Minimization of Length and Width of Ground Plane for Dual Band Patch Antenna for UWB Applications

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***Abstract*— in this paper, to optimize the ground length of Dual Band monopole patch antennas for ultra wide band is proposed. The antennas are suitable for operating frequency of 7.9 GHz and 13.5 GHz in UWB it is shown that return loss of the antennas at 7.9 GHz and 13.5 GHz is better than -10 dB. The VSWR obtained is less than 1.1 the patch antenna is found to have the compact size and more bandwidth. The return loss value of first band is 22.85 and for second band are 29.75. With radiation efficiency 93% and Antenna efficiency 80% calculated using HFSS-11 simulation software and the basic parameters of proposed antenna is tested using VNA.**

Keywords- Dual Band ,Patch antenna ,Ultra-wide band

I. INTRODUCTION

FCC (Federal communications commission) allocated a block of radio spectrum from 3.1GHz to 10.6 GHz for UWB operations [1].UWB systems can support more than 500 Mbps data transmission within 10m [1]. Compact size, low-cost printed antennas with Wideband and Ultra wideband characteristic are desired in modern communications. The Ultra wide band antennas can be classified as directional and omni-directional antennas [3]. A directional antenna have the high gain and relatively large in size. It has narrow field of view. Whereas the omni-directional antenna have low gain and relatively small in size. It has wide field of view as they radiates in all the directions [3].

The UWB antennas have broad band. There are many challenges in UWB antenna design. One of the challenges is to achieve wide impedance bandwidth. UWB antennas are typically required to attain a bandwidth, which reaches greater than 100% of the center frequency to ensure a sufficient impedance match is attained throughout the band such that a power loss less than 10% due to reflections occurs at the antenna terminals. Various planar shapes, such as square, circular, triangular, and elliptical shapes are analyzed and reported. Compared with monopole based planar antennas, the design of ultra wide band circular ring type antennas is difficult because of effect of the ground Plane.

The bandwidth of the micro strip antenna can be enhanced by modifying the ground plane [6]. Many designers have tried various ways to improve the structure of the traditional circular antennas, and many valuable results have been obtained.

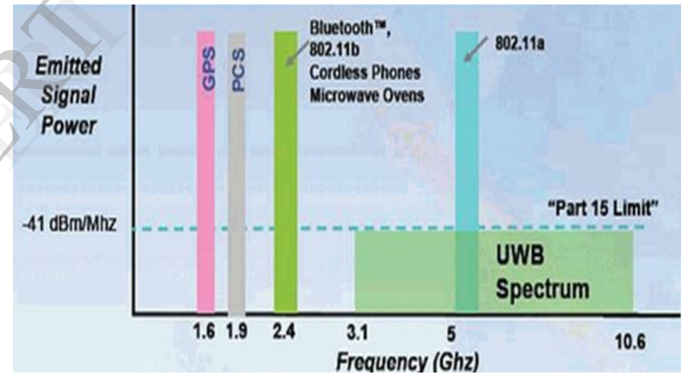

Fig. 1 UWB Spectral Mask per FCC (Modified) Part 15 Rules [1]

A. Important properties of UWB

The following properties are required for the UWB antennas:

1) Linear phase and constant group delay in directivity: If the group delay is not constant, the pulse waveform is spread out in the time domain.

2) Low return loss over ultra wide bandwidth: If there are mismatches both at the antenna end and the circuitry end, the overall dispersion characteristic is much degraded due to the multipath within the feeding cable.

3) Constant directivity over ultra wide bandwidth: The variation of the directivity according to the frequency results in the ripples of the frequency transfer function in some citation direction. The dispersion characteristic is then degraded.

B. Fundamental principles to achieve UWB

There are two fundamental principles to achieve the broadband or UWB property of the antennas [8].

1) Self similarity antenna: A self similarity antenna is with the constant electric shape over the wide frequency bandwidth. Here, the electric shape means the shape described in the dimension of the wavelength. A biconical antenna, a bow-tie antenna, a discone antenna, an equi-angular spiral antenna are the examples of this class.

2) Self complementary antenna: A self complementary antenna is usually composed of planar conductor(s), and its complementary structure is identical to the original structure. Here, complementary structure is obtained by replacing the conductor and the non-conductor parts in the plane. Among the self complementary antennas, the log-periodic antenna is well known.

II. ANTENNA CONFIGURATION AND DESIGN

For patch antenna the length and width of patch antenna are used as calculated from the equations. The first step is of dimension 2.5 x 1 mm^2 and second step is 4 mm on Y-axis and 1 mm on X- axis. The ground plane is of 25 x 25 mm^2. The slot present at patch is 3 x 6 mm^2. The ground plane is modified to enhance the bandwidth of the antenna. The whole structure of patch antenna is shown in fig. 2 and the dimensions of proposed antenna are shown in Table 1

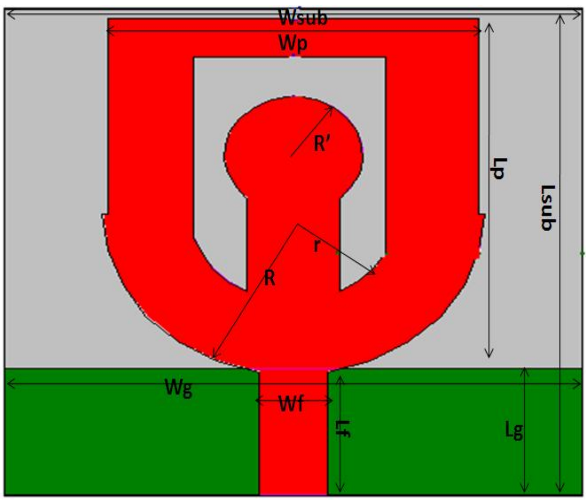

Fig. 2 Geometry of rectangular patch for UWB communication whole sturcture

Table 1 Antenna designing parameters

W sub	L sub	Wg	Lg	Wf	Lf	Wp	Lp	R	R'
25	25	25	6.5	3	6	16	17	8.25	3

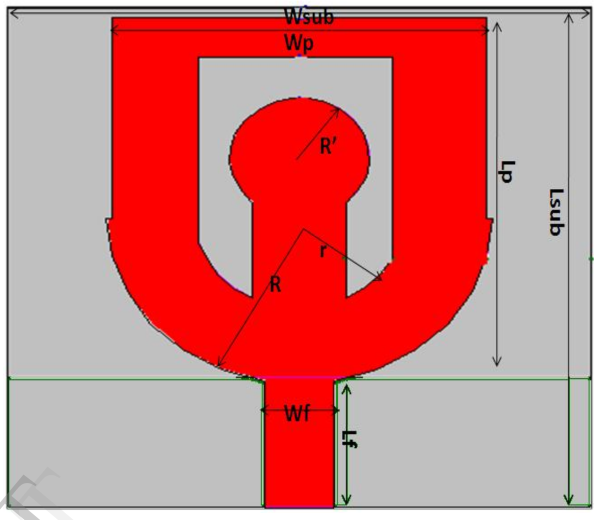

Fig. 3 Geometry of rectangular patch for UWB communication Top View

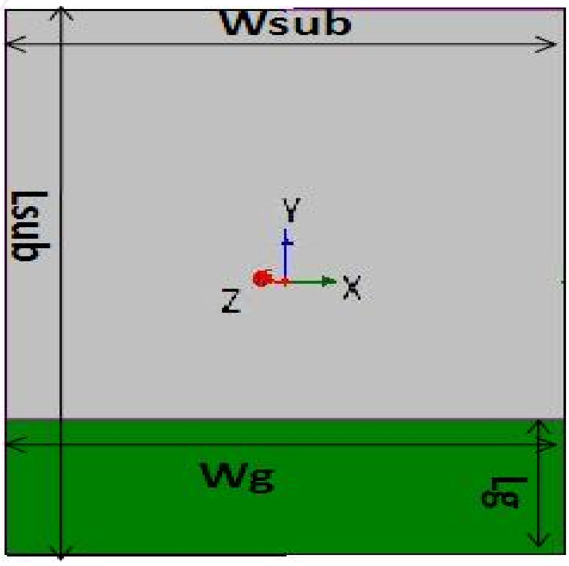

Fig. 4 Geometry of rectangular patch for UWB communication Bottom View

Whole structure, Top view and bottom view of design geometry of patch antenna is indicated in fig. 2, fig. 3and Fig. 4. The proposed antenna designed on a Rogers RT/duroid 5880TM substrate with dielectric constant ε_r = 2.2 and height of the substrate is h = 0.794 mm. The substrate has length L= 25 mm and width W = 25mm.The substrate is mounted on ground of 6.5 mm length and 25 mm width.

III. SIMULATION RESULTS

Fig. 5 and 6. Shows that S_{11} and VSWR of dual band patch antenna. This antenna is suitable for operating frequency of 7.9GHz and 13.5 GHz in UWB it is shown that return loss of the antennas at 7.9 GHz and 13.5 GHz is better than -10 dB. The VSWR obtained is less than 1.1 the patch antenna is found to have the compact size and 48.48 % Maximum Fractional Bandwidth. The return loss value of first band is 22.85 and for second band are 29.75. The plot curve for Gain, E – H Plane, Directivity and Polar Plot are shown in fig. 8, fig. 9, fig. 10 and fig. 11 respectively.

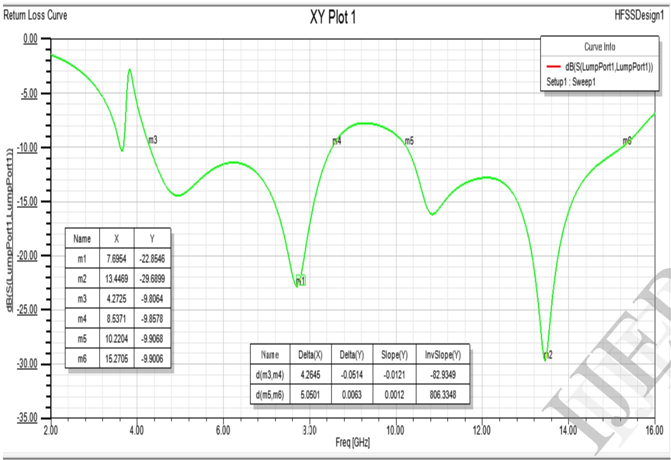

Fig. 5 S_{11} of dual band patch antenna

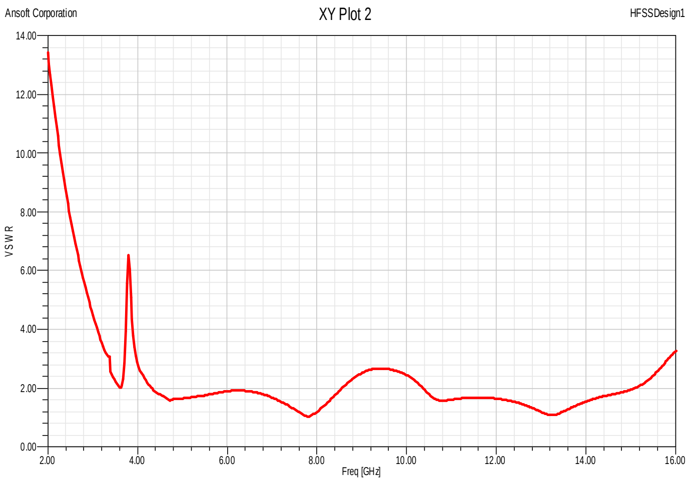

Fig. 6 VSWR of dual band patch antenna

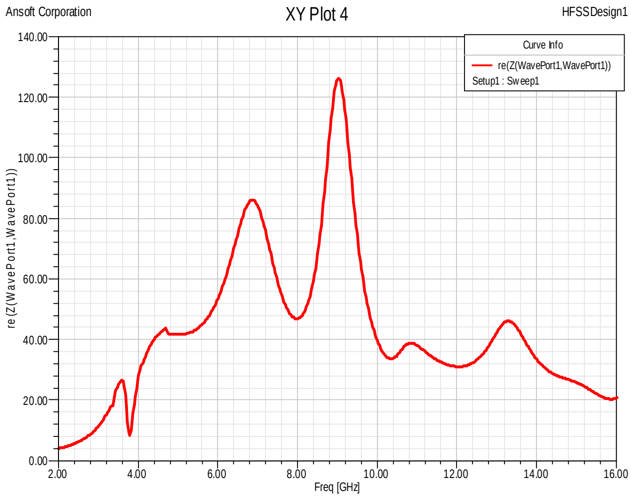

Fig. 7 Z- Parameter of dual band patch antenna

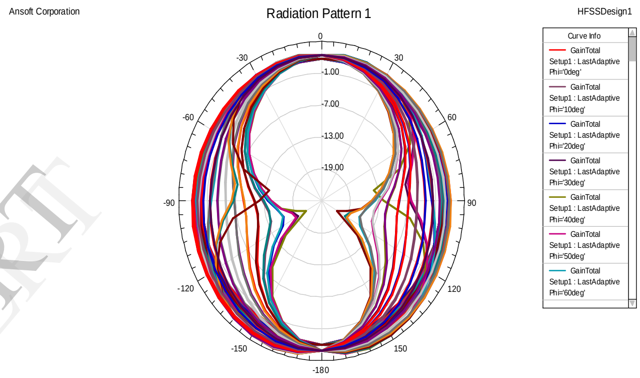

Fig. 8. Gain in db at 7GHz

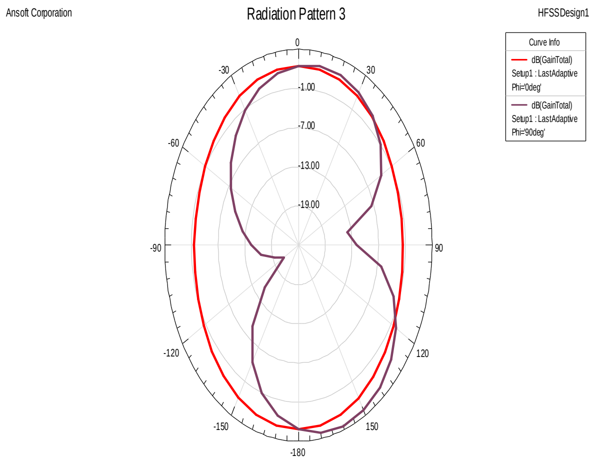

Fig. 9 E-H Plane at 7GHz

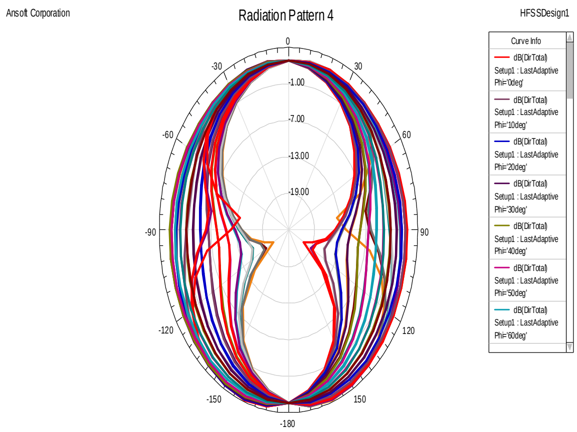

Fig. 10 Directivity at 7GHz

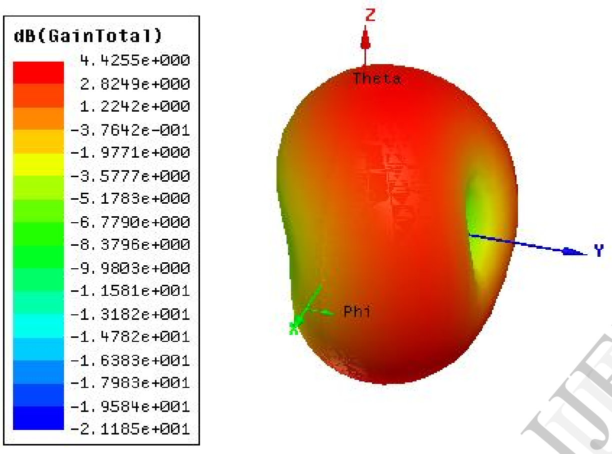

Fig. 11 Polar Plot at 7GHz

The radiation efficiency is of proposed antenna is calculated 92.778% at 7GHz as shown in fig. 12.

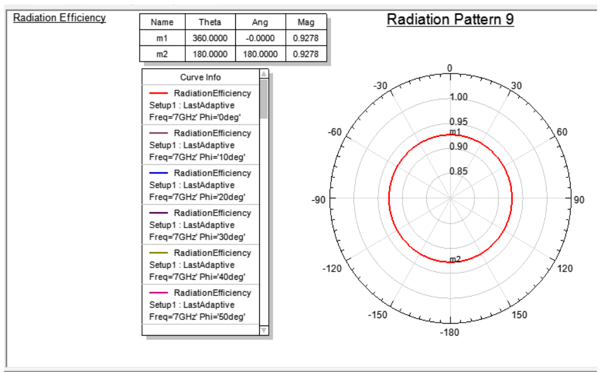

Fig. 12 Peak Radiation efficiency at 7GHz

The E-field and H-filed pattern are shown in fig. 13 and 14 at 7 GHz.

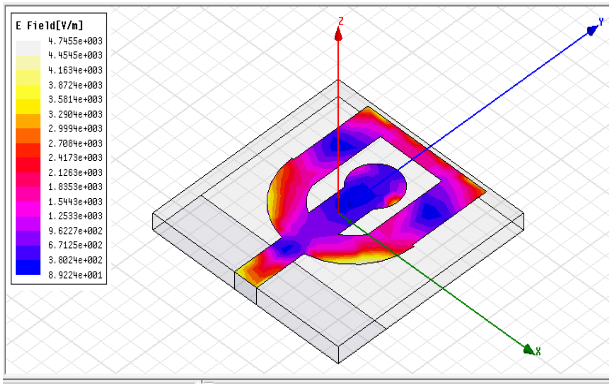

Fig. 13 E-field pattern at 7GHz

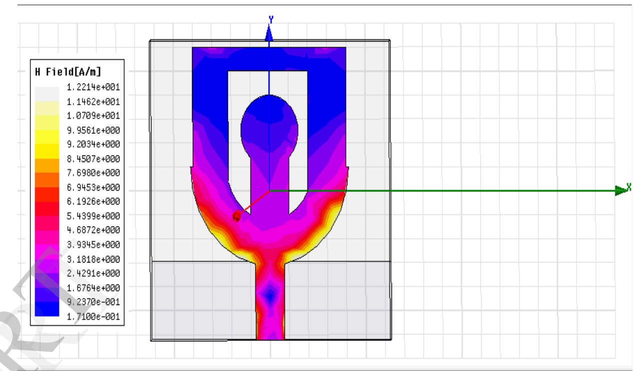

Fig. 14 H-field pattern at 7GHz

Form the fig. 15 we can conclude that if we decrease the ground length (Lg) of Substrate up to a specific manner, we can obtain the higher values of return loss and our antenna offers excellent performance in the range of 4 GHz -14 GHz in ultra wide band rather than various different shapes antennas used in this range to obtain higher values of return loss and notch frequencies.

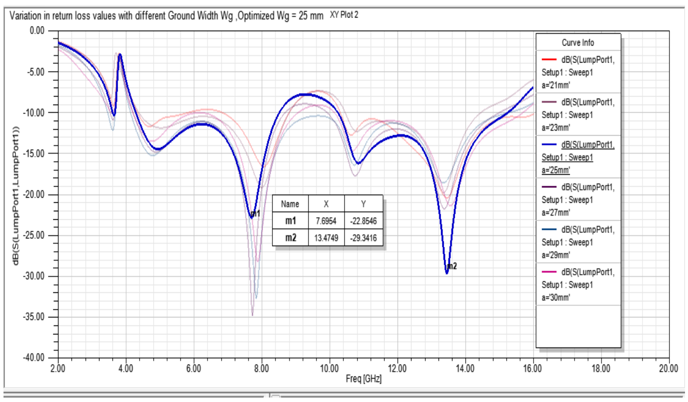

Fig. 15 To optimize the ground length Lg = 6.5 mm at 7GHz

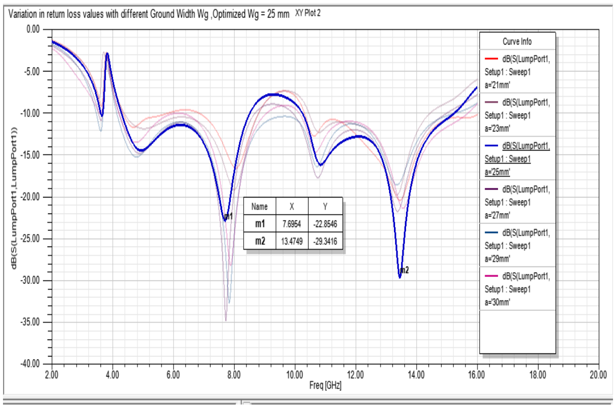

Fig. 16 To optimize the ground length Wg = 25 mm at 7GHz

IV FABRICATION

The antenna structure is fabricated on a printed circuit board (PCB) using Photolithography technique and tested. The top view and bottom view fabricated antenna is shown in Fig 12 and Fig. 13.

Fig. 12 Top view of dual band patch antenna

Fig. 13 Bottom view of dual band patch antenna

V SET UP OF ANTENNA MEASUREMENT

The set up for antenna measurement using vector network analyzer is shown in fig. 14 in this the calculation of return loss Values of the entire UWB ranges is measured and conclude that this antenna covered less then -10dB value for almost UWB.

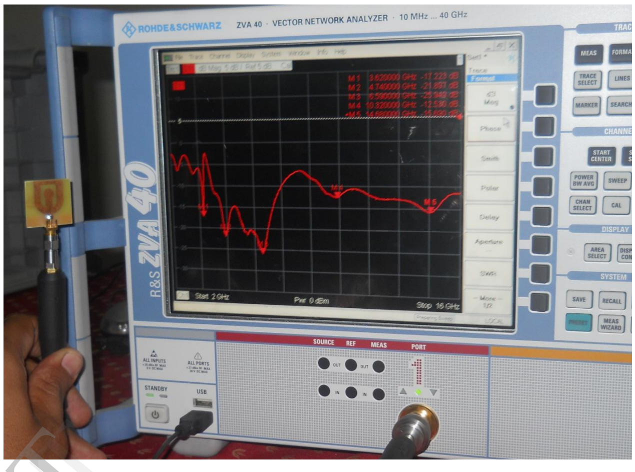

Fig. 14 Set up of antenna measurement using VNA

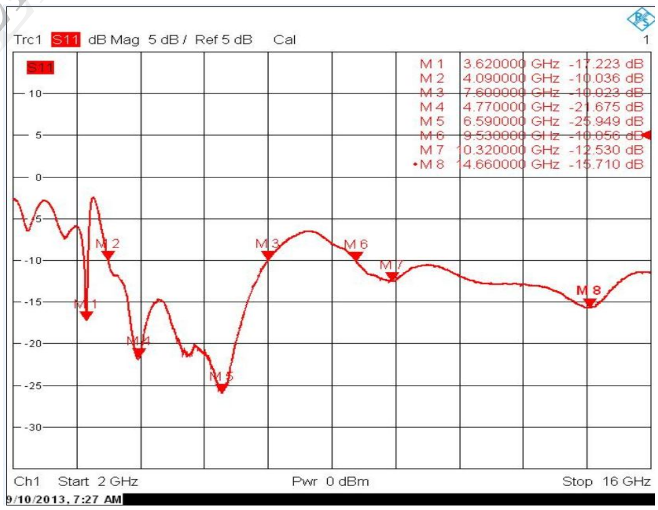

Fig. 15 Set up of antenna measurement of return loss using VNA

From the fig. 15 the value of return loss at 3.62 GHz , 4.09 GHz,4.77 GHz , 6.59 GHz , 7.60 GHz , 9.56 GHz ,10.32 GHz and 14.66 GHz are -17.223dB ,10.036 dB,-21.675 dB, -25.949 dB,10.023 dB, 10.056 dB,-12.530 dB and -15.710 dB respectivily. The measured result of input impedance are shown in fig. 16.

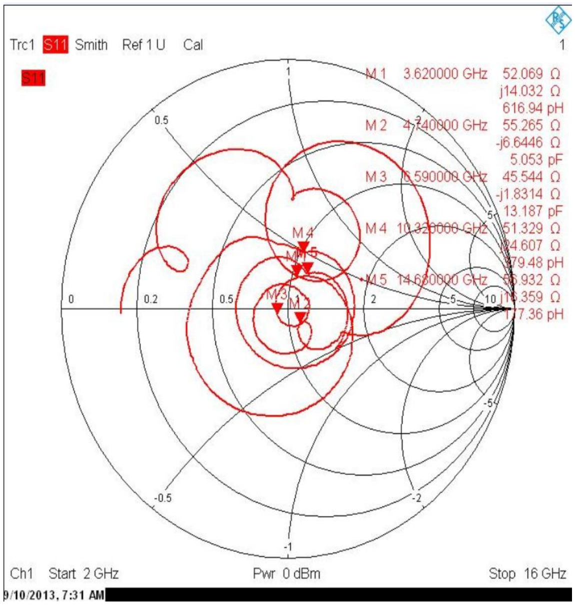

Fig. 16 Set up of antenna measurement of input impedance using VNA

VI CONCLUSION

In this paper, the Dual band monopole patch antenna for ultra wide band is simulated and tested with VNA. The fabricated antenna has advantages of small size, easy fabrication and simple construction. The simulated results of proposed antenna shows that return loss is less than -10 dB and VSWR is less than 1.1. The bandwidth is found of 4.3 GHz and 4.4GHz. It shows that the antennas can be good candidates for the operating frequency of 7.9 GHz and 13.5 GHz The return loss value of first band is 22.85 and for second band are 29.75, radiation efficiency 93% and Antenna efficiency 80% calculated and applicable for WPAN applications with band rejection of ISM, Wi Max and C – band.

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