UWB MICROSTRIP SLOT ANTENNA BASED ON TAPERING CONCEPT

M. Ravi Teja[1], P. Anusha[2], K. Gopal[3], Prof. N. UmaMaheshwar Rao[4]

[1,2,3]*Students, Department of Electronics and Communication Engineering, Vardhaman College of Engineering, Telangana State, India*
[4]*Professor, Dept. of ECE, Vardhaman College of Engineering, Telangana State, India*

Abstract - *This paper presents a planar monopole microstrip slot antenna based on tapering concept for UWB applications. Though there are infinite number of antenna designs available there are only a few of them which are small in size and suitable for UWB applications. This antenna is designed using slot and tuning stub which meets our require-ment to achieve good impedance bandwidth, stable radiation pattern and a maximum gain of 5.4 dBi and makes our antenna suitable for UWB applications.*

Key Words: Ultra Wide Band(UWB), Slot, Tuning Stub, Tapering Concept, Partial Ground

1. INTRODUCTION

UWB is a wireless technology for transmitting digital data at very high rates using very low power. UWB technology has greater capacity than other radio technologies in transmitting data in cluttered indoor environments because of the extreme broadband nature of emission. This broad bandwidth reduces the impact on the received signal level caused by frequency selective multipath and RF absorption events in a cluttered environment. UWB technology provides an advantage used to collect data for the precision analysis internal structures and movement of object by radar or radio determination systems. UWB radios mostly use frequencies from 3.1-10.6 GHz a band more than 7 GHz wide. Each radio channel can have bandwidth of more than 500 MHz depending on its center frequency. To allow for such a large signal bandwidth FCC put in place severe broadcast power restrictions. By doing so, UWB devices can make use of extremely wide frequency band while not emitting enough energy to be noticed by narrower band devices nearby, such as 802.11a/b/g radios. It uses very low energy level for short range and high bandwidth communications over a large portion of radio spectrum. Some applications of UWB technology are communication, positioning, radar and medical.

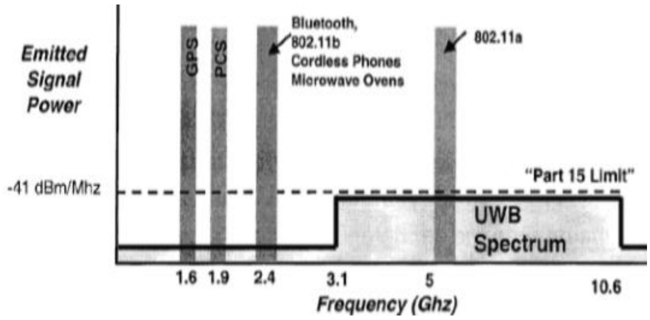

Fig. 1. Frequency and Power of Different Signals

Designing of an efficient and low profile UWB antenna to match applications these is still the interest of many rese- archers. In this paper, we propose an UWB microstrip slot antenna based on tapering concept which is of dimensions 22x24 mm2 fabricated onto a inexpensive FR4 substrate.

2. ANTENNA DESIGN CONCEPT

FR4 is a relatively cheaper board with near zero water absorption. It is most commonly used as an electrical insulator possessing considerable mechanical strength and the fabricated tolerances are quite high. So it is hard to be sure about the exact value of relative dielectric constant. However, if there are any differences in simulated and measured results arising due to FR4 board, we can trace them by parametric simulation in software. The antenna consists of a tapered shape slot attached out of the ground plane and a microstrip-line-fed rectangular stub for excitation. The slot and the tuning stub are printed on the opposite side of an inexpensive FR4 substrate of thickness 1.6 mm, with relative permittivity 4.6 and loss tangent 0.02. The characteristic impedance of the microstrip line is taken as 50 ohm. The slot in the ground plane act as a coupling to the feeding structure. The geometry and configuration of the antenna are shown Fig.4,5. Many planar antennas have been proposed for UWB applications. Among planar UWB antennas, the printed slot antenna type is most suitable for UWB applications. Slot acts as a radiating element. Conventional narrow slot antennas has limited bandwidth; where as wide slot antennas exhibit wider bandwidth. Different printed wide slot antennas fed by a microstrip line or Coplanar Waveguide have been studied but most of them are not compact and operates over a narrow bandwidth. The proposed antenna is compact and operates over a UWB range. Unlike the conventional wide slot anten-na, tapered slot is surrounded by ground strips of small wid-th, which makes the antenna smaller. Moreover, introduction of the tapered slot instead of the rectangular slot changes the electric field distribution by reducing the longest current path and reducing the slot size. As a result, the impedance matching is much improved, especially at lower frequencies, resulting in overall enhancement of operating bandwidth. Variation of the tuning stub shape and slot shape will change the coupling and, thus, control the impedance matching. In o-rder to optimize the coupling between the microstrip line a-nd the tapered slot, the rectangular stub was compared to cir-cular, square, elliptical, tapered stubs as shown in Fig.2, 3 sh-ows the simulated VSWR curves for five different stubs. It is observed that for elliptical and circular shape tuning stubs, the impedance matching becomes very poor due to poor electromagnetic coupling between the feed line and tapered slot. The rectangular shaped tuning stub showed good cou-pling with the tapered shape slot, proving wider impedance matching.

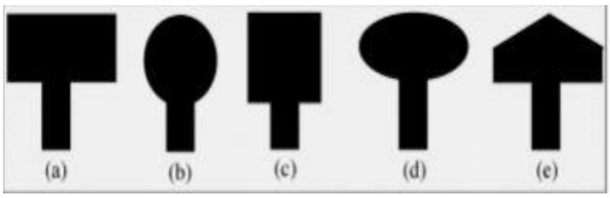

Fig.2. a) Rectangular b)Circular c)Square d)Elliptical e) Tapered stubs

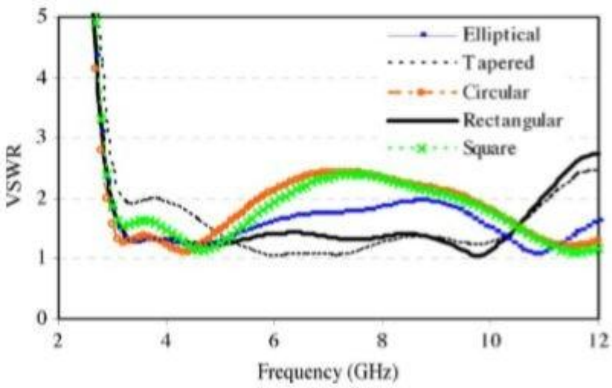

Fig.3. Simulated VSWR for different tuning stub shapes

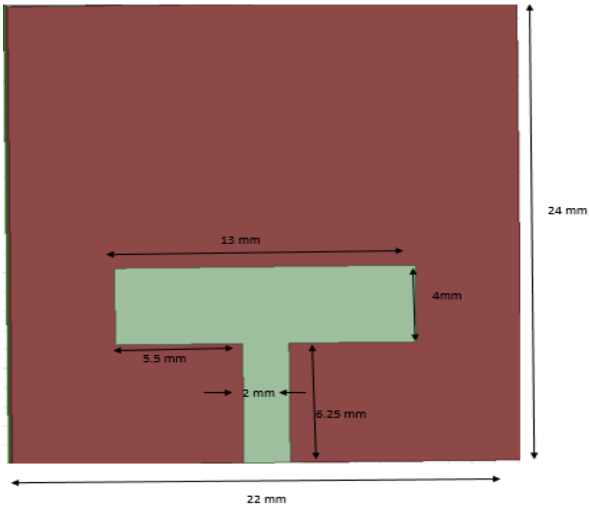

Fig.4. Top view of Antenna

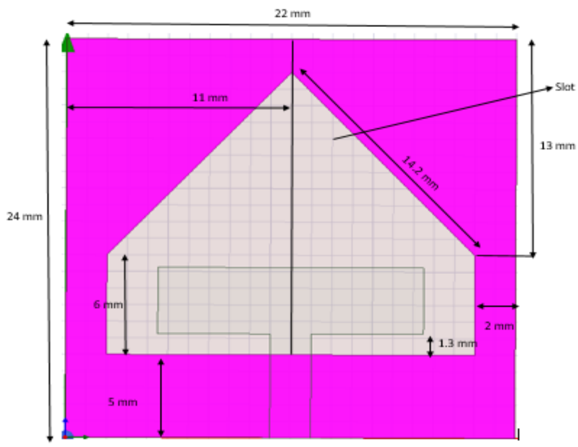

Fig.5. Bottom view of Antenna

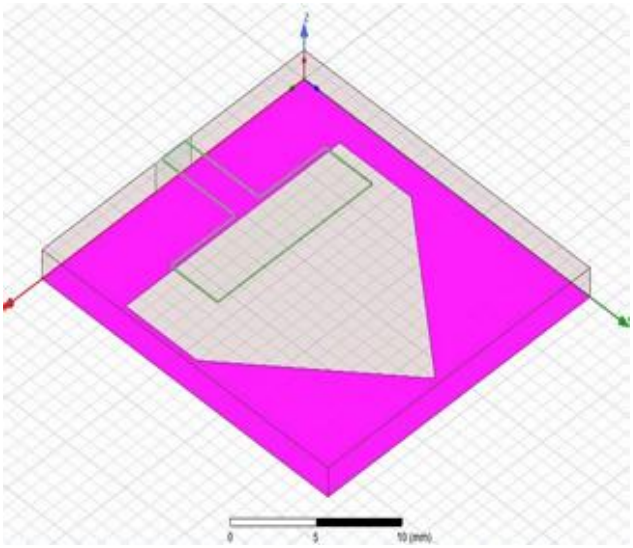

Fig.6. Designed Antenna in Simulation Tool

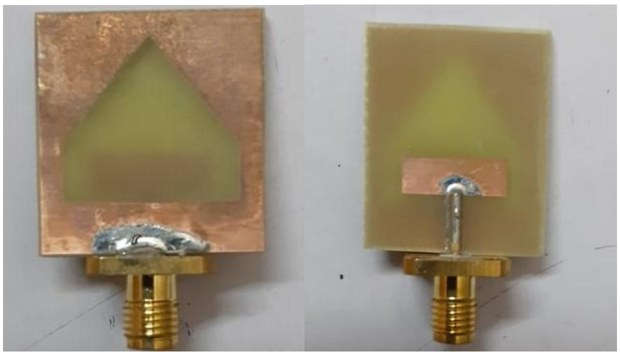

Fig.7. Fabricated Antenna

3. **SIMULATION RESULTS AND DISCUSSIONS**

The antenna performance was measured in HFSS electromanetic simulator software and fabricated results are me-asured using AgilentE8362C vector network analyzer. Fig.8 shows the simulated VSWRs against frequency which is less than 2 from 4.4-12.8 GHz and Fig.9 shows the return loss of the proposed antenna in HFSS. It is seen that the proposed antenna exhibits a wideband performance from 4.4 to 12.8 GHz covering more than 82% of UWB range. The realized gain is 3.04 dBi at 4.4 GHz, 7.5 GHz and 5.28 dBi at 9.8 GHz. Gain plots are shown in Fig 10,11,12.

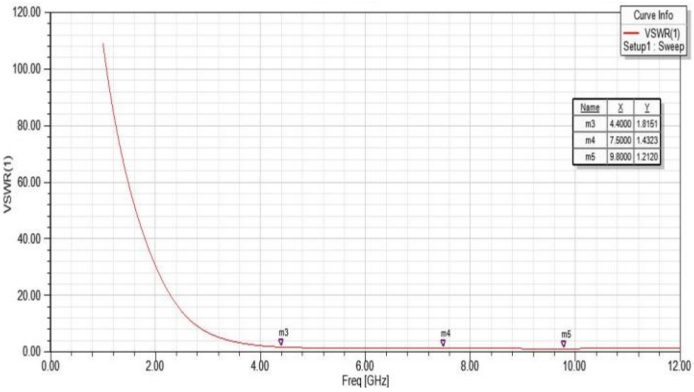

Fig.8. VSWR Plot

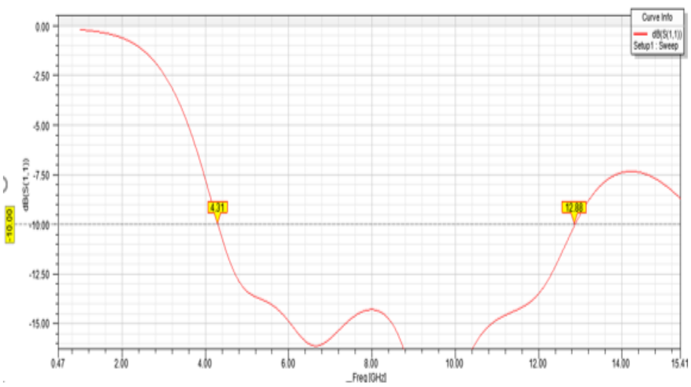

Fig.9. Return loss Characteristics

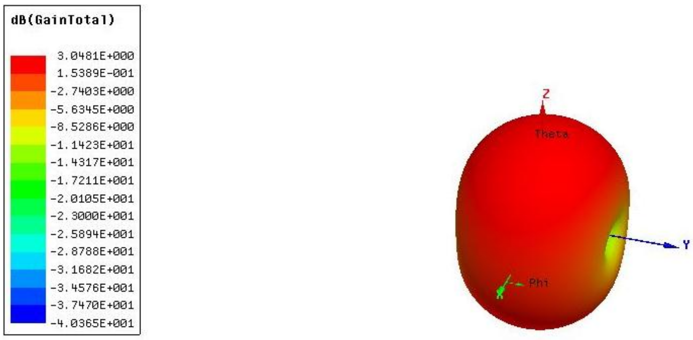

Fig.10. Gain Plot at 4.4 GHz

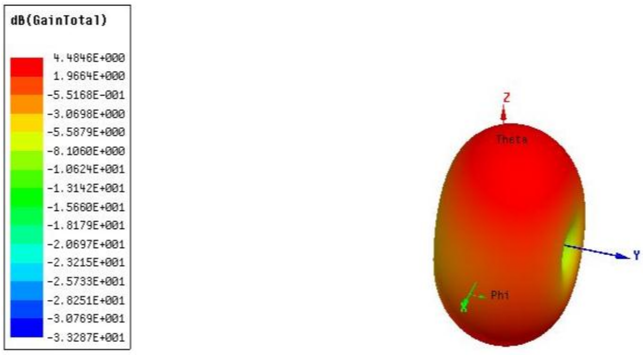

Fig.11. Gain Plot at 7.5GHz

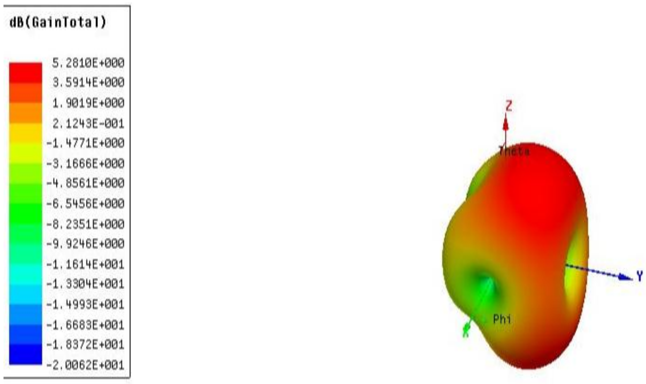

Fig.11 Gain Plot at 9.8 GHz

4. CONCLUSIONS

An UWB microstrip slot antenna based on tapering concept with microstripe linefed, rectangular stub and tapered shape slot antenna has been proposed and prototyped. The antenna is fabricated onto an inexpensive FR4 substrate with an overall dimension of 22x24 mm and simulated using HFSS and fabricated. It is found to support UWB applications. The designed antenna achieves bandwidth of 4.4-12.8 GHz covering more than 82% of UWB range and giving us high return loss, directivity and gain is also simulated by High Frequency Structure Simulator. Here slot dimensions and the feed position are varied to support different bands and to provide impedance matching. The stable radiation pattern with a maximum gain of 5.28 dBi makes the proposed antenna suitable for being used in UWB communication applications. Therefore, the proposed design is suitable for the UWB applications of the present wireless communications like geological & metrological signal, Radar navigation etc. The future works on enhancing the bandwidth can be done by increasing the slot shape, but attention should be given to manage the gain as well. The performance of the antenna can be further improved by using substrates with low insertion losses as well the emergence of an improved implementation technique.

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