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DESIGN AND ANALYSIS OF LOW COST TRANSMISSION LINE PHASE SHIFTER

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Abstract--- *This paper presents simple and low cost transmission line phase shifter. A Microstrip patch array antenna of 2X1 resonating at 2.6 GHz frequency with transmission line feeding is designed. Also the FR4 dielectric substrate of dielectric constant 4.4 and thickness 1.6 mm is used. Modification in transmission line feeding technique is done in order to achieve different phase shift values as compared to conventional path array antenna. The phase shifter is provided using different lengths of transmission line feeding. HFSS simulator tool is used to design the different lengths in transmission line to achieve different phase shift values.*

Keywords: Phase shifter, Beam steering, Antenna array, Transmission line feeding, HFSS

1. Introduction

The radiation pattern is generally very broad and the directivity is relatively low in single element patch antenna [1]. There are many techniques to overcome this problem like, enlarging the size of the element, going for array structure etc [2]. Many antenna system applications require that the direction of the beams main lobe be changed with time, which is known as beam steering [3]. This is usually done by mechanically rotating in a single antenna or an array with fixed phase to the element. However mechanical scanning requires a positioning system that can be costly and scan too slowly. For this reason, electronic scanning antennas which are known as phased array antennas are used [4]. It can sweep the direction of the beam by varying electronically the phase of the radiating element, there by producing a moving pattern with no moving parts. Phased array antennas are known for their capability to steer the beam pattern electronically with high effectiveness, managing to get minimum side-lobe levels and narrow beam widths. Normally phase shifters are the devices in a phased array antenna that allow the radiated beam to be steered in the direction [5]. Depending on the manufacturing method, phase shifters can be classified into the following categories; mechanical phase shifters, ferrite phase shifters, semiconductor device phase shifters and transmission line phase shifters [6]. In this paper electronic beam steering is achieved by using the transmission line phase shifter that provides the best results at low cost.

2. Proposed Transmission line phase Shifter

A array of 2 X 1 rectangular Microstrip patch antenna operating at 2.5 GHz frequency is designed using FR4 dielectric substrate having dielectric constant 4.4 and thickness of 1.6 mm. the optimized patch length and width are 36.5 mm and 27.5 mm respectively. The substrate length and width are 193 mm and 73.6 mm respectively. By providing small delay line for the length of transmission line feeding in 2 x 1 Microstrip antenna we obtained different phase shift values. A $+20^0$ phase shift is achieved by taking length of delay line 50.4mm in right side as in Fig.1. similarly a -20^0 phase shift is achieved by taking length of delay line 46.4 mm in left side as in Fig.2. -

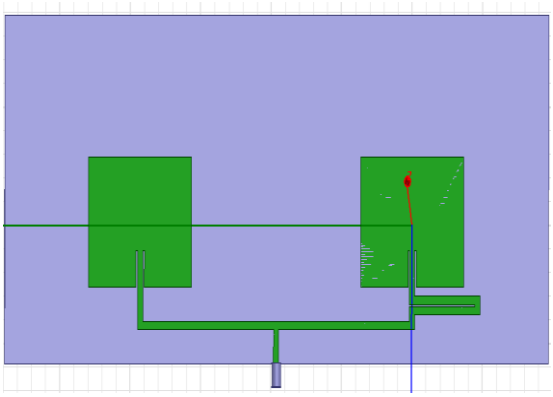


Fig 1.microstrip patch array antenna with transmission line phase shifter of $+20^0$

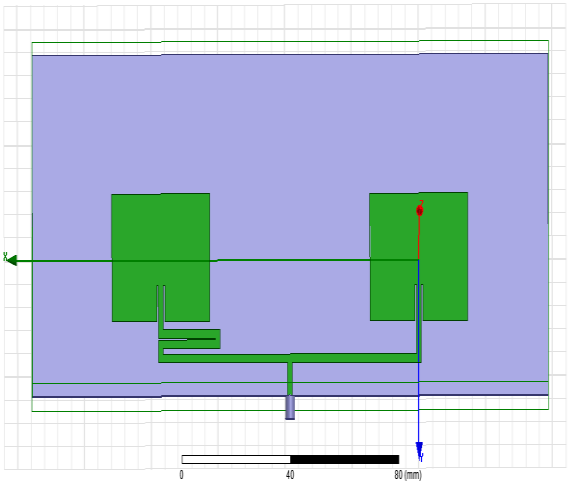


Fig.2. microstrip patch array antenna with transmission line phase shifter of -20^0

3.Results

Fig.3.shows return loss plot for array antenna with +20^0 phase shifter structure, which operates at 2.6 GHz operating frequency. In Fig. 4. Red line indicates the +20^0 phase shift value as compared to conventional array antenna which is indicated in blue line. It also indicates that there is around 4.8297dB gain obtained for this proposed antenna.

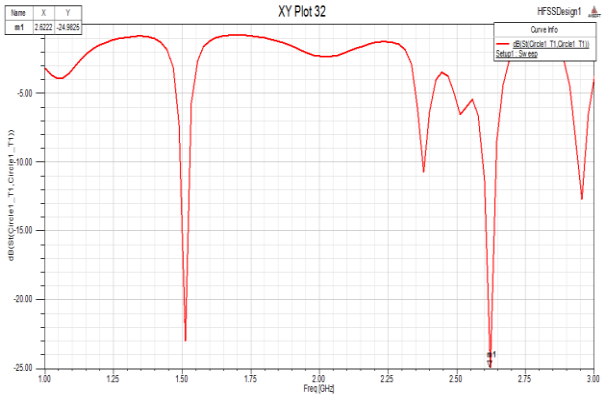
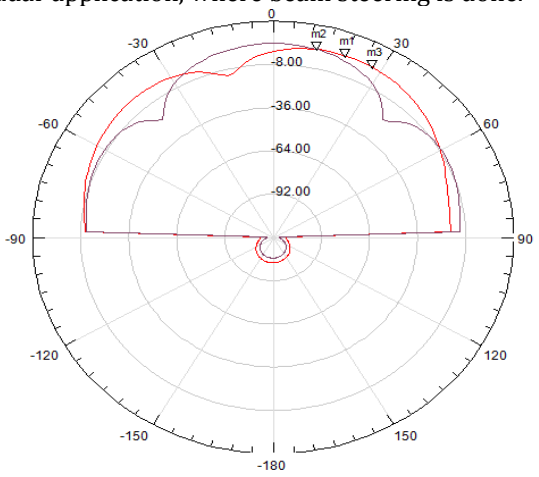


Fig.3. Return loss plot for phase shifter of +20^0

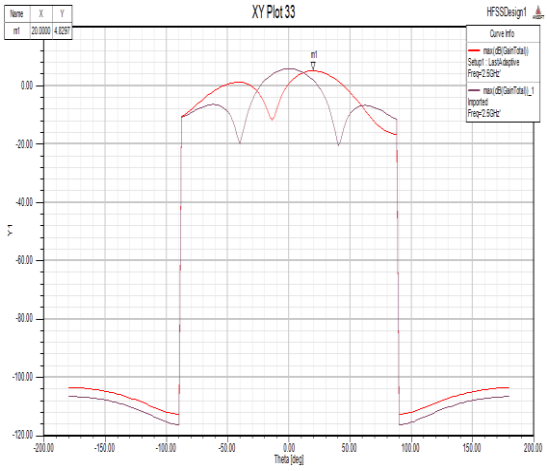
Fig.5.shows return loss plot for array antenna with -20^0 phase shifter structure, which operates at 2.6 GHz operating frequency. In Fig. 6. Red line indicates the -20^0 phase shift value as compared to conventional array antenna which is indicated in blue line. It also indicates that there is around 5.0095dB gain obtained for this proposed antenna.

4. Conclusion

In this paper +20^0 & -20^0 phase shift is achieved using transmission line feeding technique which is low cost & simple. By varying the length of transmission line we observed phase shift as compared to conventional patch array antenna but there is no change in operating frequency & gain of the antenna. The proposed antenna system can be used in radar application, where beam steering is done.



(a)



(b)

Fig. 4. (a) Radiation pattern (b) Reactangular plot of array antenna with phase shifter of +20^0

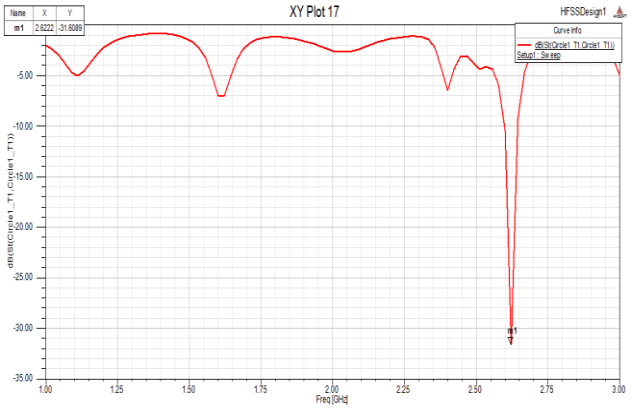
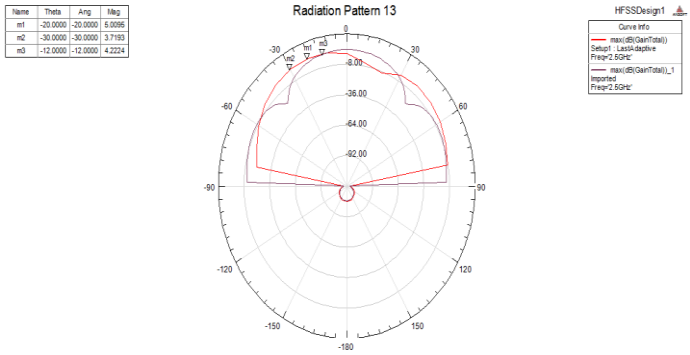
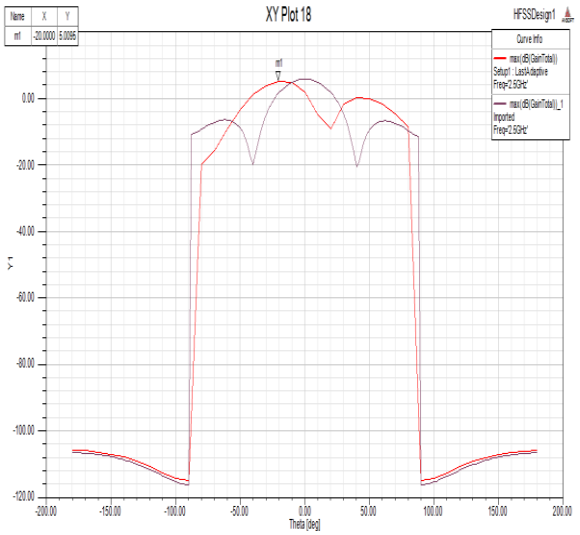


Fig.5. Return loss plot for phase shifter of -20^0



(a)



(b)

Fig. 6. (a) Radiation pattern (b) Reactangular plot of array antenna with phase shifter of -20^0

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