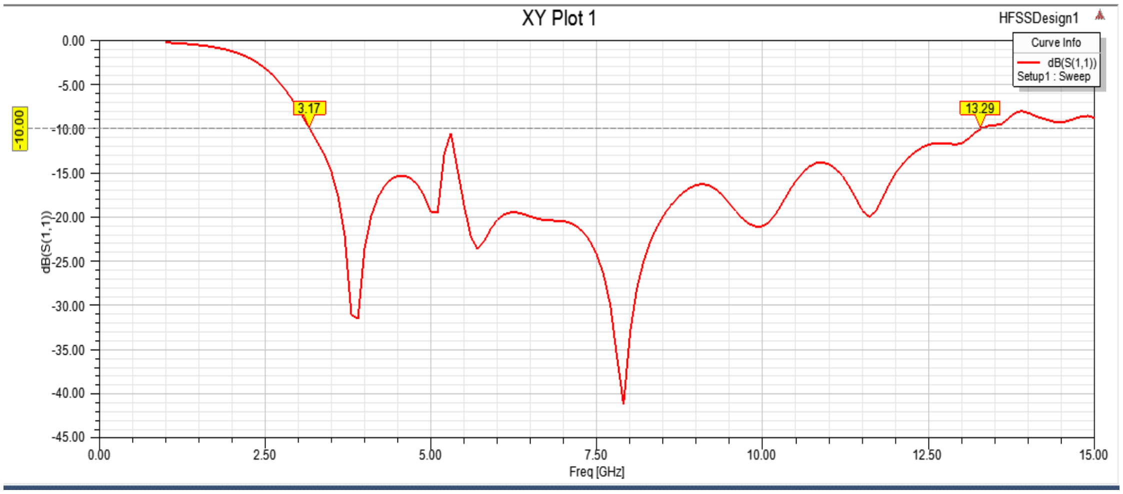


Fig4: S11 & VSWR of rectangular UWB antenna (1) with 1.6mm FR4 from 3.15-12.64GHZ (119%) 7.89GHZ BW



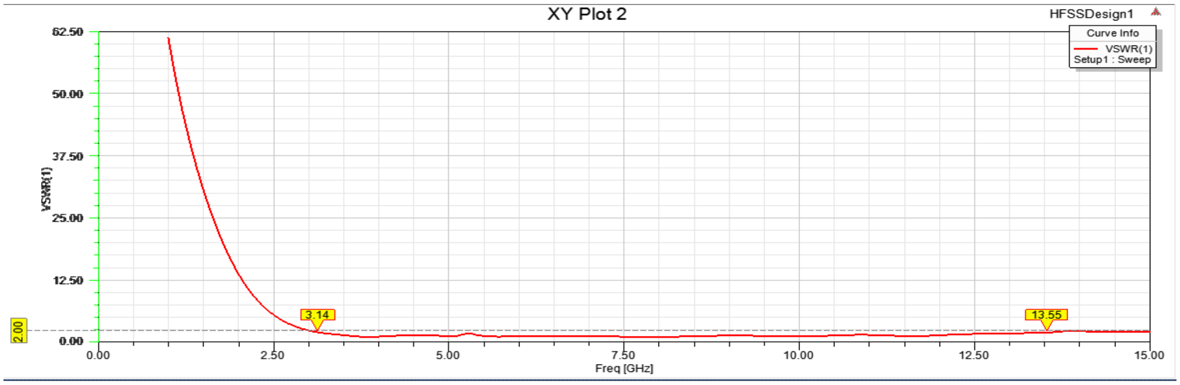
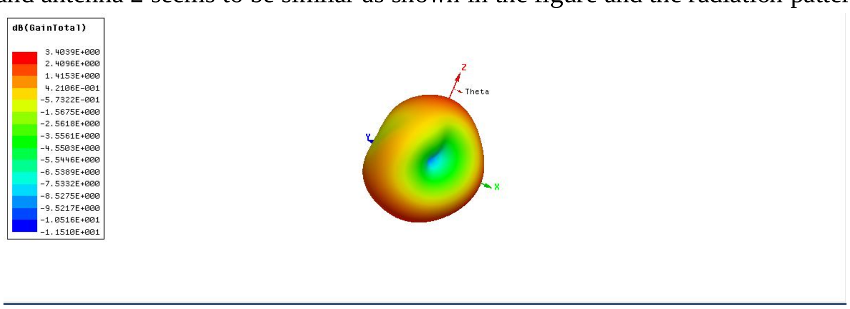


Fig4: antenna2 S11 & VSWR of rectangular uwb antenna with 1.6mm FR4 from 3.14-13.55GHZ(124%) 8.345GHZ BW

V. GAIN AND RADIATION CHARACTERISTICS OF ANTENNA

Fig5: gain and distribution of antenna.

The gain of the antenna 1 and antenna 2 seems to be similar as shown in the figure and the radiation pattern is shown in the figure6



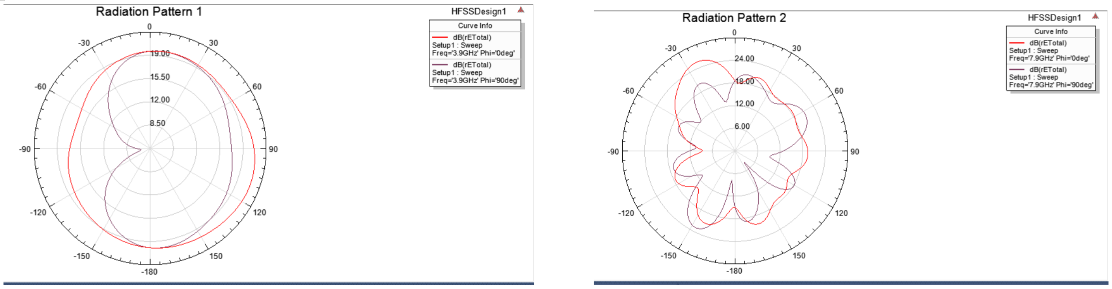


Fig6**:** Radiation pattern of rectangular uwb antenna with 1.6mm FR4 for 3.9&7.9 GHz

VI. FABRICATION

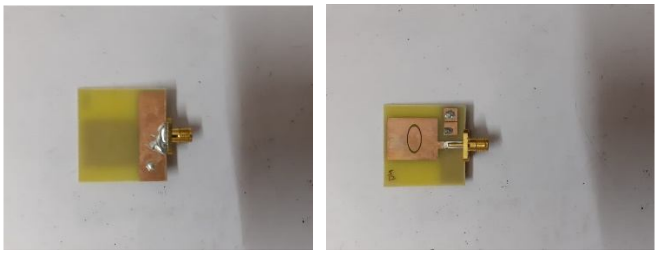


Fig7: final fabricated antenna

The above shows the fabricated antenna with fr4 substrate with 1.6mm width with relative permittivity 4.4
This fabricated antenna was simulated by using the antenna simulator

VII. CONCLUSION

In this paper, a monopole slot ultra-wideband antenna with CMT-EBG and new slots applied in some mobile terminal devices has been proposed for bandwidth enhancement. The bandwidth can be expanded to 9.33GHZ this way DVB-H and DCS1800 are covered. The gain and radiation characteristics have been compared. It has been realized that the introduction of CMT-EBG or new slots have no or very little effect on monopole slot UWB antenna in terms of their radiation patterns due to their identical curves at some particular frequencies. You can see antennas have been fabricated and simulation results have been verified.

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