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PERFORMANCE ANALYSIS OF SMALL ANTENNA WITH SLOTTED MEANDER-LINE RESONATOR AND DEFECTIVE GROUND FOR WIRELESS APPLICATIONS

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ABSTRACT

Day by day with the increasing of demand for long distance communication resulting in requirement of many antenna elements on a single structure and if we do so there is a problem of coupling between those elements which reduces the antenna efficiency. So a new methodology to improve the isolation in micro strip patch antenna arrays is described through the implementation of a slotted meander-line resonator (SMLR) which is creating defect in the micro strip structure. The resonator is designed to suppress the surface current between the two patch antennas coupled along H-plane and operating at a frequency of 5 GHz which is used in microwave links and airborne RADAR applications. The configuration has been designed, simulated and validated experimentally.

Keywords: antenna arrays, isolation, coupling, antenna efficiency, surface current meander lines, resonators.

1. INTRODUCTION

In these days Isolation enhancement poses strong challenge in array antenna applications in the antenna community. A common substrate is used by antenna arrays, multiple antenna elements designed to operate at the same frequency. When there are many elements on a substrate there may be a reduction in antenna gain, operational bandwidth, and radiation efficiency [1] due to coupling between antenna elements which may significantly interfere with neighboring antenna elements. Therefore we need to overcome this coupling effect and to improve the Performance of the antenna array by choosing suitable method. Slotted meander-line resonators (SMLRs) are Proposed to be the decoupling unit that occupies smaller area when compared to Electromagnetic band gap structures [2] [5] [6]. The meander slot structure reduces the loading effect between the two patch structures because it acts as a band stop resonator [7].

We have also used the Defected ground structure (DGS) which are used to improve the Characteristics of the Antenna. The basic element of DGS is a resonant gap placed directly under a transmission line and arranged for efficient coupling to the line. Simple micro strip filters have Asymmetrical stop bands and the need for a more complex design can be avoided if DGS elements are used to improve stop band performance. Each one occupies different area, coupling coefficient and other electrical parameters. It is used for different applications in the design of micro strip antenna such as reduction of antenna size, as delay lines, to increase the decoupling effect and also to reduce the cross polarization effect. Defected ground is also used to achieve the required resonant frequency of the antenna [3] [4]. In the design we are using the shape of meander line as the defect on the ground and the etching of the meander shape gives the defected ground for the antenna.

2. DESIGN AND GEOMETRY

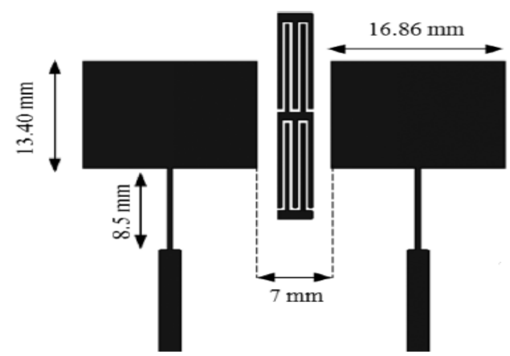

Figure-1. Proposed SMLR decoupling unit is placed in between two patch antenna elements.

SMLR placed in between two micro strip patch antennas which is seen in Figure-1. The slotted meander line structure as shown in Figure-2 is an electrical resonator because of the oscillation of currents induced within the slot. Those SMLR may be constructed eventually making defects in the micro strip structure. Due to the presentation of folded slots, those moderate wave factor through the micro strip increases, there by disturbing the current that streams through those micro strip structure. This makes a band-gap that blocks the surface currents and flows in full recurrence. This structure utilized as a decoupling unit acts like a band reject channel whose resonant frequency will be regulated by the length of the slot. To examine the execution of the SMLR, a substrate material with height 1. 6 mm and dielectric steady 4. 3 is used. Those SMLR is printed through this standard substrate, and the simulations are conveyed utilizing HFSS13. 0.

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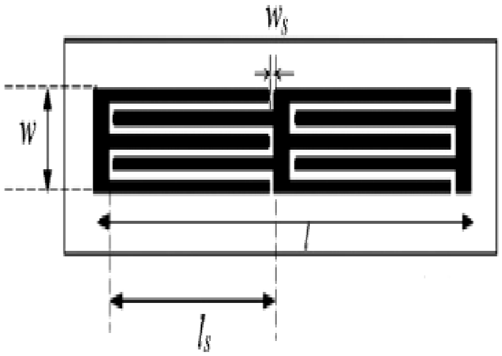

Figure-2. Two-element cascaded SMLR decoupling unit.

Table-1. Dimensions of Antenna in (mm).

Parameter	Size
L_s	11mm
W_s	0.375mm
W	3mm
L	25mm

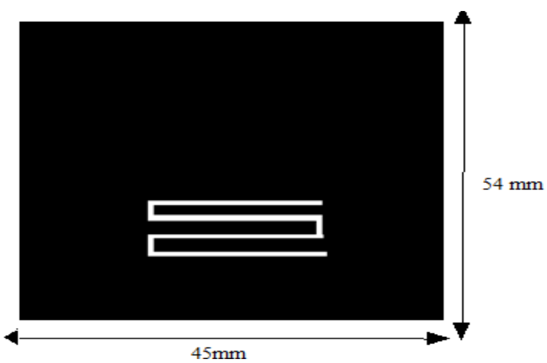

Figure-3. Defected ground structure.

To check that band-gap impact on isolation upgrade done on micro strip patch antenna arrays, a two-element array is constructed utilizing micro strip patch antennas fed through a quarter wave transformer. The patch antenna elements are computed for a operating frequency of 5GHz. The antennas are placed over a standard FR4 substrate of about 1. 6 mm height having a dielectric constant of 4.3 and loss tangent 0.023. The antenna elements are separated by an edge-to-edge separation of 7 mm. The aggregate size of antenna array is 54x45 mm^2. The SMLR is placed at the middle of the antenna elements had a minor impact on the operating frequency bringing on a small shift. This may be because of reality that the SMLR characterization and furthermore configuration about patch antenna array have been configured independently.

3. RESULTS AND DISCUSSIONS

Return loss is the principal parameter for any antenna to know the operating frequency, efficiency and operating bandwidth for making proto type of any antenna, it was design by using any simulator software. In this work Design and verification part implemented with HFFS.

3. a. Return loss

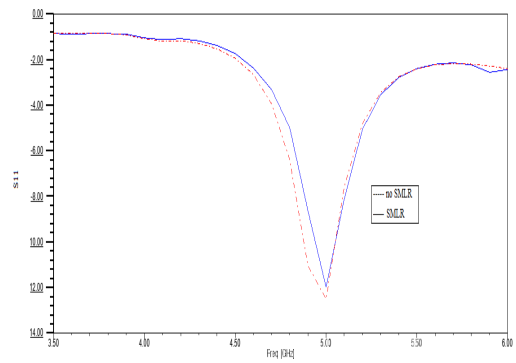

Figure-4. Simulated reflection loss characteristics of the antenna array with one antenna excited and another antenna terminated by 50Ω.

The reflection loss characteristic of proposed antenna shown in Figure-4 minimum return loss exist at a frequency of 5Ghz with a bandwidth of 0.26GHz.

3. b. VSWR

The standing wave ratio characteristic of the antenna is depicted in Figure-5.

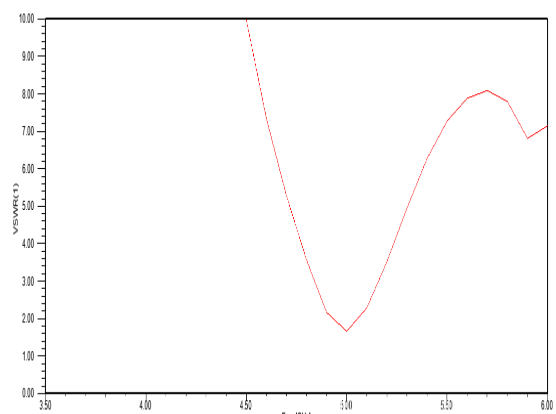

Figure-5. VSWR characteristics of the antenna array.

VSWR is the ratio of the peak amplitude of a standing wave to the minimum amplitude of a standing wave. Figure-5 shows the VSWR characteristics of the antenna array which has a magnitude of 1.6dB at resonating frequency which is reflecting 5% of the power and 95% of the power transmitting.

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3. c. Antenna gain

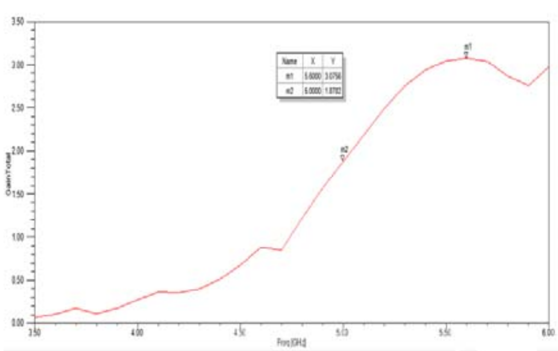

Figure-6. Gain of the antenna array.

The term Antenna Gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source. Figure-6 shows the gain vs frequency characteristics which show an array gain of 1.8dB at resonating frequency and a maximum gain of 3.07 at 5.6GHz.

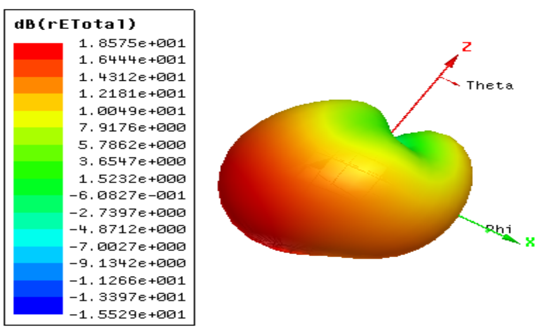

Figure-7. 3D polar plot.

In this case, a very little power is transmitted along the z-axis, which would correspond to the radiation directly overhead the antenna. In the x-y plane the radiation is maximum which is perpendicular to the z-axis

3. d. Electric field and surface current density

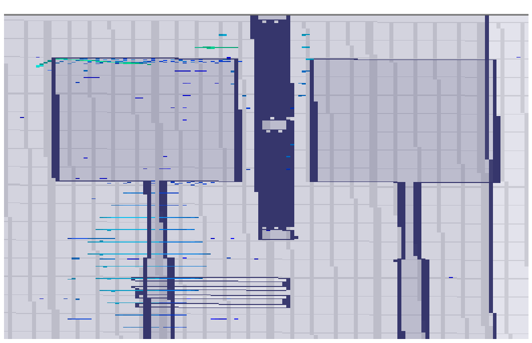

Figure-8. Electric field distribution of the antenna array.

Figure-8 shows the electric field of the antenna arrays where we observe the Electromagnetic wave propagation through the quarter wave transformer.

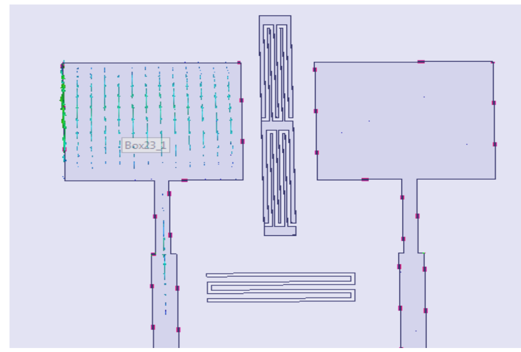

Figure-9. Current distribution of the antenna array.

Figure-9 shows the current distribution between the antenna elements which shows that there is no current passing beyond the SMLR unit as it isolates the flow of current.

3. e. Radiation pattern

Suitability of a antenna for a particular applications depends on its operating frequency and its parameters.

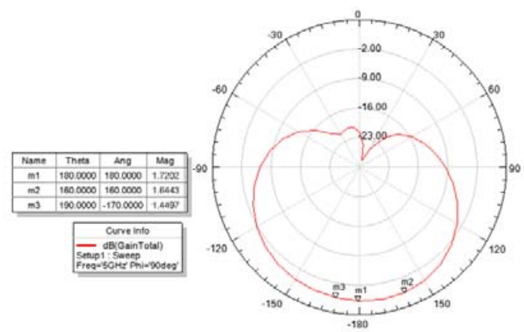

Figure-10. Horizontal Radiation pattern.

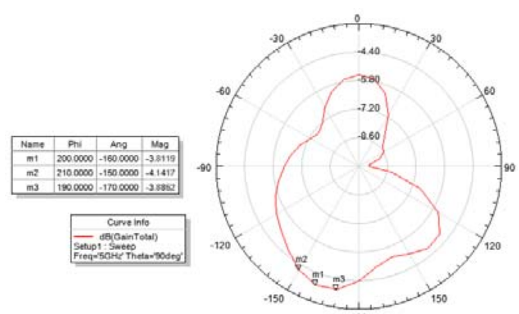

Figure-11. Vertical Radiation pattern.

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. The maximum radiation is at (ϴ=180) in Azimuth plane and (Φ=180) in Elevated plane.

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4. CONCLUSIONS

The isolation between two antenna elements using slotted meander lines is achieved using SMLR. The properties of SMLR are verified using band-gap analysis. The design shows the enhancement of isolation at the operating frequency with edge-to-edge spacing of 7 mm. The measured results justify the effect of the proposed SMLR on isolation enhancement and array size at 5GHz. The proposed antenna can be used in microwave links and airborne RADAR applications.

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