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Design of Compact UWB Antenna for Commercial Wireless Application

Waseem Ahmad*,Dr. Harish Kumar#
*M.Tech Student Shobhit University Meerut,#Bhagwant Institute of Technology,Muzaffarnagar

Abstract

In this paper a compact UWB antenna for Wireless Sensor Networks is proposed. The antenna described has the advantage that other circuitry can easily be mounted on the substrate with the antenna if desired. The calculated input impedance of the designed patch antenna was 348.1Ω.So this is highly matched antenna can be used in future wireless applications.

Key words-*UWB,Wireless Sensor Networks.*

1.Introduction

In recent years, UWB technologies have drawn great interest in the wireless community [1]. The development of UWB has unshared in a new era in short-range wireless communications. Among various potential applications, one of the most promising is in wireless sensor networks (WSNs), which requires both robust communications and high-precision ranging capabilities. There have been numerous research results in the literature to indicate that UWB is one of the enabling technologies for sensor network applications. In particular, impulse-radio-based UWB technology has a number of inherent properties that are well suited to sensor network applications. UWB systems have potentially low complexity and low cost, with noise-like signal properties that create little interference to other systems, are resistant to severe multi-path and jamming, and have very good time-domain resolution allowing for precise location and tracking. a number of UWB-based sensor network concepts have been developed both in the industrial and the government/military domain. Of particular importance are systems based on the IEEE 802.15.4a standard, which provides a well-defined yet flexible PHY and MAC layer that is suitable for a wide variety of applications. Furthermore, it works together with the ZigBee networking standard, a dominant technology in WSN systems.

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Antenna Design:

dimension of the patch along its lengths have been extended on each end by a distance ΔL, which is a function of the effective dielectric constant ε_{reff} and the width to height ratio (W/h).

A very popular and practical approximate relation for the normalized extention of the length is

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

Since the length of the patch has been extended by ΔL on each side, the effective length of the patch is now

$L_{eff} = L + 2\Delta L$

Therefore, for $\epsilon_r = 4.1$, h= 1.5mm the calculated patch was 15 x 14.5mm

Fig.**1** shows the simulated S- band linearly polarized microstrip antenna. The actual radiating element is the large patch and the smaller rectangular section is a quarter-wave transformer for impedance matching. The impedance transformer is necessary in order to match the 50Ω transmission line to the relatively high impedance at the edge of the antenna element. However, by making the radiating element rectangular it is possible to match directly to the 50Ω at the antenna input port.

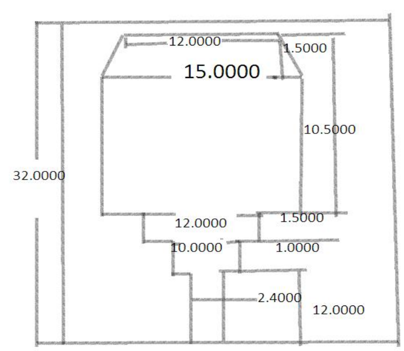

Figure 1:Dimension of Simulated Antenna

EXPERIMENTAL RESULTS:

RETURN LOSS:

An antenna constructed on 1.5 mm FR4 substrate with dimensions of $\lambda_d/2$ (λ_d is wavelength in the dielectric) had a VSWR of 1.3 when fed at the edge of patch by a 50Ω microstrip line shown in Fig. 4.2. The simulation result is below 15 dB throughout the band. The measured return loss was 11dB at from 3.1 GHz to 10.6 GHz. The graphs are shown with x-y plot in fig. 4.2(a), 4.2(b).

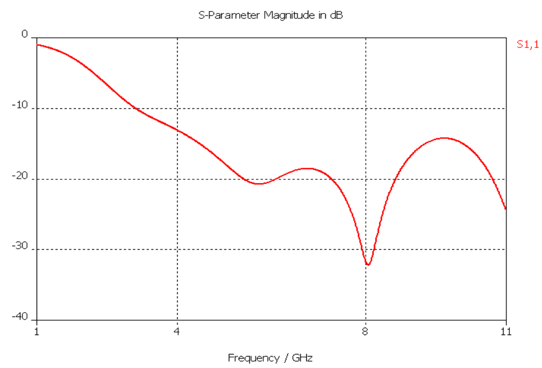

Fig.2(a). Simulated Return Loss (Log magnitude) of antenna.

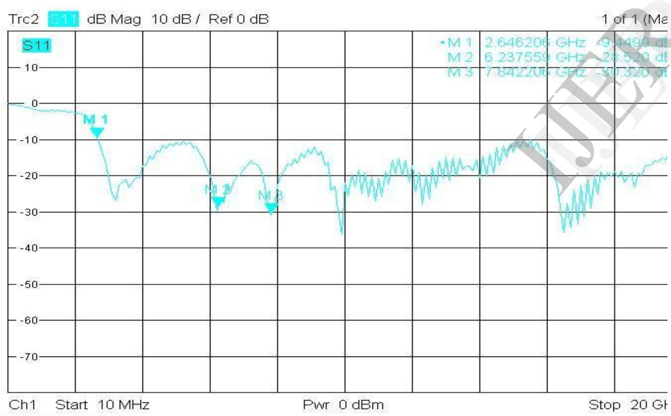

Fig.2(b)Measured Return Loss (Log magnitude) of antenna.

4.3 RADIATION PATTERN

Fig. 4.3 shows the ***E***- and ***H***-plane patterns for ***ultra wide*** band antenna constructed on an FR4 substrate (ε_r = 4.1) with thickness of 1.5mm and patch dimensions are 32x30 mm^2.

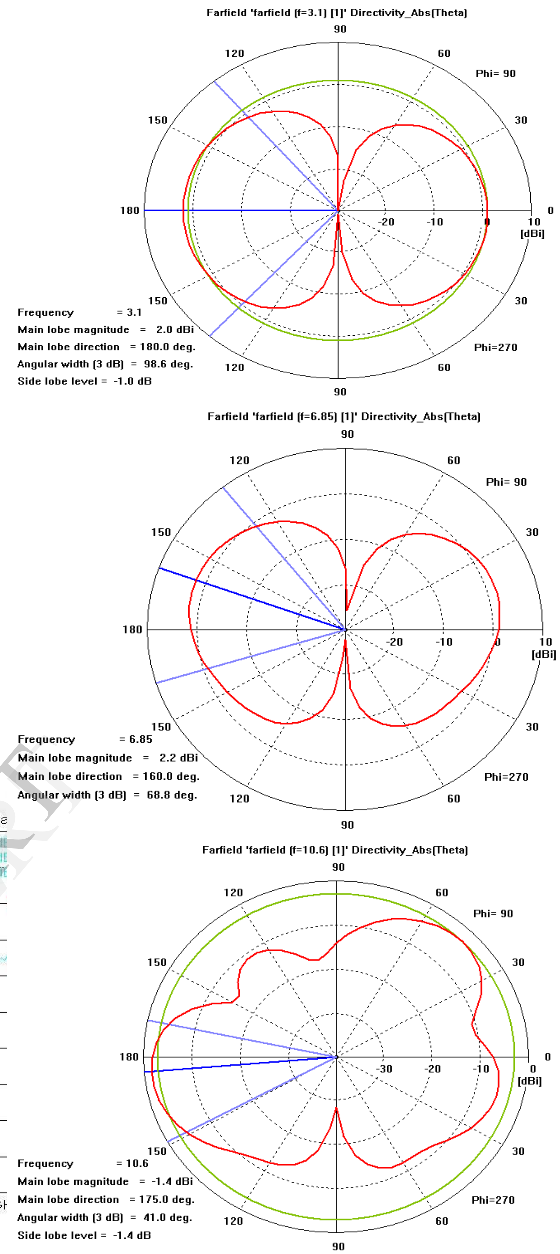

Fig. 3(a). Measured E-plane pattern for antenna.

The E-plane radiation pattern of designed antenna was found 180^0, 160^0, 175^0 offset with maximum power 0 dB at frequency 3.1, 6.85 and 10.6 GHz. The Half Power Beamwidth was found 98.6^0 , 68.8^0, 41^0.

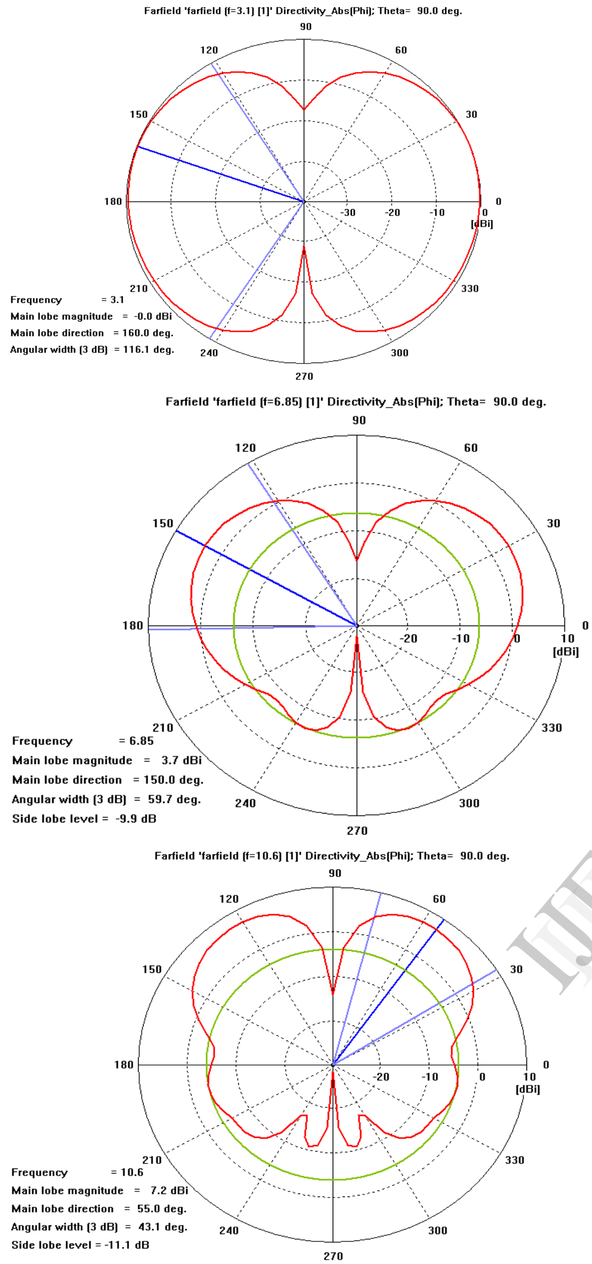

Fig. 4.3(b). Measured H-plane pattern for antenna.

The H-plane radiation pattern was found 160^0, 150^0, 55^0 offset with maximum power 0 dB and the half power beamwidth for this pattern was found 116.9^0, 59.7^0, 43.1^0. No asymmetries were seen that, could be consistently attributed to the feed line and matching transformer.

The antenna described has the advantage that other circuitry can easily be mounted on the substrate with the antenna if desired. The impedance at the center of the structure is zero while at the outer edge it is very high (hundreds of ohms) so consequently there will always be a point that provides a good 50 Ω match.

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CONCLUSION

UWB Antenna designed, simulated for Ultra wideband successfully and shows good agreement between the simulated and desired characteristics. The E-plane radiation pattern of designed antenna was found 180^0, 160^0, 175^0 offset with maximum power 2, 2.2, -1.4 dBi at 3.1, 6.85, 10.6 GHz respectively. The Half Power Beamwidth was found 98.6^0, 68.8^0 and 41^0. In this radiation pattern there were two lobes at 3.1 and 6.85 GHz but the 10.6 GHz radiation pattern is almost omnidirectional. The H-plane radiation pattern was found 160^0, 150^0 and 155^0 offset with maximum power 0, 3.7 and 7.2 dBi and the half power beamwidth for this pattern was found 116^0, 59.7^0 and 43.1^0 . Due to their compactness and easy fabrication, the proposed antennas can be useful for commercial wireless communication applications.

SCOPE & FUTURE WORK

This is the most rapidly popular topics in the antenna field in high-performance aircraft, spacecraft, satellite and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints, and low profile antennas may be required.

In the future work one can introduce Electronic Steerable UWB Patch Array that changes from classical fixed-form, fixed function antennas to modifiable (Changeable) structures that can be adapted to fit the requirements of a time varying system.

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