A New Reconfigurable Antenna based on a Rotating Feed

J. Costantine, C. G. Christodoulou
The University of New Mexico, Albuquerque, NM 87131
Email: jmc08@ece.unm.edu

Abstract— In this paper a new reconfigurable antenna technique is investigated. The technique revolves around rotating slots engraved into the patch of a microstrip antenna. By rotating the slots the antenna feed is being indirectly rotated resulting in a different antenna response for each slot position. The reconfigurable properties and advantages of this technique are demonstrated and discussed herein. Several examples and cases are presented to discuss the flexibility of the new approach.

Introduction

Several techniques have been used in the past to achieve reconfigurability in an antenna. Most techniques are based on using switches either in the form of MEMS switches or diode switches [1-5].

In [1] a fractal antenna with RF MEMS switches was used to obtain a reconfigurable antenna that radiates similar patterns over a wide range of operating frequencies. In [2] a series of pin diodes switches constitute the fundamental structure of the antenna. The tuning of the antenna is realized by literally changing its electrical length, which is controlled by the bias voltage of the solid state shunt switches along the slot antenna. In [3] the minimum number of RF MEMS was investigated and was used to achieve a reconfigurable antenna structure on a flexible substrate. New types of devices used to make an aperture antenna reconfigurable are discussed thoroughly in [4]. In [5] neural networks were used to program reconfigurable array antennas.

Here we present a new reconfigurable antenna design approach. The approach does not use switches and is based on a simple rectangular slot rotation concept. As the slot is rotated through various angles the antenna exhibits different functionality. A prototype antenna was designed and built in order to investigate the versatility of the new reconfigurability approach.

Antenna Structure and Functionality

The basic structure of the antenna shown in Fig.1, consists of 3 layers. The lower layer, which constitutes the ground plane, covers all the substrate (width 3cm and length 7.5 cm). The middle substrate has a dielectric constant ε_r=4.4 and height of 0.16cm. The upper layer, which is the patch, consists of a rectangle of 1.5cm × 2cm joined with an isosceles triangle (base=1.5 cm and height h=4 cm).

Inside the rectangular patch ten rectangular slots that follow a Chebychev distribution around a center rectangular slot, were inserted. Also, inside the triangular patch a triangular slot of base =0.75 cm and of height 0.6062 cm is inserted. The major radiating elements are the rectangular Chebychev slots. This

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antenna as presented in Fig.1 has a lot of practical applications as shown in Fig.2. It is useful in applications such as wireless video links, military and marine communications, 802.11b/g/n, wireless LAN, Bluetooth applications, WIMAX, security and surveillance applications.

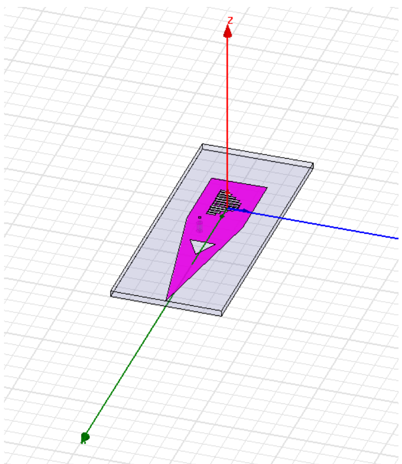

Fig.1: Antenna 1 structure

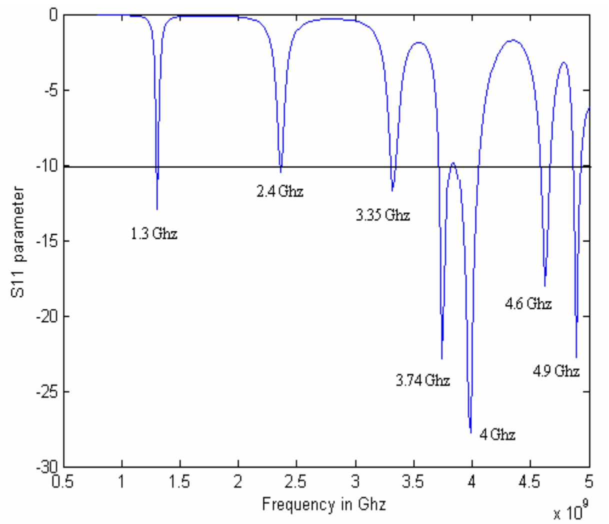

Fig.2: The antenna S11 parameter results

Antenna Reconfigurability

It is known that any slight change in the physical configuration of the antenna will result in a change in the current distribution leading to new resonances and new functions. Based on this fact and keeping the same feeding position the Chebychev slots were rotated CCW by different angles. For every angle the antenna exhibits different resonant frequencies. The rotation of the slots CCW is shown in Fig.3.

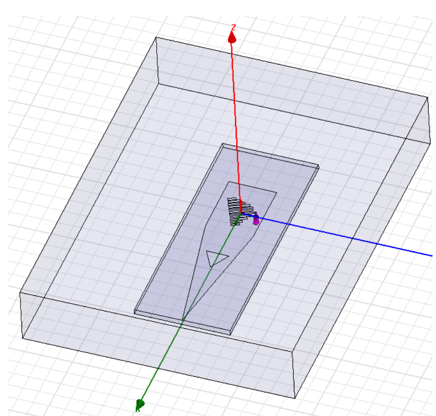

Fig.3. Rotation of the Chebychev slots

This slot rotation results in accurately tuning the antenna as shown in Fig.4. This tuning is exhibited by the shift of the resonant frequencies from one frequency into another resulting in different antenna resonances for each slot position. In Fig.4 the rotation from 230˚ to 270˚ is studied over a frequency range from 600 MHz till 5 GHz.

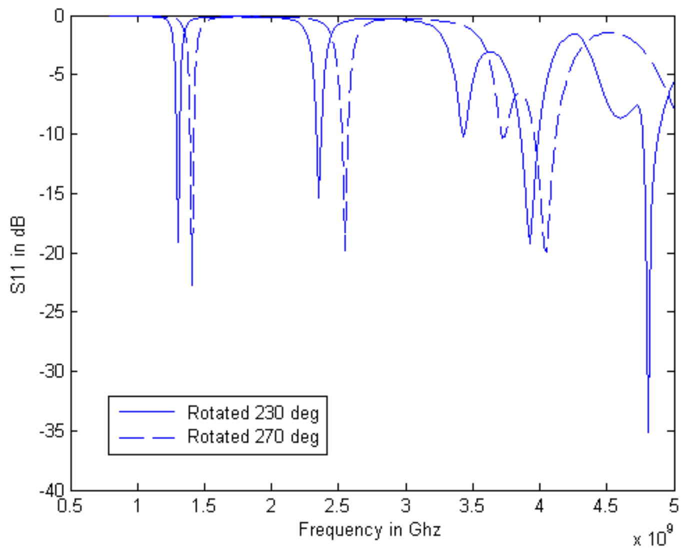

Fig.4. Antenna tuning by rotating the Chebychev slots

The fabricated antenna is shown in Fig.5. The testing of the antenna took into consideration the whole frequency spectrum from 50 MHz to 20 GHz. The S11 results of the fabricated antenna are shown in Fig.6. One can see the tuning of the antenna for different slot positions. The antenna showed reconfigurability for all slot rotations. The results shown in Fig.6 are for the initial position or 0˚, then for the positions at 90˚ and 270˚.

Conclusion

This paper presented a new reconfigurable antenna technique. This technique does not make use of any switches that are usually used in traditional techniques like switches or RF MEMS. It is an alternate way that may lead to new configurations for reconfigurable antennas in the future. We expect to control the rotation of the slots using FPGAs or any other programmable device that will take care of this rotation process. Future work will be concentrated on optimizing this new technique and apply it to other antenna structures.

Fig.5.Fabricated antenna

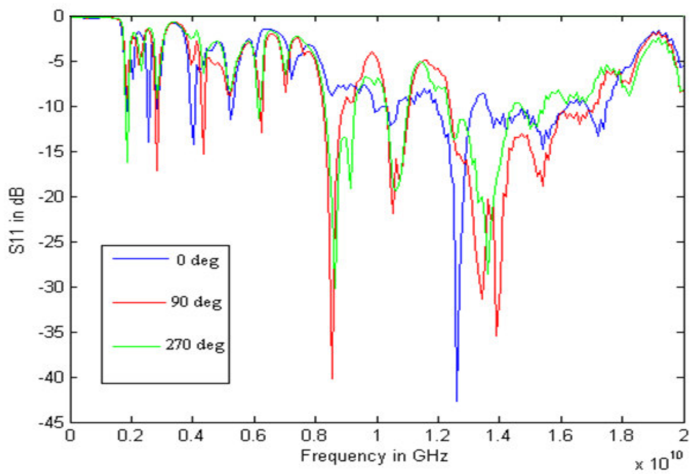

Fig.6. Tuning of the fabricated antenna

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