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A UWB Antenna with Band-Notched Characteristics for Wireless Applications

Siddharth Saxena[1], Sudhakar Shastri[2]

VIT University[1], VIT University[2], India

Siddharth.saxena2014@vit.ac.in [1] , Sudhakar.shastri2014@vit.ac.in [2]

Abstract— A compact ultrawideband (UWB)antenna having band-notched characteristics is presented. The Microstrip feed antenna consists of a square slot patch and a vertical coupling strip. As the coupling strip is placed nearly at the center of the patch a significant rejection characteristics of the antenna with wide operating band that operates from 2.9 to 12.9 GHz is obtained. Furthermore, relatively good omnidirectional radiation pattern constant gain and transmission responses are obtained in the operating band.

Keywords— ultrawideband (UWB) **,** bandnotched**,** vertical coupling strip, returnloss , bandwidth, radiation pattern, gain.

INTRODUCTION

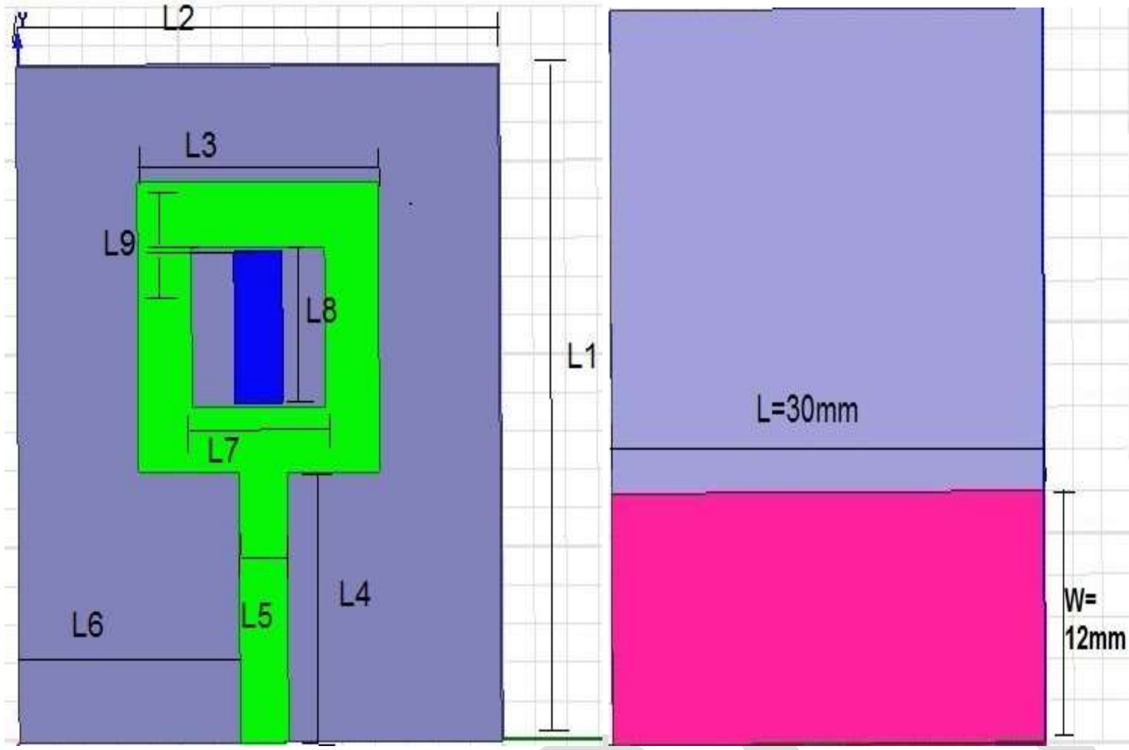
ULTRAWIDEBAND (UWB) technology has received an impulsion and attracted industrial attention in the wireless world over a decade. In 2002 the Federal Communication Commission allocated the bandwidth of 7.5 GHz (3.1–10.6 GHz) for commercial applications [1]. The reveal of an extremely wide spectrum of 3.1–10.6 GHz for commercial use has initiated a lot of interest in the research and development of UWB technology especially for short-range wireless communications. Particular attention is given to the planar UWB antennas due to their merits such as small size, high data rate, small emission power ,easy manufacture, and low cost. However, over the UWB operating band, there are some other existing narrowband communication systems, such as wireless standards like IEEE802.11a and HIPERLAN2 which create possible electromagnetic interference to the UWB applications. To overcome this problem, many significant band-notched techniques have been suggested in UWB antennas, including etching L-shaped slot[3] U-shaped slot [4], V-shaped slot [5], T-shaped slot[6], C-shaped slot [7], S-shaped slot [8], using a defected ground structure (DGS) [9] or by adding a split ring resonator (SRR) in the antenna structure, the unwanted frequencies can be rejected and performance of the antenna can be improved.

In this letter, a simple monopole antenna is investigated and a vertical coupling strip is employed to overcome the rejection frequency band for UWB operation and the rejection of (IEEE802.11a) and HIPERLAN band has been done by etching a U-shaped slot in the feed line. Proposed UWB antenna possess design specifications of 15(L) × 15(W) × 1.6(H) mm^3.Calcluated results show bandwidth of near about 10GHz i.e. from (2.9-12.9GHz). Moreover omnidirectional radiation pattern has been obtained and discussed in later section. Calculated results show bandwidth of near about 10GHz i.e. from (2.9-12.9GHz). Moreover omnidirectional radiation pattern has been obtained and discussed in later section.

ANTENNA DESIGN

Fig1.a represents the geometry of proposed UWB band notched antenna. fabrication is done on a low cost FR-4 substrate having thickness 1.6mm and relative dielectric constant of 4.4and loss tangent tan =0.002. The radiation patch is feed by a 50 ohm Microstrip line. Width of Microstrip line is 3.4mm, and antenna is designed using a square slot patch with a vertical coupling strip. The optimal dimension of the antenna is as follows:L1=35mm, L2=30mm, L3=15mm, L4=14mm, L5=3.4mm, L6=13.3mm, L7=8.3mm, L8=7.9mm, L9=0.2mm.Moreover, the overall dimensions of the patch are 15×15 mm^2anddimension of the ground plane is taken merely as length of 12mm and width of 30mm

A spacing of about 1mm is given between patch and ground plane in order to achieve good impedance matching characteristics. As coupling strip is placed at center of the Patch having a space of 0.2mm from the patch in order to generate resonance for stop band operation and hence for this strip a center frequency fr is calculated as



(a) (b)

Fig.1. Geometry of the proposed UWB antenna (a)top view and (b) back view

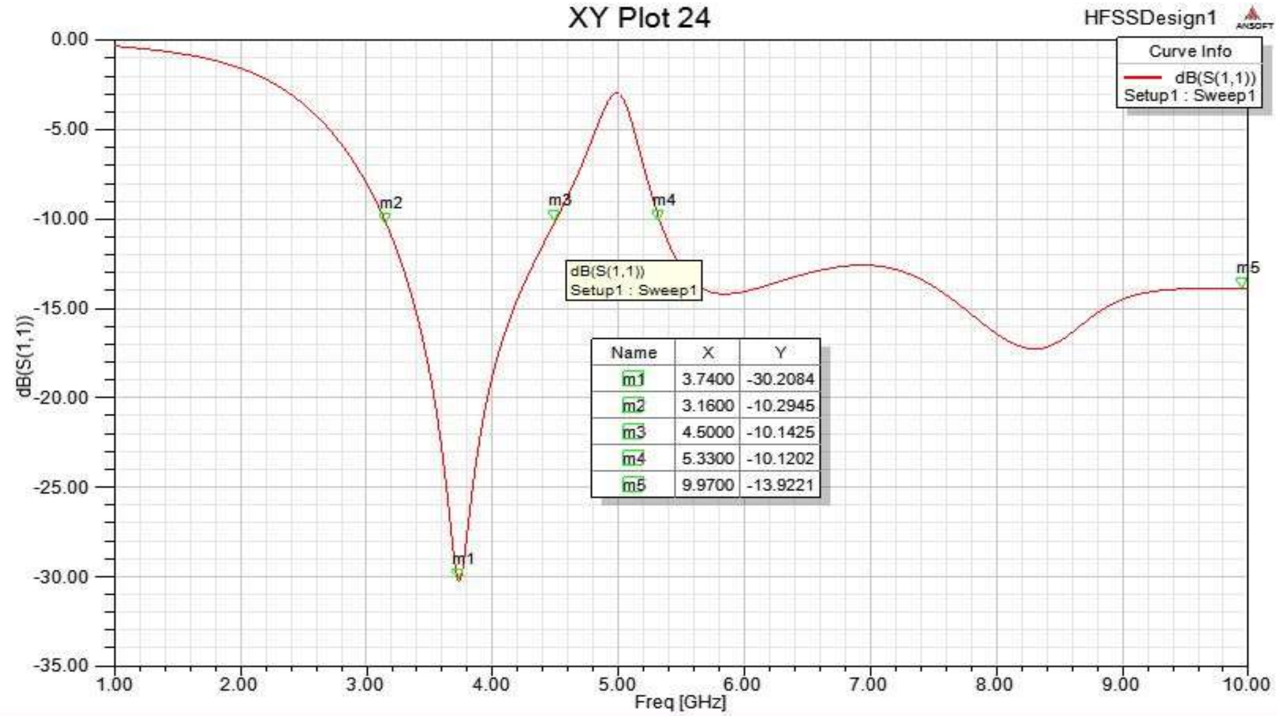
Patch having a space of 0.2mm from the patch in order to generate resonance for stop band operation and hence for this strip a center frequency fr is calculated as

$$fr = \frac{c}{(L7 - 2L9)\,.\,4.\sqrt{\frac{\epsilon r + 1}{2}}}$$

Where, c is speed of light, ∊r is dielectric constant.

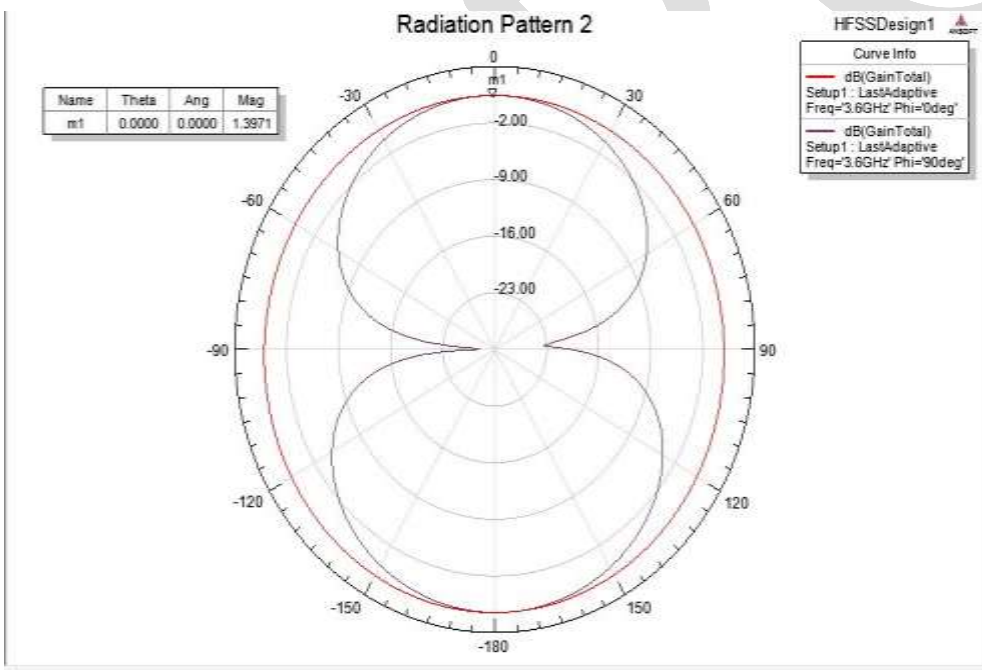
SIMULATED RESULTS

Fig.2.a shows the stimulated results of the designed antenna, return loss is found to be-30dB at 3.6 GHz and measured bandwidth is found to be from3.16 to 9.97GHz, rejecting 4.5-5.33GHz which is causing frequency interference and Fig2.b shows radiation patterns of the UWB patch antenna. In this case it has been found to be 1.39dB.



Name	X	Y
m1	3.7400	-30.2084
m2	3.1600	-10.2945
m3	4.5000	-10.1425
m4	5.3300	-10.1202
m5	9.9700	-13.9221

(a)



Name	Theta	Ang	Mag
m1	0.0000	0.0000	1.3971

(b)

Fig.2. (a) Return loss of the UWB patch antenna having notch between 4.5-5.33GHz and (b) Radiation patterns of the UWB antenna.

MODIFIED ANTENNA STRUCTURE

In fig. 3 U-shaped slot has been etched in feed line of 0.2mm width so that current length is increased and therefore extra impedance is obtained resulting in a notch and rejecting the centered frequency of about 4.6 to 6.6 GHz i.e. rejecting (IEEE 802.11a) standards [11] and gain is found to be 1.36dB as shown in fig4.a.and 4.b. respectively.

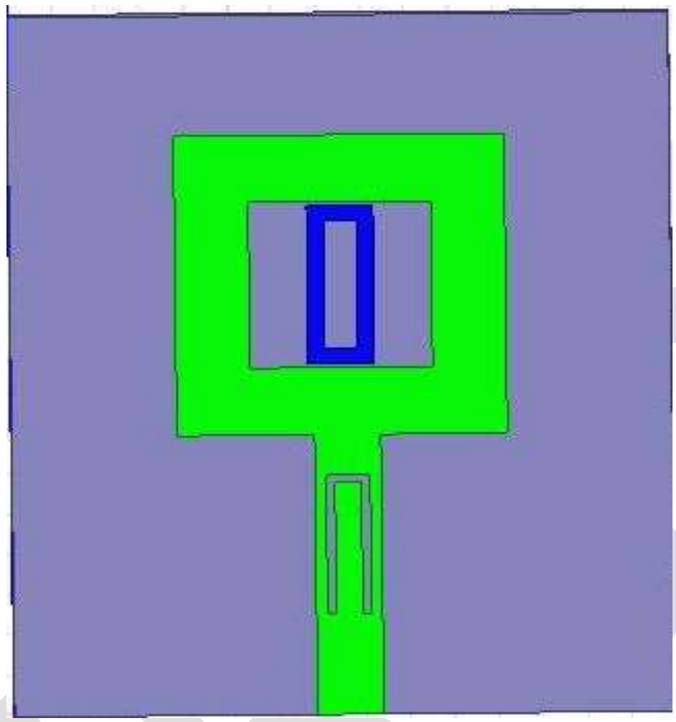
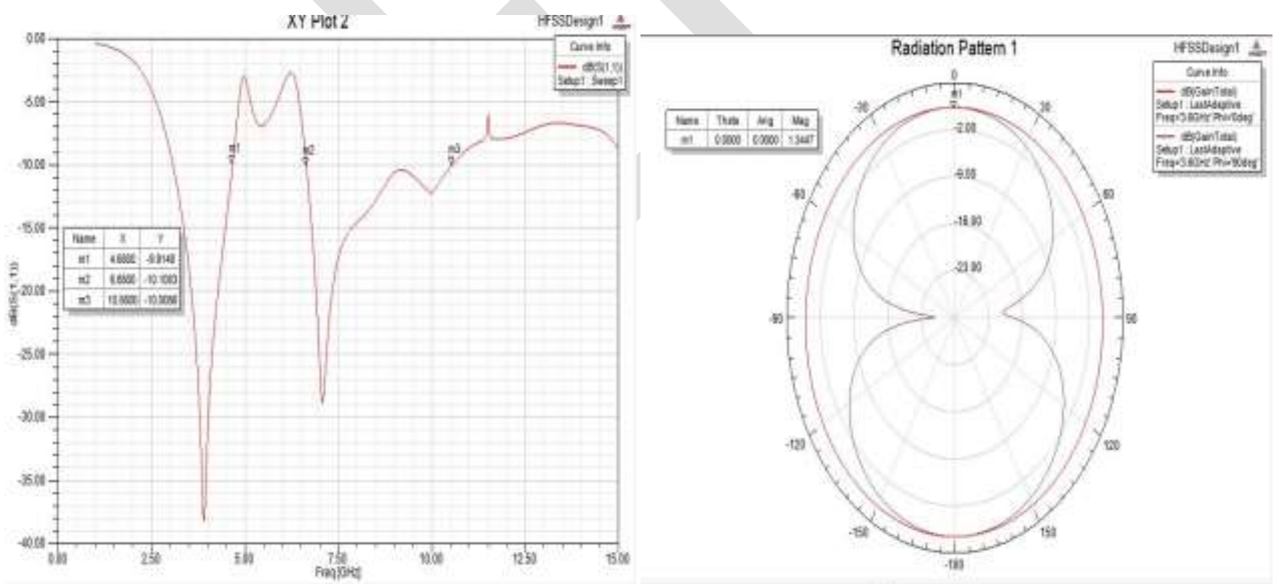


Fig.3. Geometry of the UWB patch antenna having a U-shape slot in the feed line.



(a) (b)

Fig. 4 (a) shows simulated s-parameter having a notch between 4.6-6.6GHz.
(b)shows radiation pattern with variation in gain.

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FINAL ANTENNA DESIGN

Fig.5. represents the geometry of proposed UWB band notched antenna. All the design parameters are same and antenna is fed by a 50Ω Microstrip line. [12] A coupling strip is inserted into another coupling strip and patch is cut at an angle of 45^{o}so that current length increases and results in wider impedance bandwidth.

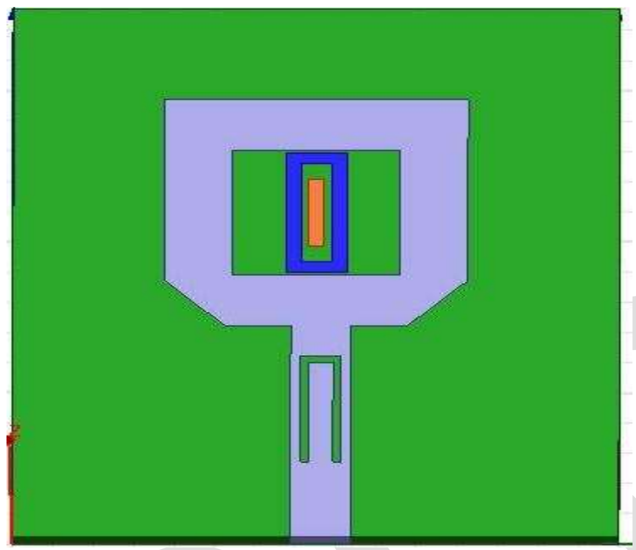
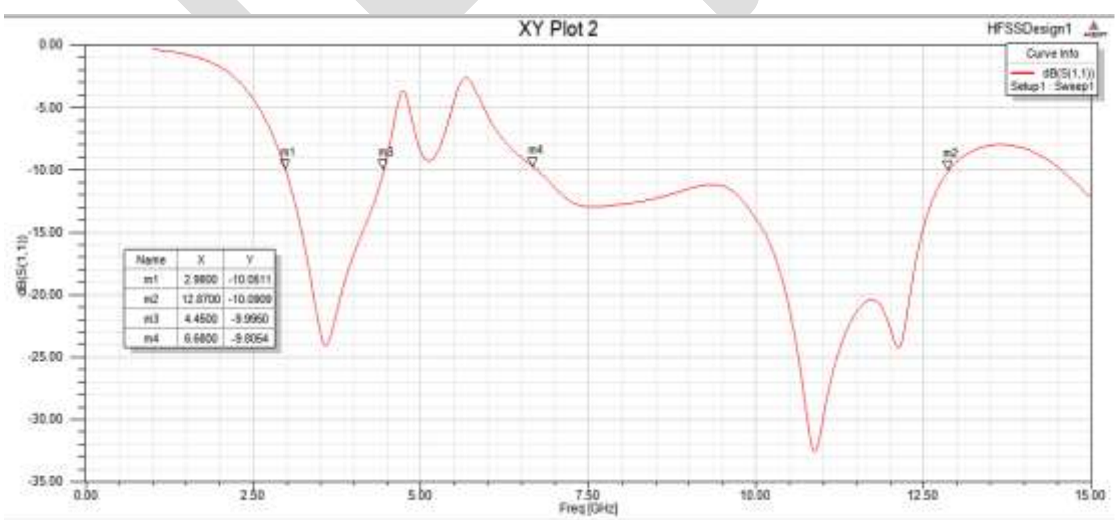


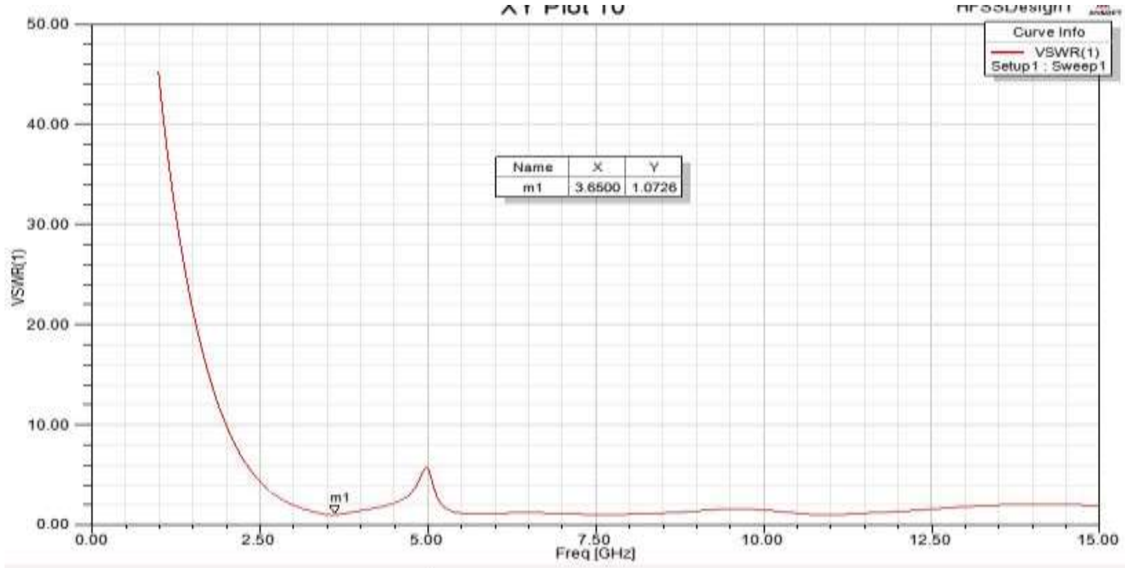
Fig.5. Geometry of the proposed UWB antenna.

SIMULATED RESULTS

The UWB patch antenna is designed with the aid of HFSS 2013 software tool and simulation results are obtained by taking suitable dimensions of antenna, so that it gives better performance and radiation. Measured *S*-parameter curve can be shown in fig.6.a. It has been observed that simulated impedance bandwidth is 2.9 to 12.9GHz rejecting frequency band from 4.4to 6.6 GHz so that effect due to interference can be avoided.



(a)



(b)

Fig.6. (a) Measured and simulated return loss of the proposed antenna and
(b) VSWR variation of the patch antenna.

Fig.7 represents radiation pattern of the UWB patch antenna with a gain of 1.36dB. Variation in gain is in accordance with variation in bandwidth. Radiation patterns are prevailed by changing theta (ɵ) and phi (ϕ) angles. Since, only theta values are varied and phi is remained constant to zero it shows variation in gain with respect to theta. As we define the gain as the ratio of radiation intensity of antenna in particular direction to radiation intensity of isotropic antenna and radiation intensity is directly associated to phi and theta values. Hence gain varies in accordance with respect to theta and phi values [13]. Fig.8 shows the simulated surface current distribution of the antenna at notched frequency.

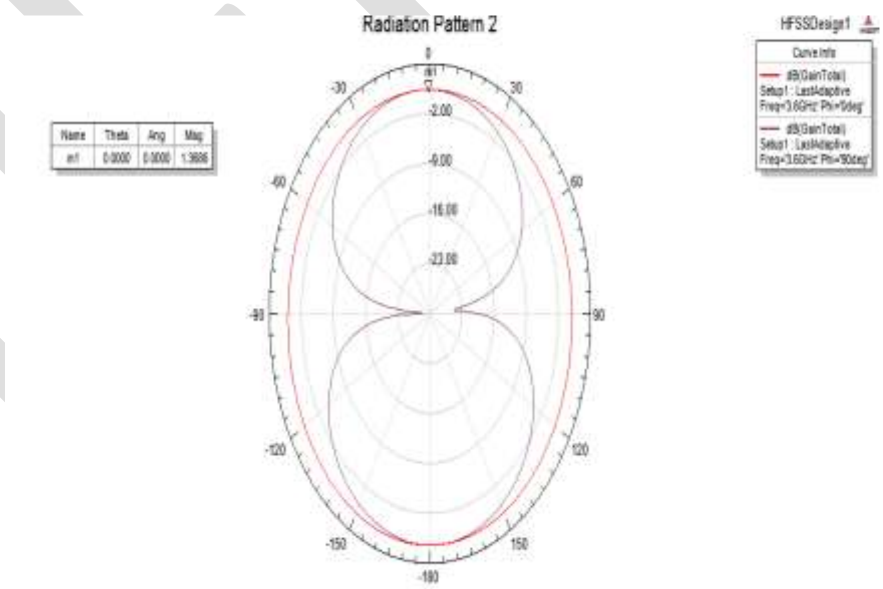


Fig.7. Radiation pattern with gain variation in UWB patch antenna

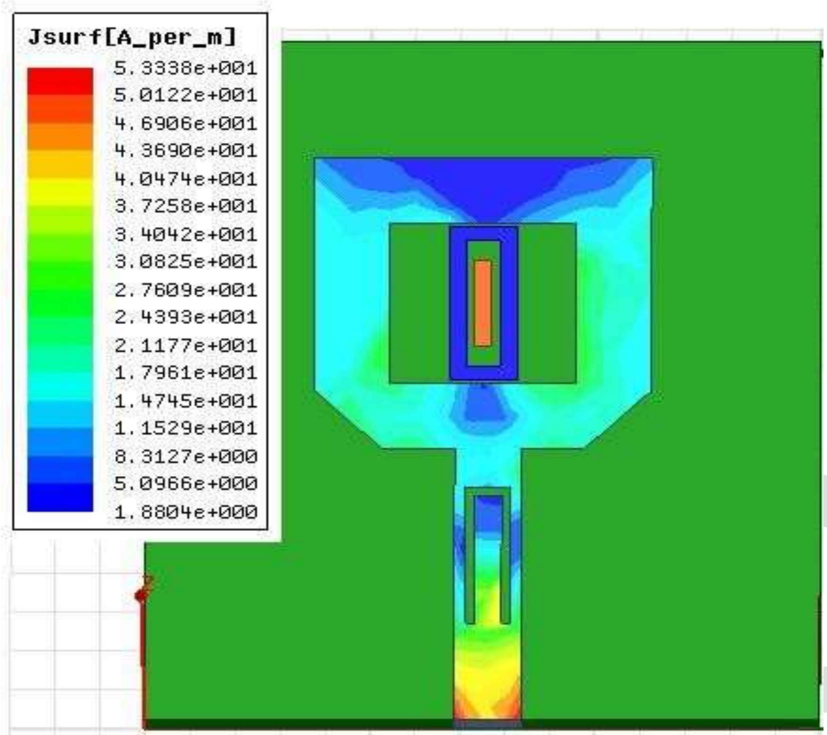


Fig 8. Simulated current distribution at center rejected frequency of 5.2 GHz for the designed antenna.

CONLUSION

A compact band notched UWB antenna is effectively realized by inserting a U-shaped slot in the feed line and etching a coupling strip in the patch, Moreover a 45^{o}cut has been made in patch in order to obtain wider impedance bandwidth from 2.9 to 12.9GHz.Interfrences from (IEEE802.11a) standards and HIPERLAN1 and HIPERLAN2 are addressed well. VSWR is obtained as 1.07(<2). Furthermore good omnidirectional radiation pattern and good impedance matching has been obtained. Thus this is well suitable for UWB applications..

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