

An Effective Way to Utilize the Neutralization Line and DGS for Improving the Isolation and Miniaturization of Two-Port Antenna

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Abstract—This paper presents a miniaturized two-port antenna with high isolation (between the antenna elements) utilizing a neutralization line (NL). The proposed antenna with the defected ground offers good impedance matching and supports further miniaturization. The spacing between the antenna elements is 0.16λ . The unconnected neutralized lines work as a decoupling element for the antenna, which offers the opposite current w.r.t. the ground current, hence diminishing the surface current. The proposed two-port antenna offers an impedance bandwidth from 5.65 GHz to 5.9 GHz with isolation higher than 23 dB.

I. INTRODUCTION

Wireless communication performance in a multipath channel can be improved using multiple-antenna elements at the transmitter and receiver [1]. There has been a need for compact antennas for wearable and portable communication. In a multi-element antenna, when the space between the antenna is less than the conventional distance ($\lambda/2$), the mutual coupling increases, which produces a serious impact on the antenna performance. The mutual coupling (MC) of the antenna with the adjacent antenna can be reduced by several decoupling techniques, such as conventional distance [2], slot-array [3], defected ground [4], and neutralized line [5], which can be used to reduce the surface current between adjacent antenna elements. A half-loop antenna as a radiator is used in [2], and in the ground, it is used to reduce the antenna size, where the distance between adjacent antennae is used to mitigate the coupling. A two-port microstrip antenna is designed with a slot-array introduced on the ground [3]. Asymmetric feed, a modified circular radiator with a slot is used to design a miniaturized antenna by [4] where a defected ground is used to reduce the MC. In [5], the circular patch is placed on a flexible substrate with edge-to-edge antenna distance of 7 mm, where the neutralized line is attached to the patch to generate the opposite current of the coupling current and improve the isolation. In this work, the miniaturized antenna is designed with the suspended unconnected neutralized line to keep in mind the compact multi-element antenna for portable and wearable applications for WLAN/ISM applications.

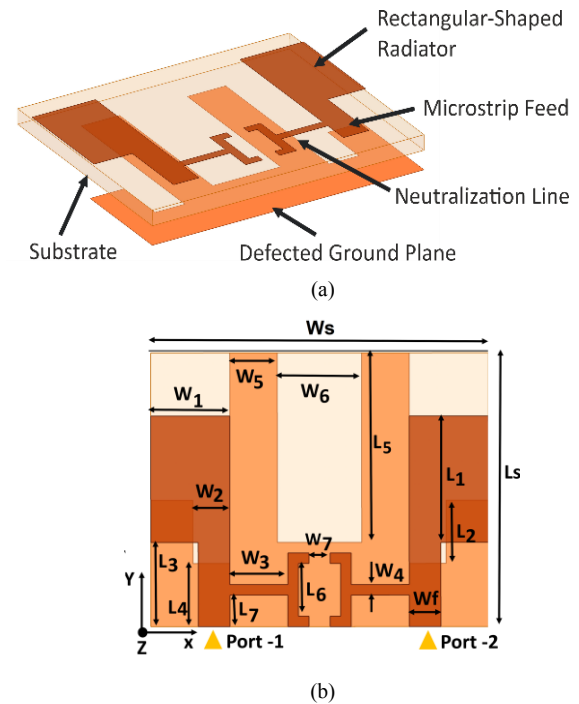


Figure 1. Proposed UNL integrated Two-port antenna (a) perspective view (b) top view and dimension in mm, $W_f=1.5$, $L_s=13$, $L_f=6$, $W_s=16$, $W_1=3.75$, $L_2=3$, $W_2=1.75$, $L_3=4$, $W_3=2.75$, $L_4=3$, $W_4=4$, $W_5=2.25$, $L_5=6$, $W_6=4$, $L_7=1.5$, $W_7=1$

II. IMPLEMENTATION OF NEUTRALIZATION LINE AND DGS IN TWO PORT ANTENNA

The perspective and top view of the proposed two-port antenna are depicted in Fig. 1. The overall dimension is $0.3\lambda_0 \times 0.24\lambda_0$ (Where λ_0 is lowest operating frequency), which is designed on an FR4 substrate (thickness (t) = 0.8 mm, $\epsilon_r = 4.4$). The rectangular-shaped radiator is used with defective ground to improve the impedance matching of the two-port antenna. The spacing between the antenna elements is $0.16\lambda_0$, which causes strong coupling current in the ground from one antenna element to another. Therefore, to improve antenna isolation and miniaturization, an unconnected neutralization line (UNL) is introduced on the microstrip feed, which reduces the surface current without increasing the antenna size. The UNL length is approximately $\lambda_0/8$ of the lower operating frequency.

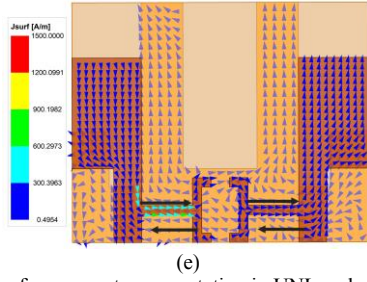


Figure 2. Surface current representation in UNL and ground plane

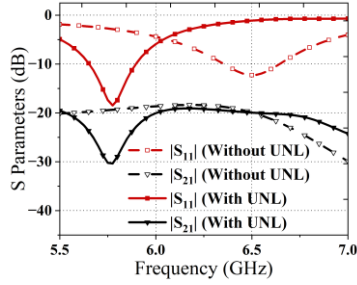


Figure 3. S parameter of the Two-port Antenna

Initially the rectangular-shaped radiator is designed with defected ground, which offers an impedance bandwidth from 6.35 GHz to 6.65 GHz, where the isolation ($|S_{21}|$) is higher than 19 dB. The UNL integrated on the microstrip feed works as a decoupling element for the antenna and offers the opposite current w.r.t the ground current as shown in Fig. 2. UNL improves isolation by weakening the surface current and simultaneously miniaturizing the antenna by shifting its frequency to a lower frequency. The proposed two-port antenna with UNL offers an impedance bandwidth from 5.65 GHz to 5.9 GHz with isolation higher than 23 dB as shown in Fig. 3.

III. RESULTS AND MEASUREMENTS

The fabricated prototype of two-port antenna is shown in Fig. 4(a). The HFSS is used for simulation of the two-port antenna and it is measured to verify the obtained simulation results where S-parameters is depicted in Fig. 4(b). A minor variation is observed in the simulated and the measured results due to soldering intolerance. Simulated realized gain varies from 2.6 dB to 3.8 at Theta = 90° and Phi = 180° as shown in Fig. 4(c). The normalized radiation pattern is depicted in Fig. 4(d), showing the stable far-field characteristics.



(a)

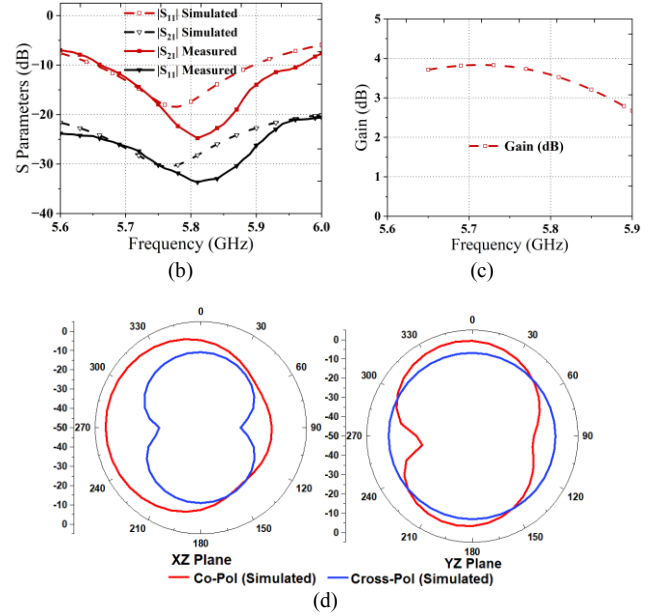


Figure 4. Results of Two-port antenna (a) Fabricated prototype (b) S-parameters (c) gain (dB)(d) radiation pattern at 5.75 GHz

IV. CONCLUSION

In this paper, the two-port antenna has been miniaturized to improve the isolation by utilizing the neutralization line. The unconnected neutralized line generates opposite current w.r.t. the ground current and weakens the mutual coupling. The maximum port isolation is 30.5 dB at 5.75 GHz, while the antenna offers bandwidth from 5.65 GHz to 5.9 GHz. The proposed antenna operates on the ISM band and can be used for wearable and biomedical applications.

ACKNOWLEDGMENT

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