Design of Unit Cell Strucuture for MIMO Antenna

S. Syedakbar, Monika Dharani G[2]
.Assistant Professor, Department of ECE,
K.Ramakrishnan College of Technology

Monika Dharani, Muthulakshmi A, AarthiJ,
UG Scholar, Department of ECE,
K.Ramakrishnan College of Technology

Abstract- This letter presents an multi-port, multiple polarization, UWB diversity antenna array. The unit cell antenna is constructed from a basic square monopole antenna. With suitable modifications in the radiating plane and the ground plane, the unit cell antenna is designed to operate between 2.9 GHz – 12 GHz to cover the entire UWB range. The designed UWB radiator is then replicated within a small space to generate triple polarization. The proposed unit cell antenna has the compact size of 14×24 mm^2. Measured results show that the proposed antenna has a wide bandwidth ranging from 3 to 12 GHz with high port isolation which demonstrate the proposed diversity antenna can be a good candidate for UWB applications. The return loss obtained for the antenna is above 20 dB. It has good voltage standing wave ratio.

Index Terms— Monopole antenna, UWB antenna, diversity antenna

I. INTRODUCTION

The need of UWB communications has been intensified as it benefits large instantaneous bandwidth, high data rate, low power spectral density and short duration pulses. Monopole antennas are good choice for UWB transmissions because of its simple structure, omni-directional pattern, less weight and ease of fabrication. Electrical resonance of a monopole antenna is greatly influenced by the radiator and the ground plane. Distance between the ground plane and the radiator plays a major role in achieving good impedance matching. A small microstrip fed rectangular patch monopole antenna with tapered ground plane is presented. Three different modes are excited and these modes are overlapped to obtain an UWB. Tapering the ground plane is done to decrease the capacitance between the radiator and the ground plane, which acts as a distributed matching network.

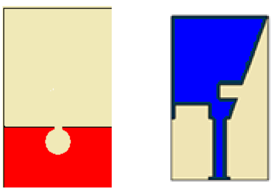


Fig. 1. Proposed UWB monopole antenna. Front view (b) Rear view L=24 mm, W=14 mm, l=15 mm, f=3mm

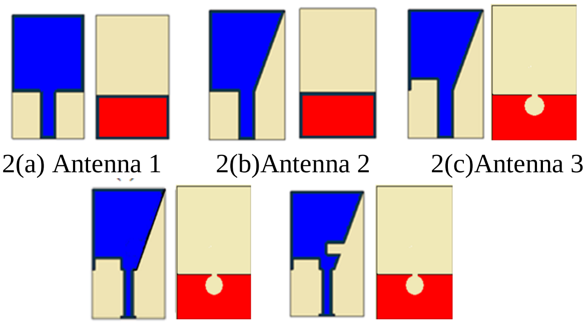
Despite many advantages offered by the UWB technologies, multipath propagation and fading degrades the performance of the system by decreasing the signal to interference ratio of the information signal. This issue can be mitigated by adopting diversity scheme. Diversity improves the reliability of the signal by receiving the replicas of the information signal through multiple paths.

Section II of this paper presents the design, evolution, and development of the proposed UWB antenna and eight port diversity antennas. The simulated and measured impedance characteristics, vswr, radiation patterns and diversity characteristics of both unit cell antenna are discussed in Section III. Section IV concludes the manuscript.

II.DIVERSITY ANTENNA CONSTRUCTION

A.Evolution of a Unit Cell

The proposed compact monopole antenna is shown in Fig. 1. The compact nature of the antenna enhances the capacitance in the feed point. To counterfeit this, effective inductive loading is done. The radiator of the antenna is a modified rectangle and it is printed on 1 mm thick FR4 substrate with dielectric constant 4.3 and loss tangent 0.025. The area occupied by the monopole antenna is 14 × 24 mm^2.



2(a) Antenna 1 2(b)Antenna 2 2(c)Antenna 3
2(d) Antenna 4 2(e) Antenna 5

Fig. 2 describes the evolution of the designed monopole antenna. In Fig. 2(a), the antenna is a simple rectangle shaped radiator and a ground plane of length *'g'*. The length *'g'* is so chosen to achieve good impedance matching throughout the entire frequency range. The rectangular radiator is tapered, as in Fig. 2(b), to enhance the impedance bandwidth through inductive loading. Further bandwidth enhancement is achieved by introducing a rectangular slot in the radiating plane of the antenna as shown in Fig. 2(c). Further, the capacitance between the radiator and the ground plane is decreased by etching out a small portion of the radiator close to the feed point. This leads to the introduction of new modes centered around 3.5 GHz, 6.4 GHz and 10.7 GHz. For better impedance matching of these modes a hexagonal slot, as illustrated in

Fig.2(d) is introduced to the ground plane. The electrical length of the antenna is increased by creating a slot on the tapered radiator, as delineated in Fig. 2(e), which results in increased bandwidth and better impedance matching when compared to the former antenna. The ground structure of both antenna remains the same whereas the front view varies for both antenna. After this cut at the radiator, we will get the structure of the unit cell which can be used for diversity applications.The reflection coefficient characteristics of the various stages evolved with the design of proposed UWB monopole antenna in both rectangular plot and 3d rectangular plot is shown in Fig. 3.

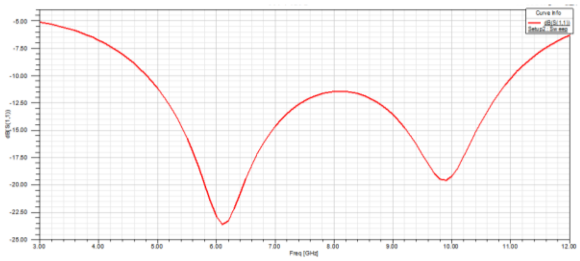


Fig. 3(a). Reflection coefficient of antenna1.

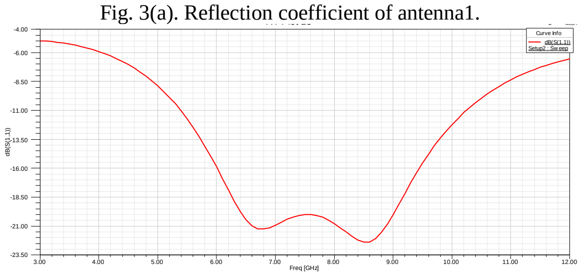


Fig. 3(b). Reflection coefficient of antenna2.

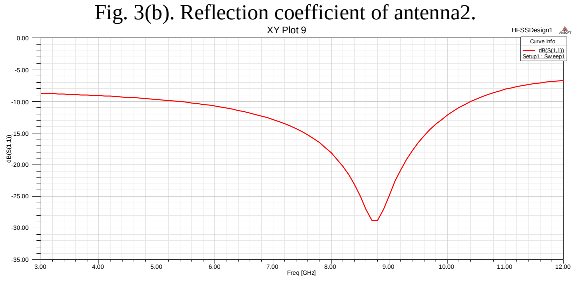


Fig 3©. Reflection coefficient of antenna3.

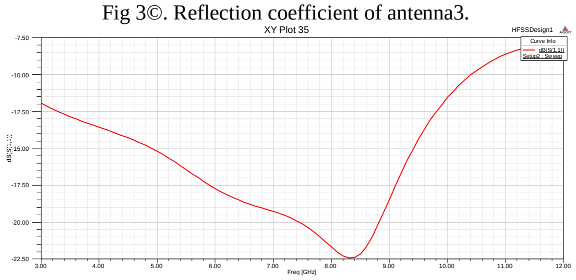


Fig 3(d). Reflection coefficient of antenna 4

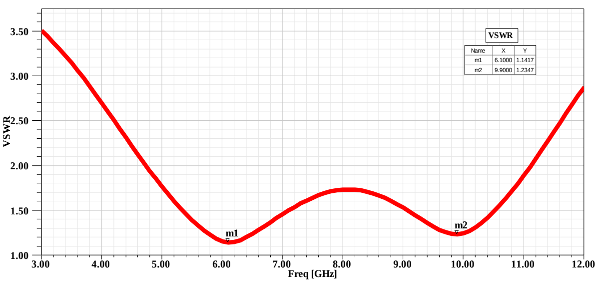


Fig 4(e). Reflection coefficient of antenna 5

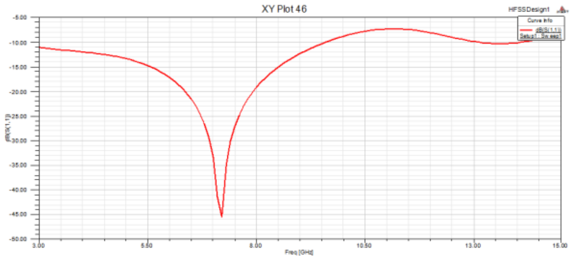


Fig 4(f). VSWR of antenna 1

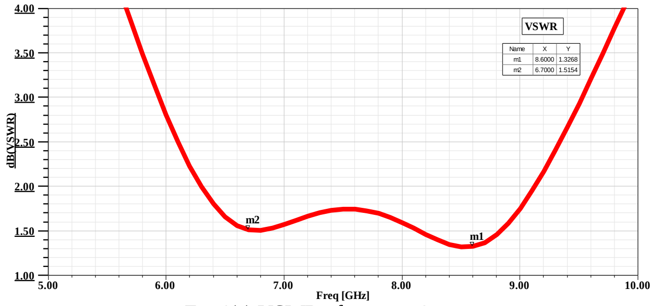


Fig 4(e) VSWR of antenna 2

III. RESULTS AND DISCUSSION

The results of the two antennas are simulated for various output variables and are observed. The various output variable includes vswr, gain, radiation pattern and s parameters. Fig. 3 depicts the measured and simulated results of reflection coefficient characteristics of the proposed unit cell UWB antenna. The decrement in the capacitance is done to provide broadband impedance matching as shown in Fig. 3, makes the antenna resonate from 2.9 GHz - 12 GHz. The effect of the ground plane modifications and loading is to broaden the resonances and to reduce their peak resistance. The VSWR characteristics of the various stages evolved with the design of proposed UWB monopole antenna in both rectangular plot is shown in Fig. 4.The gain characteristics of the various stages evolved with the design of proposed UWB monopole antenna in both polar plot is shown in Fig. 5.

IV. CONCLUSION

A compact UWB monopole antenna is presented which is suitable for high speed communication. Each element of the compact UWB MIMO antenna is realized by using stepped slots that are fed by microstrip line. The measured results match reasonably well with the simulated results and shows that the proposed diversity architecture is a suitable model for dense MIMO systems with additional degrees of freedom, channel capacity and mean signal energy.

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