Evaluation of Modeling Accuracy of Reconfigurable Patch Antennas

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Abstract-Evaluation of frequency reconfigurable patch antennas for multi-standard personal communication systems, using PIN diodes as switches. Two different configurations are studied with dual-band behavior: a patch antenna with two switchable slots; and a rectangular patch with a switchable parasitic element. One of the objectives is to evaluate the reliability of the simulation software to design and predict the performance of reconfigurable antennas with embedded active elements. These antennas were fabricated and the measured results show good agreement withthe simulations. Each of the designed antennas enable electronic switching of the operating frequency, while maintaining good input impedance match and stable radiation characteristics.

Index Terms- Reconfigurableantennas,multifrequencyantennas, PIN diodes, switches, modeling accuracy.

I. INTRODUCTION

Frequency reconfigurable antennas are very attractive in wireless communication systems, because they enable to accommodate more than one service in the same antenna. The resonant frequency adjustment is accomplished by changing the shape of the radiating element. Micro strip antennas are widely used to provide reconfigurability due to their advantages of low profile, lightweight, low fabrication cost, and ease of integration with RF devices. The drawback of the more basic printed antenna designs is its narrow impedance bandwidth characteristic. The frequency band selectivity can be achieved by controlling the state of switches inserted in the antenna, which can be PIN diodes or RF MEMS. The switches can encompass several functions on reconfigurable antennas, for example modify the antenna feed location and, therefore, adjust the resonant frequency control the electrical length of slots placed along the patch connect or disconnect several elements in antenna arrays or, similarly, connect parasitic elements to the radiating patch in order to increase the total length of the antenna.

The first antenna configuration is basically consists on a patch antenna with two slots incorporated, each one closed by a switch near the center. When the switches are in the off-state, the currents flow around the slots and the average length of the current path is the longest and hence the antenna resonates at the minimum operating frequency. Conversely, when the switches are turned on, some of the electric currents flow through the switches, the length of the current path decreases and the resonance frequency increases.

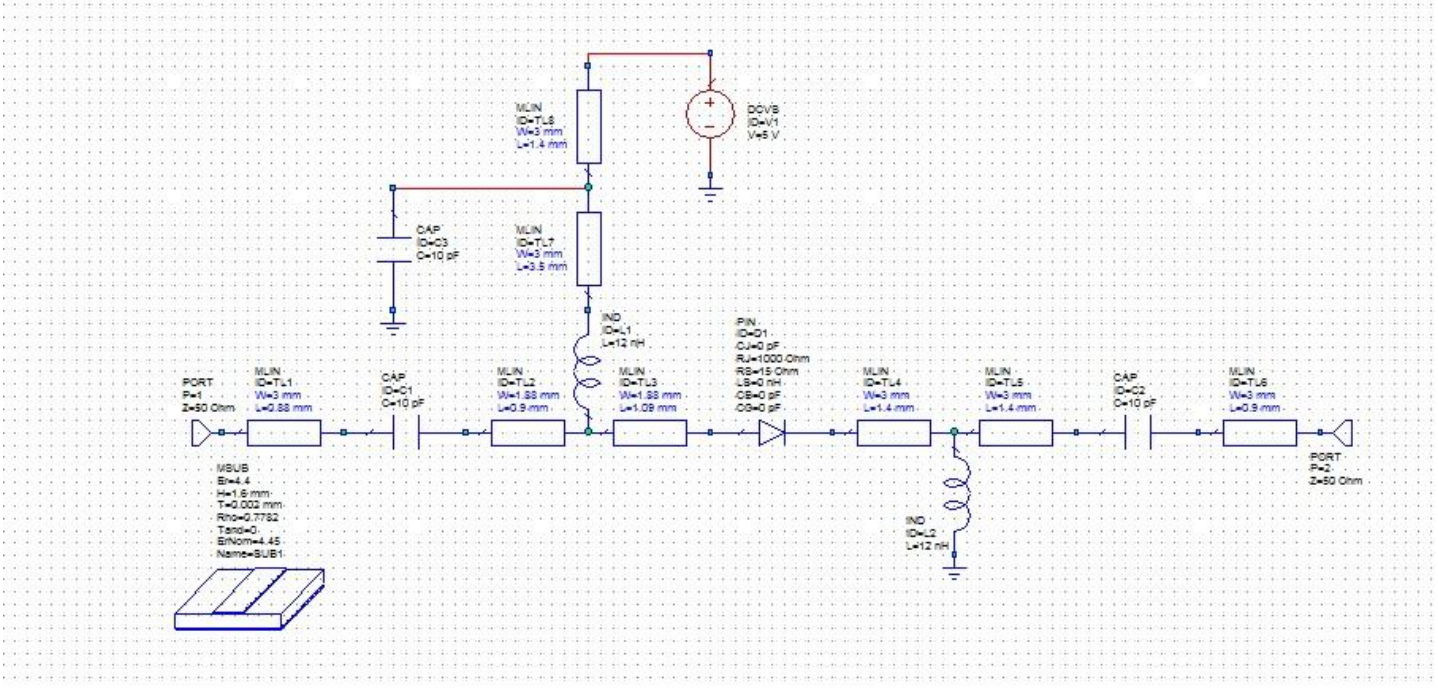
The second antenna configuration is patch with an inscribed rectangular slot fed with a coaxial probe in the inner patch. When the switches are turned off, the resonant frequency is basically defined by the inner patch, although, due to the proximity, the parasitic element produces some influence in the antenna operation. In the closed configuration, the switches connect the parasitic element to the radiating element thus increasing the antenna size, consequently lowering the resonance frequency. Simulations showed that at least four switches are needed on this antenna, in order to obtain a good match for both operating frequencies

II . Research Elaborations

When the switches are in the off-state, the currents flow around the slots and the average length of the current path is the longest and hence the antenna resonates at the minimum operating frequency. Conversely, when the switches are turned on, some of the electric currents flow through the switches, the length of the current path decreases and the resonance frequency increases. RF MEMS switches are being used instead of PIN diodes, especially at frequencies of operation above 1.89 GHz to 2.37GHz. For this reasons, the next step is to replace the PIN diodes switches by RF MEMS and reduce the number of active and passive elements in the antennas.A reconfigurable microstrip patch antenna with switchable slot has been designed, fabricated, and measured. The antenna has been designed to work at two operating frequencies with small frequency ratio. The effects of the feeding position, slot lengths, and slot position on the return loss, bandwidth, and frequency ratio are needed to be observed.

The Performance of the micro strip antenna depends on its dimension. Depending on the dimension the operating frequency, radiation efficiency, directivity, return loss and other related parameters are also influenced.The basic antenna structure

consists of a square radiating stub, a feed line, and a ground plane with a rectangular slot. The proposed antenna is connected to connector for signal transmission.



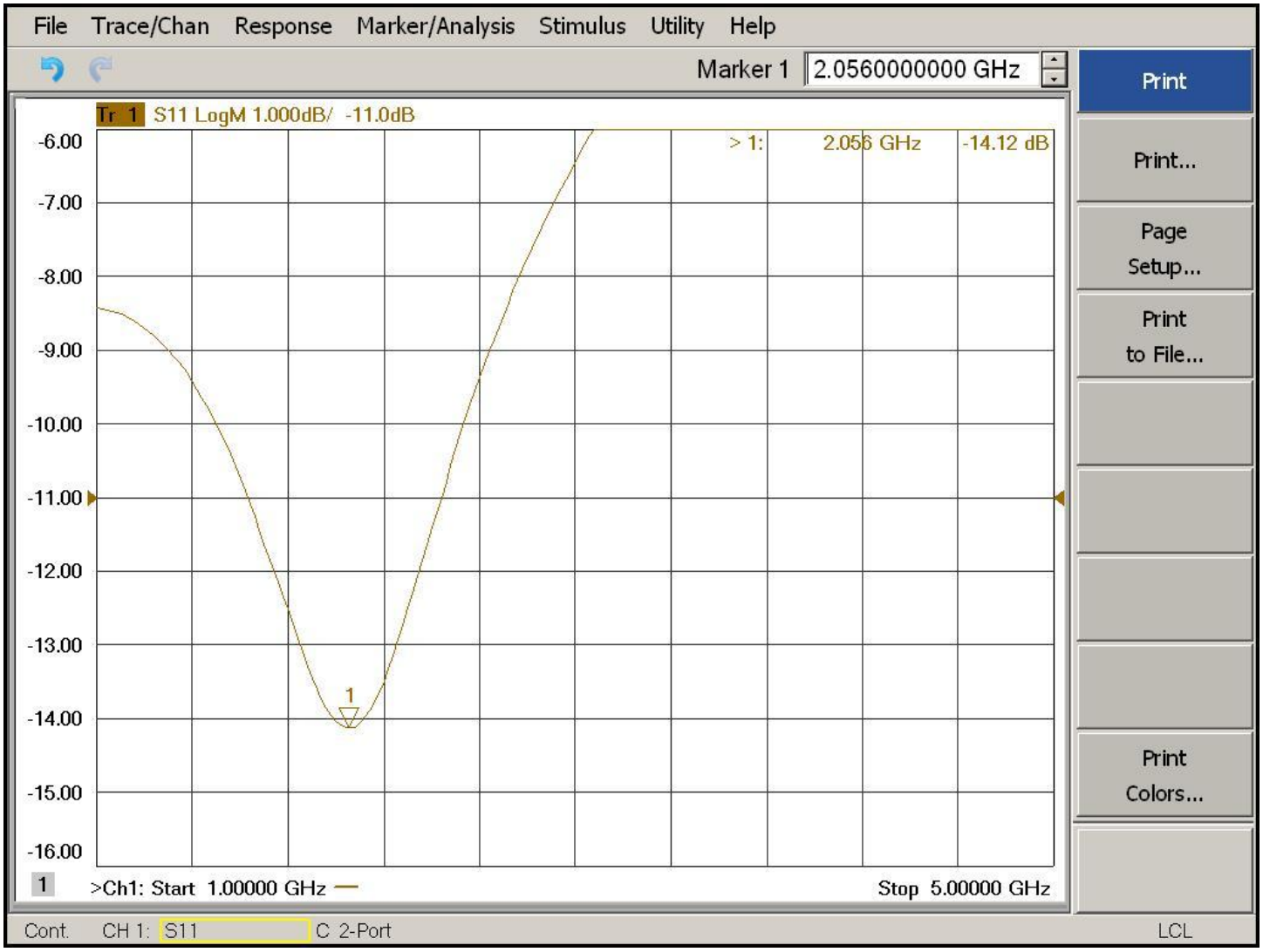
PIN diode circuit

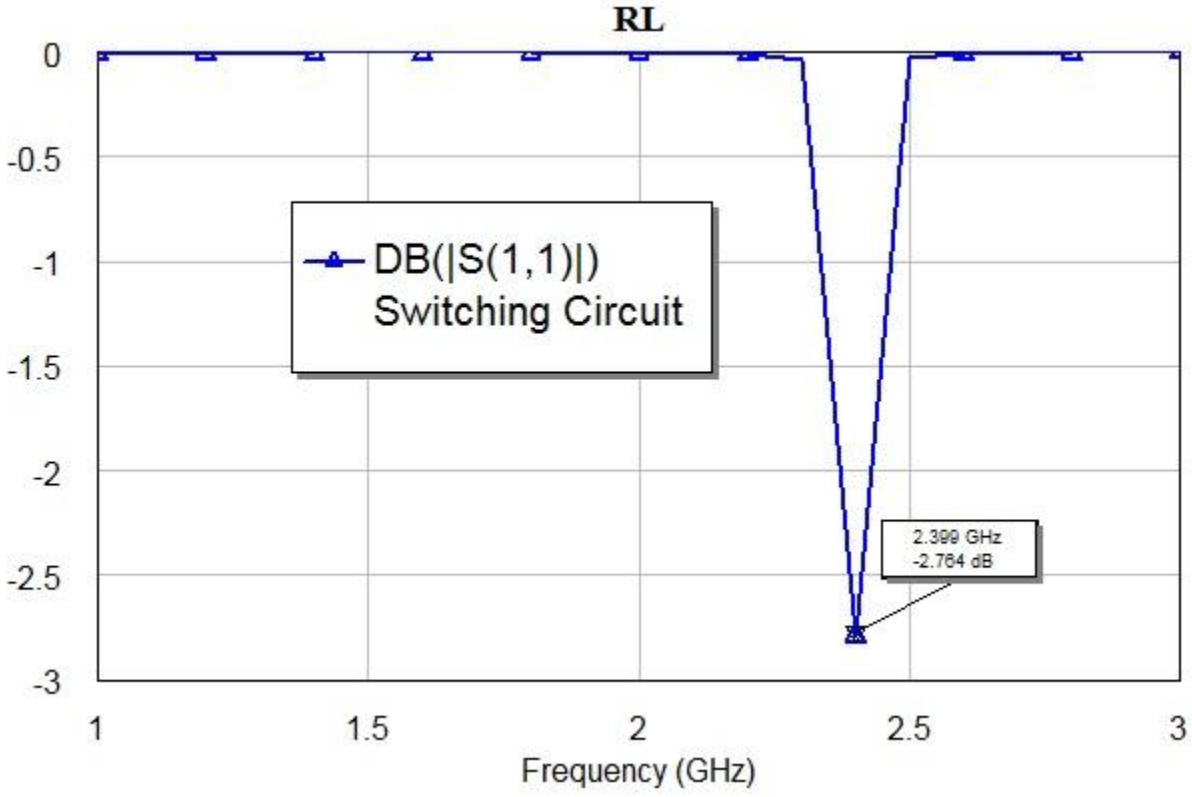
In computer simulation, these PIN diodes, DC blocking capacitor, RF choke inductor are modeled using the resistance, inductance, and capacitance (RLC) model. The PIN diodes are modeled as capacitors in the off state and resistors in the onstate. The datasheet of the PIN diode provides the value of the capacitance and the resistance which are in the range of 0.2pF −0.55pF and 1.5Ω−9Ω, respectively. Its value depends on reverse voltage or forward current applied. As a result of extensive parametric study, it has been obtained that the PIN diode is modeled as capacitance with 0.2pF in offstate and resistance with 1.5Ωin onstate. Thevalue of RF choke inductor is 1μH and the capacitor is 10nF. We used entirely 11 DC blocking capacitors, 10 RF choke inductors and 10 PIN diodes on the antenna. Off state between antenna with biasing line circuit as seen on and the conceptual antenna as seen on. It is shown that there is slight change in resonance frequency about 4.97%. The simulated results for several combinations of active switches arepresented and summarized −10dB. It is shown that the operating frequency can be reconfigured accordance to combination of onswitches is applied. However, the measured results are different from the simulated results due to soldering imperfection in antenna fabrication.

Use of Simulation software

1. IE3D Software
2. Antenna Test Unit
3. Vector Analyzer

III. Results or Finding





IV. Conclusions

This works presents the simulated and measured results of reconfigurable slotted micro strip antenna. It is shown in simulation that the operating frequencies can be tuned within 1.28 GHz to 2.92 GHz by using combinations of active switches. Therefore, it has been proven that the reconfiguration of the operating frequencies can be achieved by changing the slot length on the
Antenna by turning onor offthe switches in certain combinations.

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