A New Reconfigurable Meander Line Antenna

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***Abstract*—In this paper we present a new reconfigurable meander line antenna. The antenna is a non uniform meander line with five turns. A p-i-n diode is used as a switch to connect and disconnect parts of this antenna, allowing it to tune its operating frequencies between 4G LTE and other wireless communication applications. The position of the p-i-n diode is optimized to achieve tuning between various wireless communications applications of interest to mobile devices. The antenna with its compact size is designed, built and measured where analogy is found between the measured and calculated data.**

I. INTRODUCTION

The rise of new wireless communication applications has pushed designers to develop antennas that cater for ,both, the existing and new applications, simultaneously. This trend in wireless communications is accompanied with the rise in need for reconfigurable antennas that can reconfigure their structure and redistribute their fields.. Reconfigurable antennas have been proposed using RF switches such as p-i-n diodes, RF MEMS or Varactors. The fast switching characteristic of these switches allow reconfigurable antennas fast tuning and adaptability to changes in the operational environment.

A reconfigurable pixilated antenna is designed in [1] for Multiple Input Multiple Output (MIMO) channels operation. This antenna resorts to RF MEMS to achieve beam forming, pattern and polarization diversity. A varactor based reconfigurable PIFA antenna is proposed in [2] for mobile devices. The antenna resorts to two varactors to tune between GSM, UMTS, PCS and WIMAX applications. Another planar inverted E antenna (PIEA) [3] resorts to a p-i-n diode to cover applications such as 4 G LTE as well as other mobile wireless communication applications.

Meander lines are proposed to achieve a smaller, more compact antenna for mobile devices. In [4] a multi band monopole using a meander structure is proposed for mobile devices. The reconfiguration of meander line antennas preserves the compact antenna size feature while allowing frequency tuning, operation reconfigurability, and multi-functionality. In this paper we present a new reconfigurable meander line antenna. This antenna resorts to one p-i-n diode to switch between various wireless communications applications and the various bands of 4G LTE.

II. ANTENNA STRUCTURE AND DESIGN

The antenna proposed herein is a non-uniform meander line. It is composed of five turns of microstrip lines, and the dimensions of each turn are optimized by simulation. The antenna structure consists of three layers: the full ground plane (40 mm × 40 mm) constitutes the bottom layer, an FR4_epoxy substrate (□r = 4.2, tanδ = 0.02, thickness = 3.2 mm) constitutes the middle layer, and the microstrip meander lines constitute the patch at the top layer. A Coaxial probe feed is used to feed the antenna. The feeding position is optimized using HFSS. The antenna dimensions are optimized to achieve the desired operation. The space distance between each vertical line is optimized to be 2mm. The width of each meander line is 1mm. A rectangular feeding patch is added to the design in order to enhance the matching of the antenna. Fig.1 shows the geometry of the proposed patch with its corresponding dimensions.

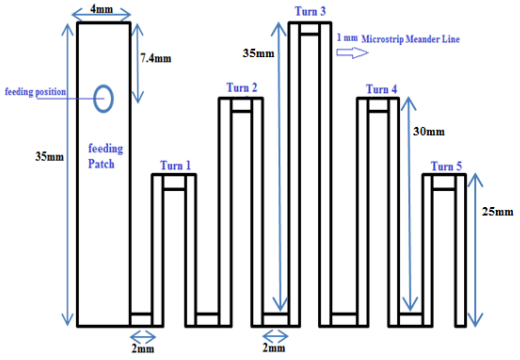

Fig.1 The meander line patch

One of the target frequencies of this antenna design is the 4G LTE band 3 (1710 MHz-1880 MHz). However in order to cover this application a wide band operation at these frequencies is required. Thus the height of the substrate is chosen to be 3.2 mm for improved bandwidth. One p-i-n diode (BAR 64-03W) [5] by Infineon is used to reconfigure the antenna. The position of the p-i-n diode is optimized to allow frequency tuning in the desired bands. Fig.2 shows the simulated antenna with the p-i-n diode position.

III. ANTENNA RESULTS

The antenna is simulated with an actual p-i-n diode model. When the switch is activated the antenna covers operations at applications such as 4G LTE Band 3, GSM, GPS, and WiMAX. When the switch is OFF, the antenna operates at WLAN and WiMAX.. The measured antenna frequency tuning is shown in Fig.3 between the two operating states of

the switch. It is important to note that the reflection coefficient threshold is considered at -6 dB instead of -10 dB for the application of this antenna. A comparison between the X-Z plane cuts of the measured and simulated radiation pattern at 3.5 GHz when the switch is ON is shown in Fig.4.

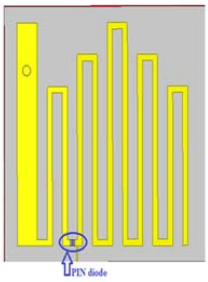

Fig.2 Patch with p-i-n diode position

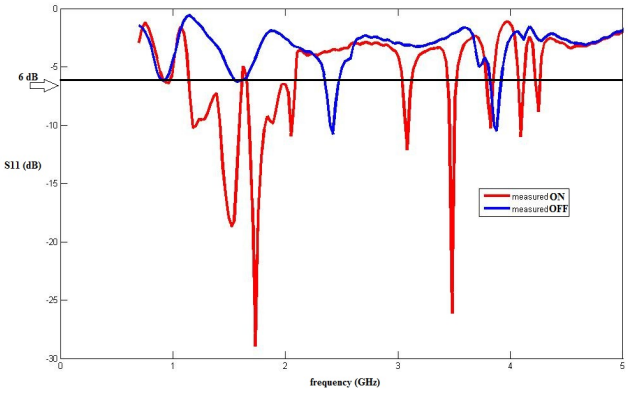

Fig.3 Themeasured antenna reflection coefficient for when the switch is ON and OFF

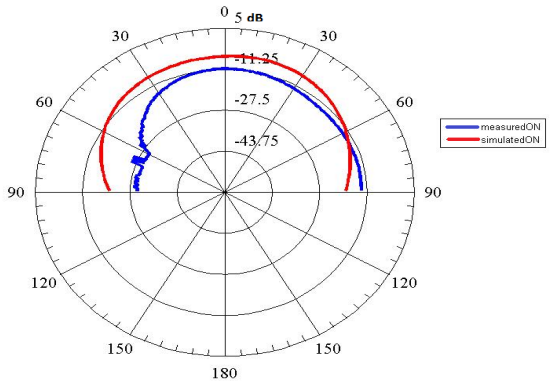

Fig.4 A comparison in the X-Z plane cuts of the radiated field at 3.5 GHz when the switch is ON

IV. SWITCH BIASING

One of the most challenging tasks when designing a switch reconfigurable antenna may be to successfully bias the switch while preserving the normal antenna operation. The switch used herein is a p-i-n diode [5] by Infineon. The antenna is first fed through a bias tee that mixes both RF and DC signal to feed the antenna and get the DC signal to the p-i-n diode. The DC signal is generated by a constant current driver that generates constant current for variable load and the RF signal is generated by the network analyzer. The anode of the p-i-n diode receives the DC signal while the cathode is connected to the ground of the antenna through an inductor that acts as an RF choke. Thus it prevents the RF signal from crossing into the ground while biasing the switch. The equivalent circuit of the bias tee is shown in Fig.5.

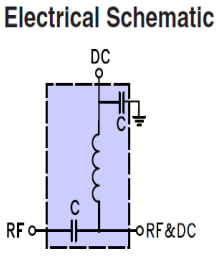

Fig.5 Equivalent bias tee circuit

V. CONCLUSION

In this paper we present a new switch reconfigurable meander line antenna. The antenna is proposed for mobile devices since it achieves operation at 4G LTE and other wireless communication applications. An actual p-i-n diode is incorporated into the antenna structure to achieve function tuning between various applications. The antenna is simulated and measured and analogy is found between measurements and simulations.

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