AN ELECTRONICALLY SCANNABLE WIDEBAND LEAKY-WAVE ANTENNA USING VARACTOR DIODES

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Abstract: This paper presents an electronically scannable, dual beam, slot line leaky-wave antenna with high frequency scannability and fixed frequency beam steering in the H-Plane. The proposed log periodic design of the slot lines is so selected that it will suppress the dominant mode and radiate the first higher order mode and provides a wide resonating impedance bandwidth. Varactor diodes embedded between the slot lines and ground plane can improve the scan angle and allows fixed frequency beam steering by varying the bias voltage of the varactor diode. Experimental results using HP8510c Vector network analyzer shows that the structure is giving a frequency scannability of about 20° over the resonating band. The scanning angle of the proposed antenna can be controlled at fixed frequency by integrating the varactor diode into the radiating slots and varying it bias voltage.

Key Words: Beam Steering, Log Periodic Slots, Leaky wave antenna.

I. INTRODUCTION

Antenna beam steering can be effectively implemented by making use of the frequency scannability existing in leaky-wave antennas, which has been implemented with microstrip technology in recent years [1,2,3]. The Frequency scannable leaky-wave antennas found coast effective in systems like low cost radars, side looking sensors in vehicles and imaging because phase shifters and associated circuit elements are not required to steer the antenna beam [4]. The fixed frequency scannability is often preferable to frequency scannability in certain applications where narrow frequency band is available and wide angle of coverage is required [5]. The leaky-wave antenna presented here is both frequency scannable and fixed frequency scannable suitable for integrated array applications.

Here we present the outcome of the experimental study of log-periodic slots loaded leaky wave antenna (Fig.1), which has the excellent advantage of wide bandwidth and beam scanning properties. The antenna provides wide bandwidth of about 21.36 % and has frequency scannable pencil beam in the H-Plane, which is also scannable at fixed frequency by varying the reverse bias voltage of the varactor diodes embedded at the radiating slots.

II. ANTENNA DESIGN.

Figure 1 shows the proposed log-periodic slots loaded, leaky-wave antenna configuration. The antenna dimensions were optimized using Zeland IE3D for higher frequency scannability in the higher order mode. The eleven slot leaky wave antenna (LWA) is etched on a printed circuit board with dielectric constant $\varepsilon_r = 4.2$ and thickness d = 1.6mm. Design ratio (τ) of the log periodic structure is varied from 0.6 to 0.9 and optimized experimentally for bandwidth. In order to provide fixed frequency beam steering, the antenna is loaded with

varactor diodes at the radiating slots. Electromagnetic coupling through a 50Ω feed line is used to excite the proposed antenna.

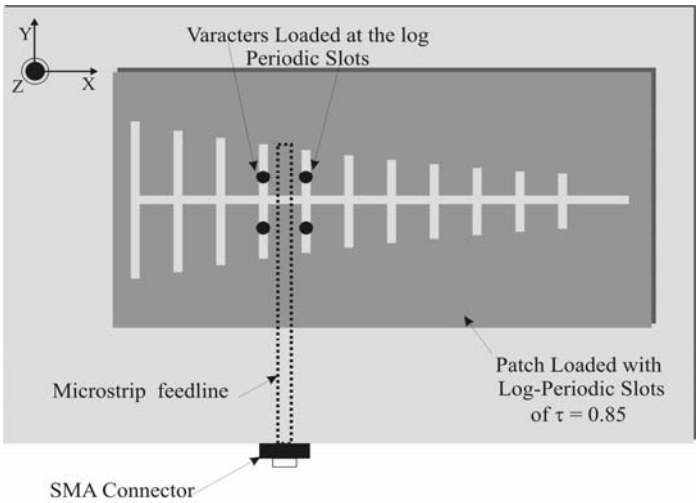

Fig 1. The Geometry of the proposed Leaky Wave Antenna

III. EXPERIMENTAL RESULTS

The proposed log-periodic, leaky wave antenna is studied experimentally using vector network analyzer HP8510C. The design ratio, τ, of the log-periodic slot line structure is varied for different values from 0.6 to 0.9. The measured return loss characteristics of the leaky-wave antenna is depicted in Fig 2, It is found that for τ = 0.85 the antenna exhibits a wide bandwidth of about 21.36% over the -10dB resonating band from 4.6GHz to 5.7GHz.

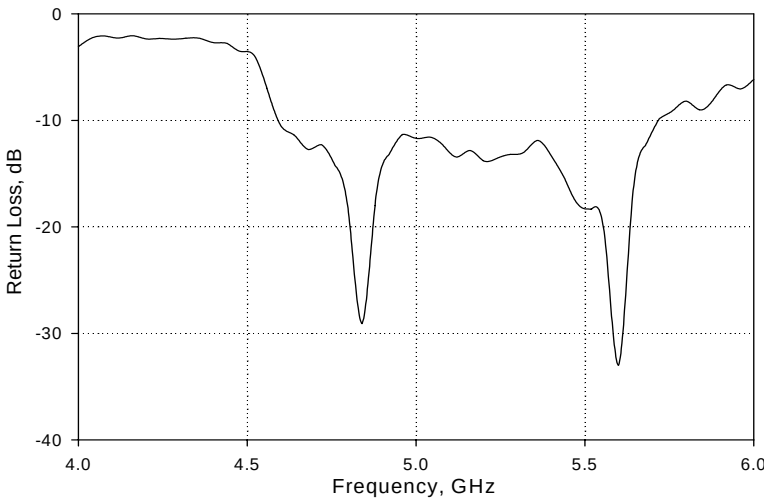

Fig 2. Return loss of the log-periodic slots loaded leaky-wave antenna

The frequency scannabilityof the proposed antenna is depicted in fig 3. The antenna has a frequency scannability of about 20° while the reverse bias voltage of the varactor is 30v in the resonating band. The impedence band width and frequency scannability remains almost the same while varying the bias voltage

across the varactor diodes.

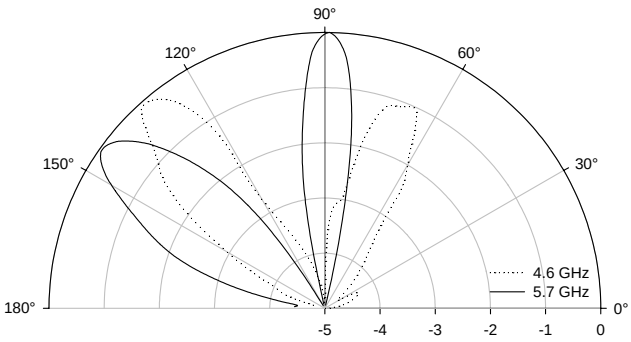

Fig 3: The experimental radiation pattern shows frequency scanability, with varactor bias voltage of 30 V

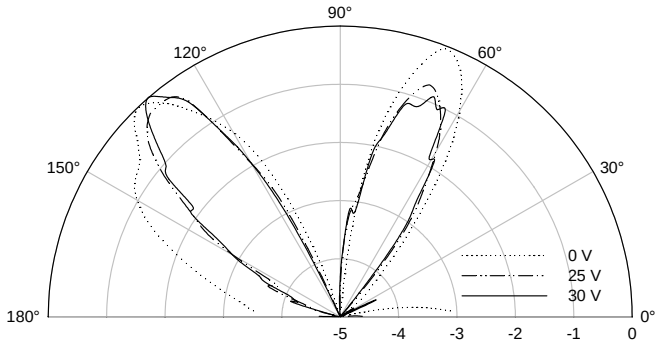

Fig 4: Fixed frequency beam steering at 5.2 GHz for different bias voltages

IV. CONCLUSION

A wide band, beam scanning, log-periodic slots loaded leaky-wave antenna which finds applications in side looking radars in automobiles or any type of low cost tracking systems is developed. The experimental analysis shows a wide band width of about 21.36 % over the resonating band of 4.6 to 5.7 GHz. The antenna exhibits a maximum frequency scannability of about 20° and a fixed frequency beam steering of 8° when the bias voltage is varied from 0 – 30 V.

V. REFERENCES

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