Performance of Full Azimuth Beam Switching Antenna System

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***Abstract*—A novel concept of Beam Switching Antenna is presented working at 5.8 GHz. The system is composed of reconfigurable 6-ways Radial Power Divider (RPD) and Yagi Uda monopole antenna arrays. Varactor diodes are used in each RPD port which act as switcher allowing or blocking the propagation of the common input power to the corresponding output. As a result, six beams are generated covering full azimuth plane with 10 dBi gain. The proposed structure is suitable for future Gigabit WIFI applications at 5 GHz Band.**

Keywords— Beam Switching Antenna, Reconfigurable Power Divider, Single Pole 6 Throws, Yagi Uda Antenna.

I. INTRODUCTION

Beamforming is seen to be the future strategy to increase channel capacity and improve the signal to interference/noise level for future wireless communications using sectorisation approach [1]. Phased antenna arrays are mostly employed in different configurations to steer the radiation pattern and are divided in two categories: Adaptive and Switched Beam Antenna (SBA) arrays [1-2]. However, these configurations cover only an area of 180° due to the Planar Printed Circuit Board (PCB) technology used on the antenna to achieve a maximum of directivity [3].

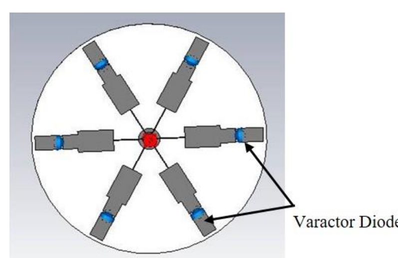
Recently, many studies are interested to ensure 360° coverage of azimuth plane using Frequency Selective Surface (FSS) by controlling plane or surface electromagnetic waves [4-6]. The first concept consists on surrounding an omnidirectional source by using active cylindrical Partially Reflective Surface (PRS), which reacts with a Transverse Electric (TE) plane wave, [4]. However, the switched beam can only be achieved by controlling the surface waves by using active High Impedance Surface (HIS) printed inside the substrate wherein a patch antenna is printed [5-6]. In [2], the authors presented a design of a reconfigurable Radial Power Divider (RPD) using active HIS where PIN diodes are used to control the distribution of electromagnetic waves inside reconfigurable RPD. Mushroom like unit cell is introduced for the periodic surface which is composed from a large number of active elements connected to vias [2-6]. This technique behaves such as a parallel-plate waveguide [2] which needs a large surface to block the propagation of surface waves and has bulk dimensions.

In order to avoid using of HIS structures, a new simple and low cost planar RPD is proposed. It is composed of a coaxial probe, which excites the structure, and six microstrip output lines loaded by tunable devices adjusting power distribution of RPD.

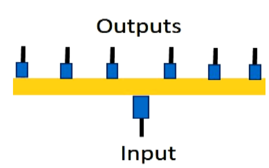
II. RECONFIGURABLE 6-WAYS RADIAL POWER DIVIDER

A radial power divider is a passive device which splits the input power in N ways with same amplitude and phase [7]. The switching system is created by adding active elements in each output to control of the power distribution. In this work, the idea consists to create a Single Pole 6 Throw (SP6T) switcher from RPD to feed antenna arrays and thus ensuring switching operation.

The number of outputs is set to be six due to the recent studies which demonstrated that the division of azimuth plane into six sectors can enhances the capacity of channel better than conventional techniques (Omnidirectional and Tri Sectors) [3,6-8].



(a)



(b)

Figure 1. Reconfigurable 6-ways Radial Power Divider: (a) Top view (b) Side view.

The proposed reconfigurable RPD is presented in Fig. 1. Unlike PIN diodes number reported in [2], only six varactor diodes are used in this design.

Fig.2 illustrates the scattering parameters of the proposed 6-ways RPD.

From the curves, isolation levels of deactivated ports are greater than 15-dB while insertion loss S_{21} is 3-dB at 5.8 GHz.

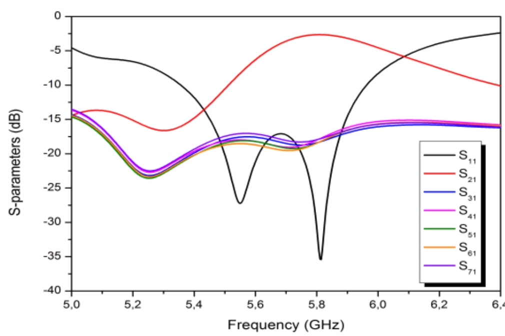


Figure 2. S parameters of Reconfigurable 6-ways Radial Power Divider.

III. . BEAM SWITCHING ANTENNA SYSTEM

The whole switching beam antenna system is made by the proposed SP6T connected to six Yagi Uda monopole antenna which are shown in Fig.3.

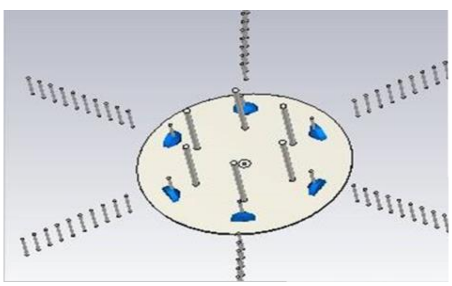


Figure 3. Yagi Uda Antenna array.

The return loss of the proposed system is presented in Fig.4. A bandwidth of 600 MHz (from 5.5 GHz to 6.1 GHz) is achieved.

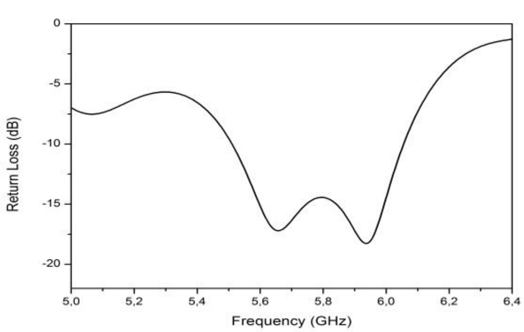


Figure 4. Return Loss.

Six beams with 3-dB beamwidth of 70° are generated by the proposed system covering full azimuth plane according to results presented in Fig.5. It is worthy to mention that the same performances could be obtained with only few active elements compared to that used in [4, 5].

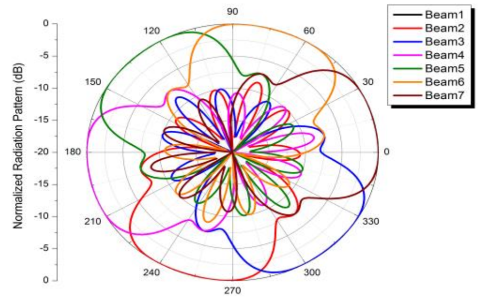


Figure 5. Six Switched Beams.

IV. CONCLUSION

In this paper, a beam switching antenna has been designed at frequency 5.8 GHz. In this concept, a planar reconfigurable radial power divider loaded by six varactor diodes is used to make a compact SP6T in simple way. Simulated results are provided showing good performance in terms of isolation and insertion loss. Then, six Yagi Uda monopole antenna arrays are connected to SP6T to build Switched Beam Antenna. As results, six beams with 10 dBi gain scan the entire azimuth plan in six steps. The proposed antenna with these features can be used in base station applications.

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