Design A Compact CPW-fed UWB Antenna With WLAN band notch characteristic

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Abstract— UWB antenna with single band-notch characteristics, to obtain WLAN band-notch characteristic, is being proposed in this paper. In this paper, we have designed a compact coplanar waveguide (CPW) fed UWB antenna. The proposed antenna works in frequency range 3.1-10.6 GHz with VSWR<2. By cutting two symmetrically slot in the ground plane, the frequency range of 5-6 GHz of WLAN is being notched. The overall dimensional of antenna is $26*30*1.6mm^2$. This antenna is design on FR-4 substrate 1.6mm white and effective dielectric constant (ϵ_r =4.4). The simulation results of antenna shows the perfect impedance matching in all bandwidth (7.5 GHz) of UWB, also stable radiation patterns and constant gain. All simulations in this work has been carried out by using Ans oft HFSS 10.

Index Terms— UWB characteristic, CPW-fed antenna, band notch characteristics, C-shaped slot.

I. INTRODUCTION

UWB is seeking great attention of the researchers in the recent times and proving to be the most fruitful of all the wireless technologies. Since the Fedral Communication Commission (FCC) decided the range for this band to be 3.1-10.6 GHz there has been a great development in the field of wireless communication. UWB antenna being the key of UWB communication has attractive features of compact size, wide omnidirectional radiation pattern, impedance bandwidth, low power consumption, ease of manufacture and unipolar configuration. The printed monopole antennas with a very large bandwidth are currently in great demand as they assemble most of the above mentioned requirements.

There are others narrow bands services also operate in this range for example; WLAN (Wireless Local Area Network) between 5.15 GHz to 5.825 GHz and WiMAX (Worldwide interoperatibility for Microwave Access) between 3.4 GHz to 3.69 GHz [2] so the interference happens between UWB and narrowband systems. But due to the low power consumption and high data rate UWB technology is more prominent. UWB band being immune to multiple fading, low power requirements and providing high rate of data transfer has numerous potential application including non-cooperative radar imaging, target sensor data collection, precision locating and tracking application.

As WLAN band lies within the UWB band the interference from the WLAN band imposes serious problems in UWB application system [3]. To avoid interference between UWB and WLAN systems, a filter is required which suppresses this undesired band but it increases the complexity [4]. Therefore antenna with band-notch characteristic can solve the purpose. Several attempts have been made to suppress a frequency band, by embedding U-shaped or V-shaped slots on the radiating patch [5, 6]. In this proposed antenna design, we have produced band-notch characteristic by planting two vertical slots on the ground plane instead of radiating patch. The formula below gives the notched frequency (f) in terms of the length of the slot (L), speed of light(c) and effective dielectric constant (ϵ_{eff}).

$$f_{notch} = c / 2L\sqrt{\epsilon_{eff}}$$

$$\epsilon_{eff} = \epsilon_r + 1/2$$

$$2$$

On based the background of the researches above the proposed antenna designed with two Rectangular-shape slots in ground patch symmetrically with quarter wavelength which are responsible the needed notch frequency 5.5 GHz. The CPW-feed has the advantage of compact size compared with existing antenna [6] and without much adjustment the existing structure can be used for notched design. The antenna is simulated and analyzed by using simulation software, Ansoft HFSS.

II. ANTENNA DESIGN AND RESULTS

In this paper, we have used coplanar waveguide (CPW) to fed the antenna. CPW transmission line is probably the most used line for designing microwave circuits for mmwave applications as it allows for easy fabrication of active devices due to the presence of the centre conductor and close proximity of the ground planes. Unlike microstrip, CPW has substantially less losses at frequencies approximately above 20 GHz. This is due to a large proportion (approximately half) of the field existing outside the dielectric. As a result, the dielectric loss is lower and the dispersion of the signal is considerably less.

In this design the substrate FR4 is used as it is cheap and easy to fabricate. These values W & T are taken half wavelength of lower frequency (3.1 GHz) and the substrate height is h=1.6mm, dielectric constant ε_r =4.4 and loss tangent d =0.02. The dimensional of the antenna are optimized with HFSS tool. The optimization was performed for the most excellent impedance bandwidth. The final parameters are W =30mm, W₁ =12.6mm, W₂ =3.8, T₁ =9.1mm, T₂ =15.5mm, S1 =5.75mm, S2=5.25 mm.



Fig. 1 Simulated VSWR of antenna without slot with optimal dimensions.

Fig. 2 (a, b) shows the configuration of the proposed monopole antenna consisting a radiating patch and CPW feed without slot and with slotted ground plane respectively. The ground plane slot provides an additional current path. So this structure changes the inductance and capacitance of input impedance which plays the important role to notch the WLAN (5-6GHz) frequency. Fig. 1 shows the simulated VSWR without slot the value of VSWR is less than 1.8 in overall band width 3-11GHz.







Fig. 3 Simulated VSWR of antenna with slot with optimal dimensions.

Similarly we can see in fig. 3 the antenna with slot on the basis of VSWR. This is clear that at WLAN band the response of the antenna is not linear because the value of VSWR exceed up to 10 at 5.5GHz and the at remaining band the VSWR less than 2.

Since UWB system uses pulse communication, a key matter is pulse distortion by the antenna. Ideally, a linear phase response (constant group delay) is needed fig.4 shows the graph between group delay vs frequency.





band width of UWB. It shows relationship between gain and frequency (3 to 11 GHz). The variation of gain of proposed antenna is about 3.5dBi.







Figure 6: Radiation pattern of proposed antenna at 3 GHz frequency



Figure 7: Radiation pattern of the proposed antenna at 7 GHz frequency



Figure 8: Radiation pattern of the proposed antenna at 10 GHz frequency

The E field and H field radiation pattern of the proposed antenna at frequency 3 GHz, 7 GHz, 10 GHz can be observed in the figures 6, 7, 8 respectively. It is seen that this antenna has the nearly omni-directional radiation pattern like normal monopole antennas. However, the omni-directional radiation properties have a little deterioration as frequency. Over the entire bandwidth, it's similar to a conventional wideband monopole antenna.

III.CONCLUSION

From the measured results, it is achieved that the operating bandwidth is 3.1GHz to 10.6 GHz for VSWR < 2, and the rejected frequency range is obtained as 5.10 GHz 5.75 GHz for -3 dB return loss. Therefore a compact monopole antenna for wideband application has been designed and successfully implemented with experimental and numerical results. The WLAN frequency range has been significantly notched by mismatching done by cutting slots in the ground plane. Stable radiation patterns and constant gain in the UWB band are also obtained.

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