Comparative Study of n-dimensional Ultra Wideband Microstrip Patch Antenna with Partial Ground Plane

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ABSTRACT— In this paper, n-dimensional microstrip patch antenna with partial ground plane is designed for ultra wideband applications and is compared with circular patch antenna with partial ground plane. The performance parameters such as bandwidth and resonant frequency are considered for comparison. The simulations are carried out using Ansoft HFSS.

KEYWORDS— *Microstrip Patch Antenna (MPA), Ultra Wideband Antenna (UWB).*

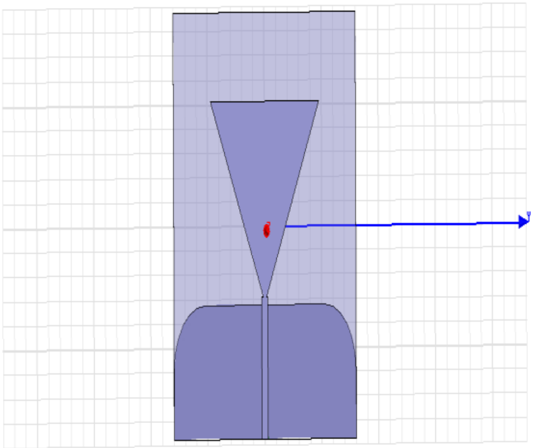
I. INTRODUCTION

In February 14, 2002, the Federal Communications Commission (FCC) changed the Part 15 rules which oversee unlicensed radio gadgets to incorporate the operation of UWB gadgets. The FCC likewise dispensed a data transfer capacity of 7.5GHz, i.e. from 3.1GHz to 10.6GHz to UWB applications [1], by a wide margin the biggest range assignment for unlicensed utilize the FCC has ever allowed. Ultra-wideband (UWB), a radio transmission innovation which involves an amazingly wide transmission capacity surpassing the least of 500MHz or if nothing else 20% of the middle recurrence [1], is a progressive approach for short-run high-data transfer capacity remote correspondence. Contrasting from customary limited band radio frameworks (with a transfer speed typically under 10% of the inside recurrence) transmitting motions by adjusting the adequacy, recurrence or period of the sinusoidal waveforms, UWB frameworks transmit data by producing radio vitality at particular time moments as short heartbeats along these lines involving extremely vast data transfer capacity and empowering time adjustment. Because of the transmission of non-progressive and short beats, UWB radio proliferation will give high information rate which might be up to a few hundred Megabytes for every second, and it is hard to track the transmitting information, which very guarantees the information security. For a similar reason, the transmitting power utilization of UWB frameworks is amazingly low in correlation with that of conventional thin band radio frameworks. Additionally, the short heartbeats offer ascent to evasion of multipath blurring since the reflected signs do not cover the first ones. Due to these charming properties, UWB innovation is broadly utilized in numerous applications, for example, indoor situating, radar/restorative imaging and target sensor information gathering. One of the difficulties for the execution of UWB frameworks is the advancement of an appropriate or ideal reception apparatus. The primary critical prerequisite for outlining a UWB radio wire is the to a great degree wide impedance data transfer capacity. In 2002, the US FCC apportioned an unlicensed band from 3.1GHz to 10.6GHz on the recurrence range for UWB applications [1]. Consequently, up to 7.5GHz of transfer speed is required for a workable UWB radio wire. Furthermore, ordinarily, the return misfortune for the whole all-inclusive band ought to be in the model of not exactly - 10dB. Next, for indoor remote correspondence, omnidirectional property in radiation design is requested for UWB radio wire to empower comfort in correspondence amongst transmitters and beneficiaries. Thusly, low directivity is fancied and the pickup ought to be as uniform as workable for various headings. Another essential prerequisite is the radiation effectiveness. Since the power transmitted into space is low, the radiation productivity is required to be very high (regularly the radiation productivity ought to be no under 70%). Also, straight stage in time space qualities is fancied for UWB application. Since straight stage will deliver consistent gathering delay, the transmitted signs, in the type of to a great degree short heartbeats, won't be contorted and subsequently the framework works successfully. To wrap things up, since UWB innovation is mostly utilized for indoor and convenient gadgets, the measure of the UWB receiving wires is required to be adequately little with the goal that they can be effectively incorporated into different types of gear. Diverse UWB radio wires are, for example, rectangular fix, roundabout fix [2], fixed receiving wire utilizing Particle Swarm Optimizer [3], U-opening, E-space patches, H-shaped slotted circular patches are composed in [4]-[6]. This paper exhibits the examination of n-dimensional microstrip fix radio wire with roundabout fix reception apparatus for ultra wideband applications. The work is novel in its kind according to author’s learning.

The organization of the paper is follows: Section II presents the antenna design. Simulation results are discussed in section III and followed by conclusion.

II. ANTENNA DESIGN

Fig. 1 shows the schematic geometry of an n-dimensional Microstrip Patch Antenna with (N=3,4,5,6,8,10,20,1000) and other dimensions. The antenna consists of a metallic patch printed on R04350B substrate with relative permittivity $\varepsilon_r = 3.4$ and a partial ground plane. A 50-Ω microstrip line of width 1.04mm is used as the feeding technique.



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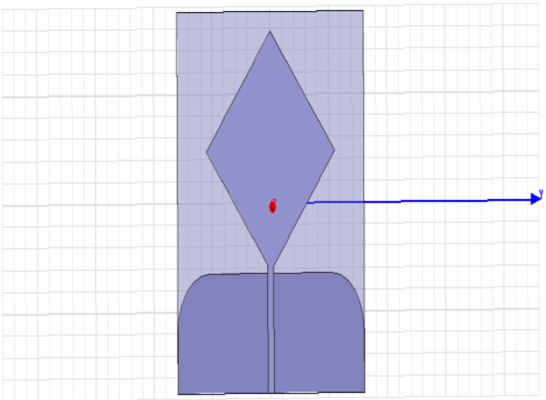

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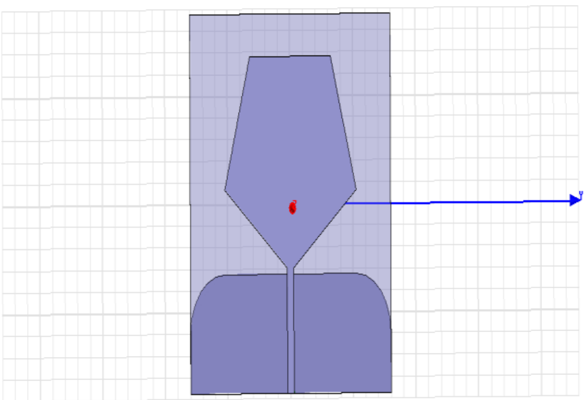

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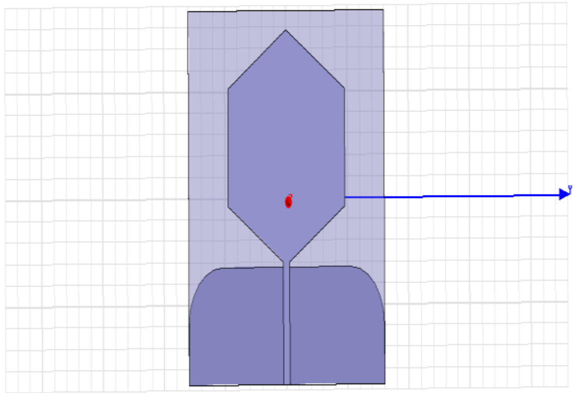

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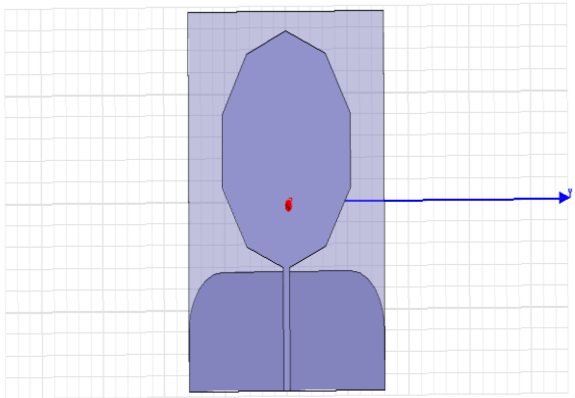

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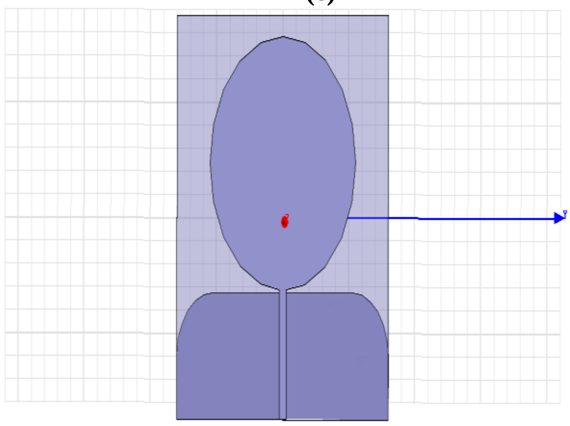

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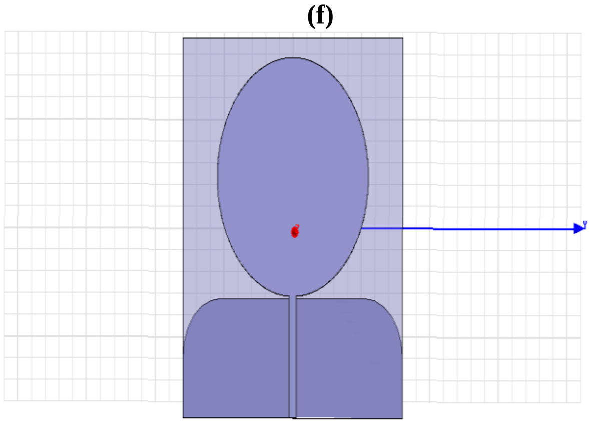

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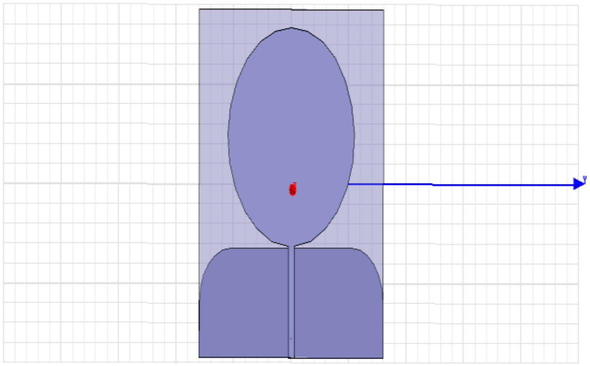


(h)

Fig. 1 The geometry of the n-dimensional microstrip patch antenna simulated using HFSS with (a) n=3, (b) n=4, (c) n=5, (d) n=6, (e) n=10, (f) n=20, (g) n= 1000

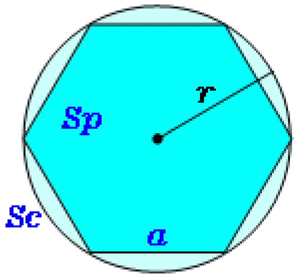
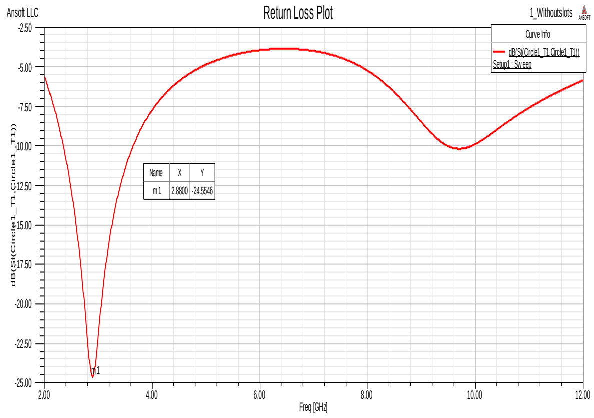


Fig. 2 Hexagon inscribed in circle

From Fig. 2 since the area ratio of Sp/Sc =0.99999934 (about equivalent to 1) for n=1000, the simulation was halted at it. To the human eye patch antenna with n=1000 practically resembles a circle. Afterward, a circular patch of 11mm was etched on a similar substrate with the end goal of examination with various sided MPA.

III. SIMULATION RESULTS AND DISCUSSIONS

The Antenna synthesis and analysis are carried out using design tool Ansoft HFSS. The simulated results for UWB microstrip antenna with varying 'n' are shown in Fig. 3 below



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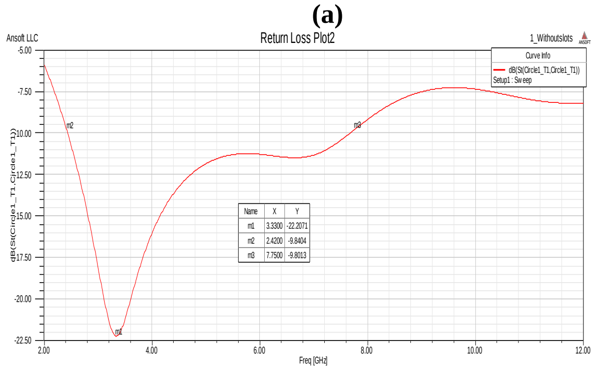

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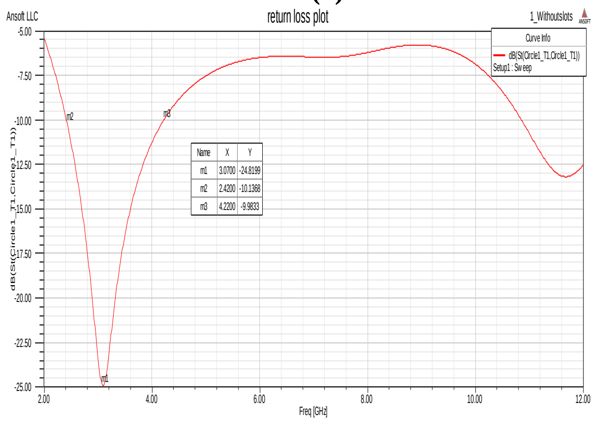

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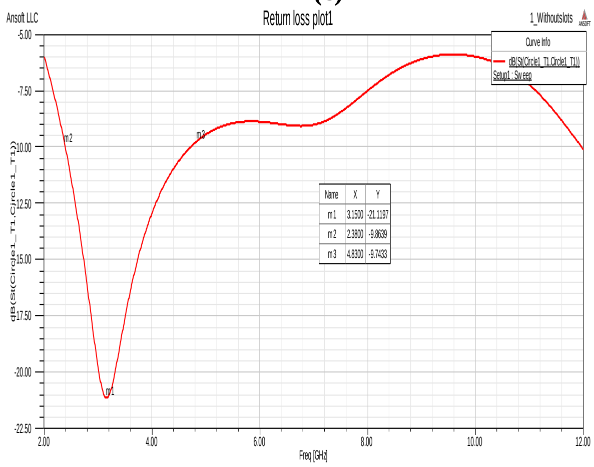

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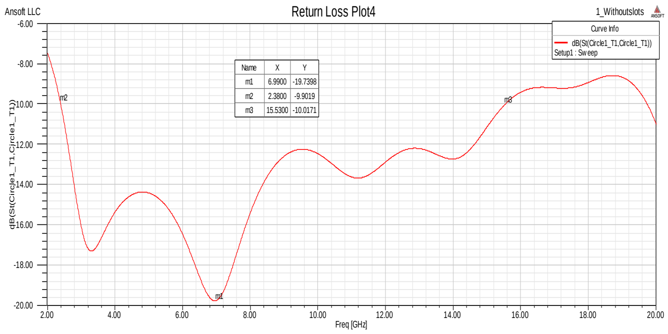

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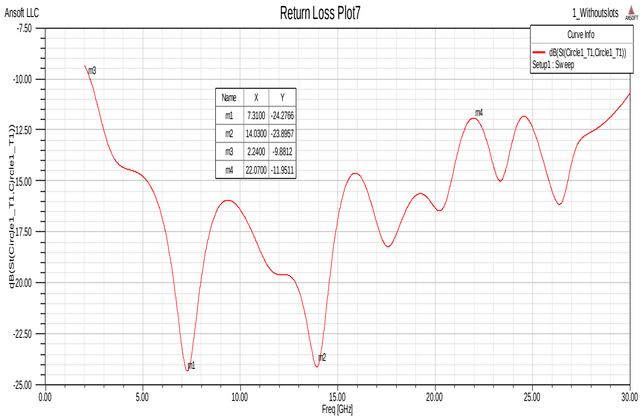

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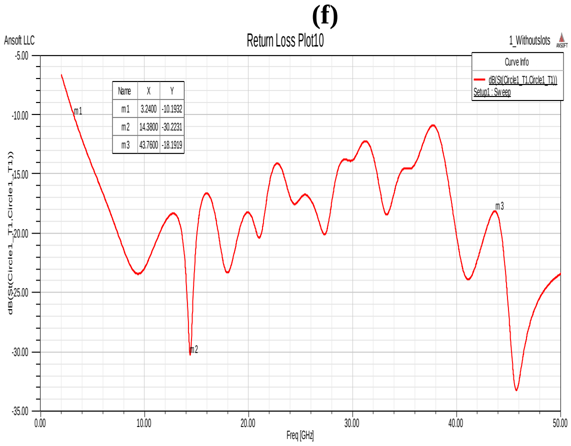

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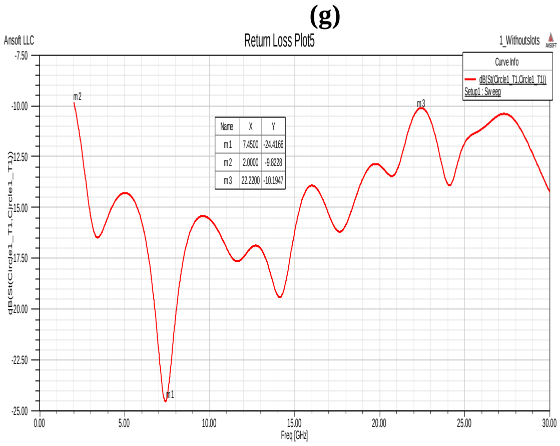

(h)

Fig. 3 Simulated Return loss plot for UWB microstrip antenna with (a) n=3, (b) n=4, (c) n=5, (d) n=6, (e) n=10, (f) n=20, (g) n= 1000

The summary of the simulated results is presented in Table. 1 below

Table. 1: Summary of the simulation Results

N	Resonant Frequency in GHz	Return Loss in dB	Frequency range in GHz	Bandwidth in GHz
3	2.8	-24	2.2 - 3.8	1.6
4	3.07	-24.8	2.42 - 4.2	1.78
5	3.1	-21.11	2.38- 4.83	2.45
6	3.3	-22.07	2.4 - 7.75	5.35
10	6.69	-19.7	2.3- 15.53	13.23
20	7.73 &14	-24 & -23	2.2 – 22	19.8
1000	14.2	-30	2 – 43.76	41.76
circle	6.4	-24	2 - 22	20

As seen from Table. 1 the resonant frequency and bandwidth of microstrip patch antenna with partial ground plane increases with increment in ‘n’. The increment in bandwidth is due to increase in the perimeter of the patch antenna with increase in ‘n’. Also, it is observed that the patch antenna with n=10 will have same performance as circular patch antenna.

IV. CONCLUSION

Comparative study of N-dimensional Microstrip Patch Antenna designed using HFSS is presented in this paper. The performance parameters such as resonant frequency and bandwidth are observed to increase with increment in ‘n’ for microstrip patch antenna. For, n=1000, the designed antenna and circular patch will have same performance. The designed antennas are suitable for ultra wideband applications. In Future, the bulkiness of the antennas can be treated for miniaturization.

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