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MAGNETIC CURRENT DISTRIBUTION ANALYSIS OF CPW FED ARROW SHAPED UWB ANTENNA

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ABSTRACT

An investigation of magnetic current distribution of CPW fed arrow shaped UWB antenna is reported. This enables the precise prediction of working principle of UWB antenna, since the traditional UWB antenna simulations ignore important details. The computation was performed numerically for an arrow shaped antenna at different resonant frequencies at various input current phase changes and was found that the traveling wave characteristic of the antenna exhibits the UWB property. The computed result is compared with different geometries, such as circular disc monopole and eared antenna.

Keywords: *CPW feed, UWB Antenna, Magnetic Current Distribution*

1. INTRODUCTION

The demand for wireless services such as wireless local area network (WLANs), wireless personal area networks (WPANs), wireless telemetry, telemedicine, cellular network and wireless sensor network (WSN) is increasing for the past one decade. New generation of wireless radio system aim to provide flexible data rates including high, medium and low data rates for a wide variety of applications like video, data, ranging etc., to as many mobile users as possible. The explosive growth of the wireless market is expected to continue in future. Since more and more devices are going wireless every day, accommodating the demand for high capacity and data rate within the limited bandwidth is a challenging task. It is essential that current and future wireless technologies can coexist with devices operating at various frequency bands.

Ultra wideband is a promising solution to this problem that can coexist with other licensed and unlicensed narrowband systems. Federal Communications commission (FCC) in USA allowed the unlicensed use of UWB devices in 2002 subject to the emission constraints. Due to its unlicensed operation and low power transmission, UWB can coexist with other wireless devices and its low cost, low power transceiver circuitry makes it a good candidate for short to medium range wireless systems such as WSNs and WPANs. The controlled transmitted power of UWB devices affects the other narrowband system only at a negligible level. Hence UWB has emerged as one of the hot topic for wireless world including wireless home networking, high density use in office buildings and business cores, UWB wireless mouse, keyboard, wireless speakers, wireless USB high speed wireless body area network (WBAN).

The design rules and results of reflection and radiation characteristics are discussed in many literatures [1-7]. Although certain level of maturity is attained in the design, the operating principle of this antenna is discussed only for few antennas a circular disc monopole and eared antenna [8,9].

In this paper the working principle of the CPW fed arrow shaped antenna is presented. The magnetic current distribution of the antenna is analyzed at different resonant frequencies. Conclusions are drawn by investigating the current distribution of the antenna at different phases and validated by comparing with that of circular disc monopole and eared antenna.

2. ANTENNA GEOMETRY

The geometry of the proposed antenna is illustrated in Fig.1. The antenna is printed on a low cost FR4 substrate with relative permittivity ε_r =4.4, thickness of 1.6mm, 26×30mm^2 (L×W). A 50Ω CPW transmission line with width of 3.8mm feeds the antenna. The arrow shaped radiator is

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optimized using CST Microwave studio based on Finite Integration Technique [10]. The optimized geometrical parameter of the antenna is shown in Table.1

Table 1. Geometrical Parameters Of The Proposed Antenna

Parameter	Dimension (mm)	Description
L_f	15.5	Feed length
W_g	12.6	Width of Ground
L_g	12	Length of the ground plane
W_f	3.8	Width of the feed line
g	0.5	Gap between feed and ground
L_{T1}	5	Tapering length
L_R	8	Length of the radiator
L_{T2}	8	Tapering length
W_S	2	Width of the slot

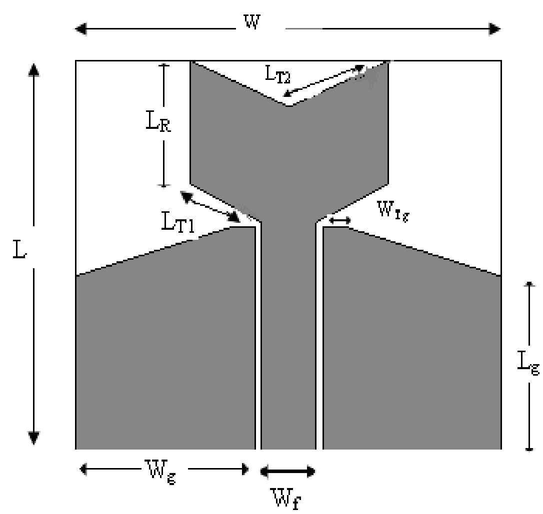

Fig.1 Geometry Of The Proposed Antenna

3. SIMULATED RESULT AND DISCUSSION

The simulated return loss characteristic of the optimized antenna is shown in Fig.2. It is observed that the antenna exhibit three resonances at 4.136GHz, 8.0358GHz and 10.582 GHz. The overlapping of these closely spaced multiple resonances across the spectrum results in ultra wide bandwidth ranging from 3.502 GHz to 12.01 GHz (return loss <-10dB). The simulated current distribution of the arrow shaped antenna at all resonances is presented in Fig 3. Fig.3a shows the current pattern near the first resonance at 4.136 GHz. The current pattern near the second resonance at around 8.0358 GHz is shown in Fig.3b indicating approximately second order harmonics. Fig.3c illustrates more complicated current pattern at 10.582 GHz corresponding to third harmonic.

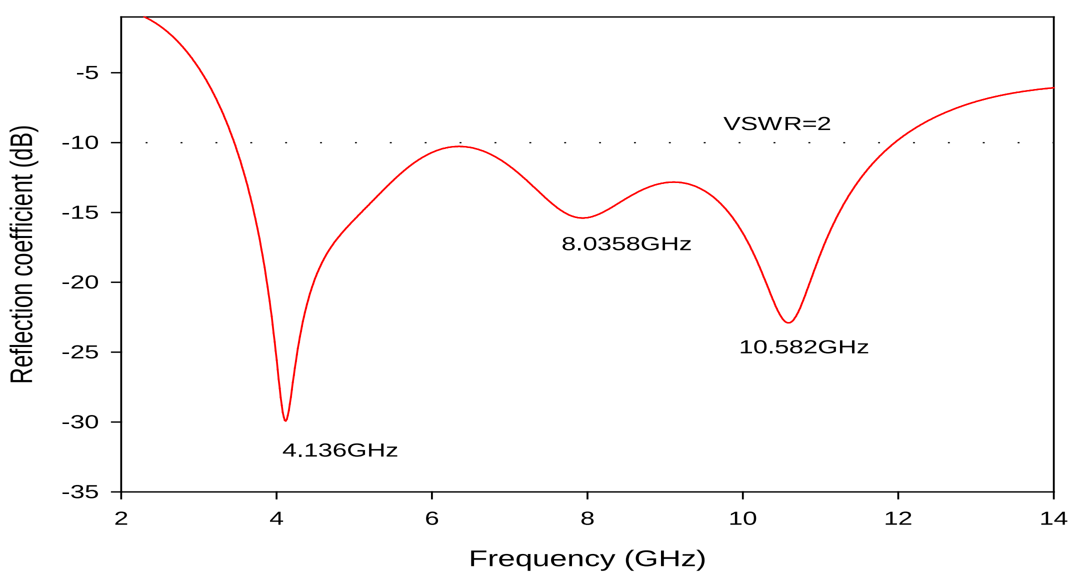

Fig.2 Simulated Return Loss Characteristics

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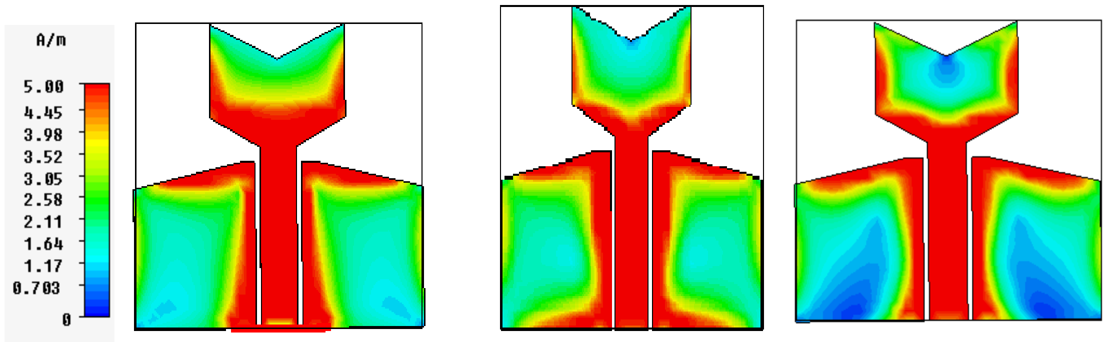

a **b** **c**

Fig.3 The Current Distribution Of The Antenna At A. 4.136 Ghz B.8.0358 Ghz C.10.582 Ghz

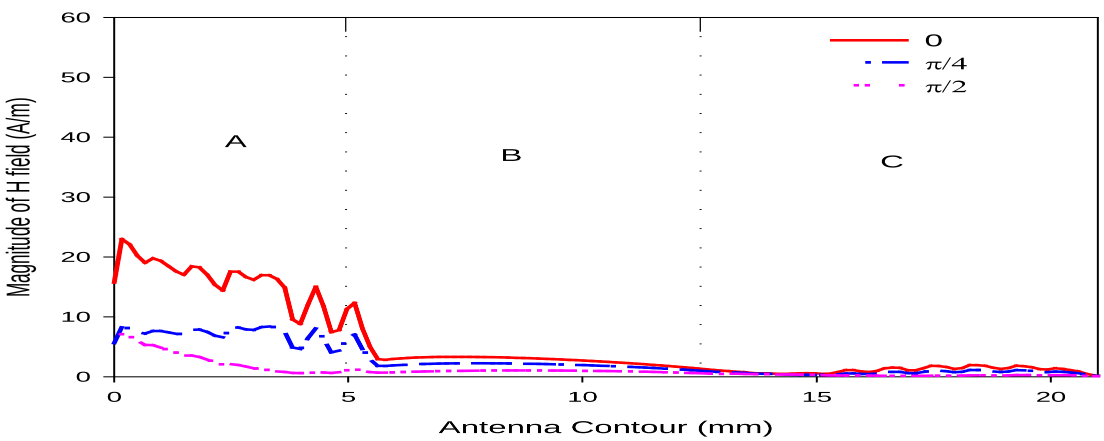

Fig.4 The H Field Distribution At 4.136 Ghz

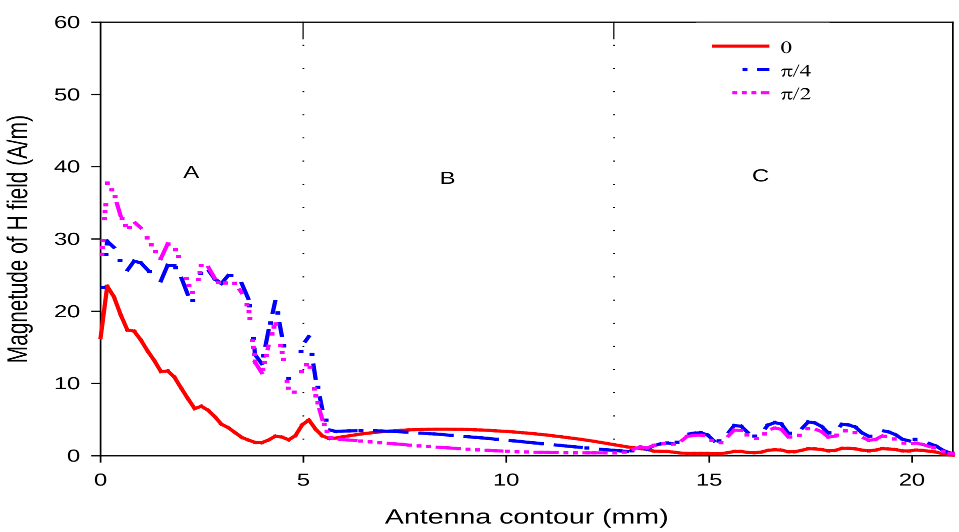

Fig.5 The H Field Distribution At 8.0358 Ghz

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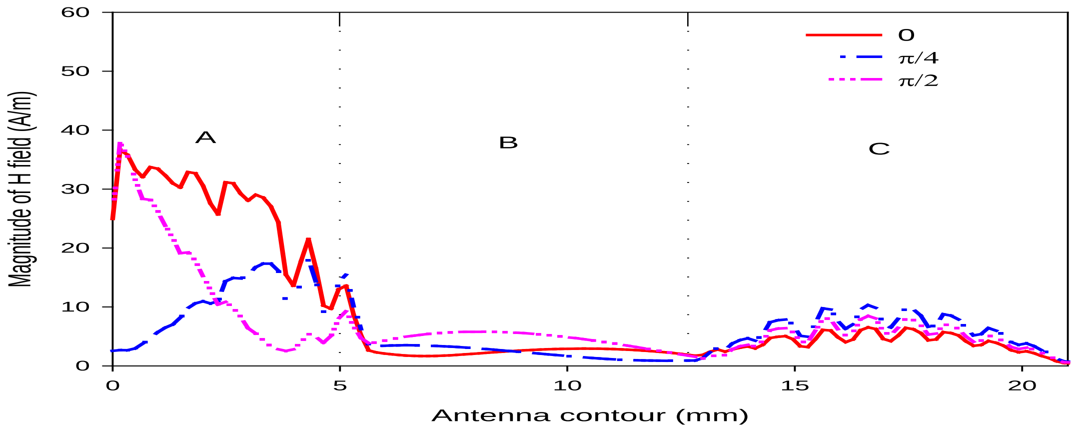

Fig.6 The H Field Distribution At 10.58 Ghz

The current is mainly distributed along the edges of the antenna for all resonant frequencies. It is also observed that the amplitude of current distribution decreased when moving away from the transition region of the antenna and first resonance frequency is associated with the dimension of the antenna.

To totally realize the operation of the antenna the absolute values of magnitude of H field at different phases of current at the input of the antenna were studied. The H field value at the edges of the antenna divided into 3 contours (L_{T1}-A, L_R-B,L_{T2}-C) as shown in Fig.(2, 4-6) were obtained via CST and combined in MATLAB to have total field distribution on half the antenna circumference. The boundaries between the sub-contours are indicated in dashed line.

At first resonance current is oscillating and has pure standing wave pattern along most part of the antenna edge and behaves like oscillating monopole as shown in Fig.4. At higher resonance frequencies the behavior of the current becomes more complicated. Fig.5 indicates a complete current variation pattern at the second harmonic. The current is traveling along the lower edge but oscillating at the top edge.

At third harmonic this feature of traveling wave seems to predominate at the lower edge, while standing wave retains on the top edge with an envelope peak indicating that the transition part of the antenna is more effective part in the radiation mechanism of the antenna. The proposed antenna exhibits the traveling and standing wave characteristics similar to circular disc and eared antenna and ultra-wide bandwidth is achieved due to the overlapping of multiple resonances.

4. CONCLUSION

The H field analysis on the contour of the antenna for different input phase current of antenna demonstrates that the antenna operates in hybrid mode of traveling and standing wave. The traveling wave characteristic predominates at the lower edge near the feed and standing wave dominates at the upper edge away from feed. The traveling wave characteristic is the most important aspect for achieving wide bandwidth. The transition region of the antenna is the most effective part in radiation mechanism and wide bandwidth is due to the overlapping of multiple resonances.

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