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Array Antenna for Wireless Applications

[1]Dr. Vaishali M. Dhede, [2]Vaishali V. Thorat

[1]Assistant Professor, Electronics and Telecommunication Engineering, Jaihind College of Engineering, Kuran, Pune, India

[2]Assistant Professor, Electronics and Telecommunication Engineering, D.Y. Patil School of Engineering, Ambi, India

[1]Corecponding Author's Email id: vaishali_dhede@rediffmail.com

ABSTRACT

This paper presents Array Antenna at 2.45GHz for wireless Applications. Here substrate integrated waveguide technique is used which is useful planer circuitry. A new design of array antenna was used to improve performance of antenna. The proposed array antenna has been design on FR4 substrate. It has overall size is 110 mm × 73 mm × 1.6 mm3. The proposed 2x1 antenna system with SIW operates at 2.5 GHz with a bandwidth of 60 MHz. The gain of a 2x1 patch antenna array is 6.7 dBi without SIW and 8.5 dBi with SIW. The proposed array Antenna has VSWR less than 1.4. The simulated outcome demonstrates how the enhanced antenna gain of the novel design technique for the 2x1 patch array. In comparison to the 2x1 array antenna design without substrate integrated waveguide, this result demonstrated a considerable improvement in Gain of 1.8 dBi. This proposed 2x1 patch array antenna is suitable for wireless applications.

Keywords : Array, wireless, gain.

I. INTRODUCTION

Antennas are used in both short- and long-distance wireless communication systems. When low power consumption and strong gain characteristics are required, long-distance wireless applications are where antenna arrays are most frequently utilised [1-2]. An antenna can be built utilising waveguide or microstrip technology. Due to its small size and simplicity of integration, microstrip is widely utilised; nevertheless, when frequency rises, undesired radiation appears in the microstrip circuit [3]. Due to its benefits, including its high density architecture, little insertion loss, cheap cost, high Q-factor, and ease of integration with planer and non-planer circuits, substrate integrated waveguide (SIW) technology has been put forth [4][5]. Filter [6], planar slot antenna array [7], power splitter [8], diplexer, and hybrid coupler [9] are only a few applications where SIW is widely utilised. The corporate feed method for the rectangular Patch array antenna is detailed in [10]. By using LTCC and PCB technology, it is simple to construct SIW structures, allowing them to work flawlessly with microstrip circuits. We may construct a full circuit in planar form using SIW technology, which is made up of a metalized via array and is ideally suited for the design and production of RF-wave integrated systems.

In this study, a new SIW implementation will be created to enhance the gain capabilities of microstrip antennas.

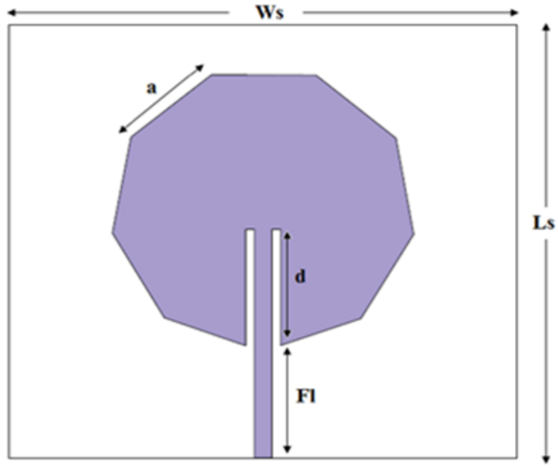
The 2.5 GHz frequency of WiMAX applications was considered when designing the antenna. In order to increase gain performance over earlier research, an array antenna with SIW was used in the development of the SIW design.

II. STRUCTURE AND DESIGN OF MICROSTRIP PATCH ANTENNA USING SIW

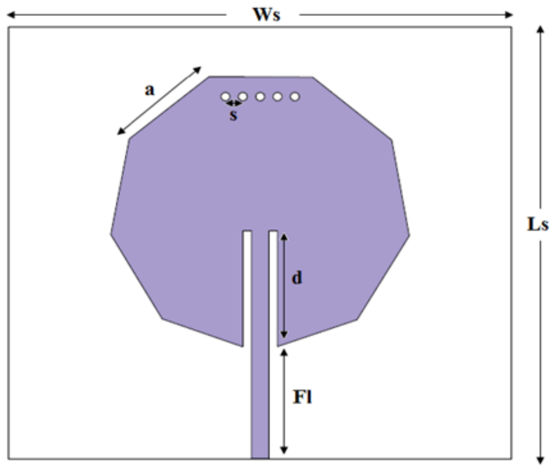
The single element nanogonal antenna with matching port created using SIW methods is shown schematically in Fig. 1. The SIW resonator is seen schematically in Fig. 1 and is made up of a bottom metal layer, a dielectric substrate, a top metal layer, and via holes that link the top and bottom metal layers. By substituting a section of the inserted microstrip line for the metal through at the bottom middle area, a conversion between the microstrip line and SIW resonator is realised. The coupling strength is influenced by the depth d at which the microstrip line is inserted into the SIW resonator. Superior coupling size and a higher SIW resonant frequency result from a larger depth d. When the distance between grounds through is significantly less than the wavelength, the fundamental capacity of the electromagnetic field is constrained inside the cavity. By using eq [1], the side length of a nanogonal patch antenna was computed.

$$a = \frac{2\lambda}{9 * \sqrt{\varepsilon_r}} \quad .... (1)$$

A two-element antenna array (2x1), which is an expanded version of a single nanogonal element antenna, is shown in Fig. 2. Antenna with two elements that is a two-element array of a single element antenna. The proper Microstrip T junction feeding network is included in the proposed nanogonal antenna array to reduce the spurious radiation. The feed network in this uses a microstrip T-junction power splitter and is symmetric to the horizontal axis, dividing input power evenly between the two arms. The simulated results demonstrate how significantly improved gain and directivity of the proposed nanogonal antenna array. The suggested antenna's substrate is 110 x 73mm, and the patch's nanogonal side length is 12mm.



(a) Without SIW



(b) With SIW

Figure 1: Geometry of single element microstrip antenna without and with SIW

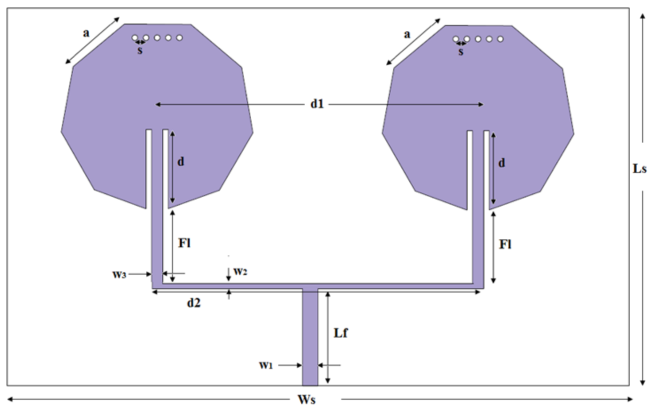


Figure 2: Geometry of Proposed 2x1 Nanogonal antenna array with SIW

The dimension Proposed of 2x1 Array Antenna with SIW as shown in table.

Table 1: Dimension of Proposed 2x1 Array Antenna with SIW

Parameters	Dimensions (mm)	Parameters	Dimensions (mm)
a	12.0	Ls	70.0
d	11.0	Ws	110.0
fl	14.0	Lf	18.0
W1	3.0	d1	1.8
W2	1.0	d2	6.0
W3	2.0	s	1.5

III. RESULTS AND DISCUSSIONS

The proposed 2x1 Nanogonal array antenna has been design using HFSS software. The simulated return loss of antenna with & with SIW techniques is shown in figure 3 Blue graph (without SIW) getting return loss -17.21 dB at 2.54GHz and Red graph (with SIW) getting return loss -23.45 dB at 2.53GHz. The excellent improvement in return loss using SIW techniques in patch array antenna.

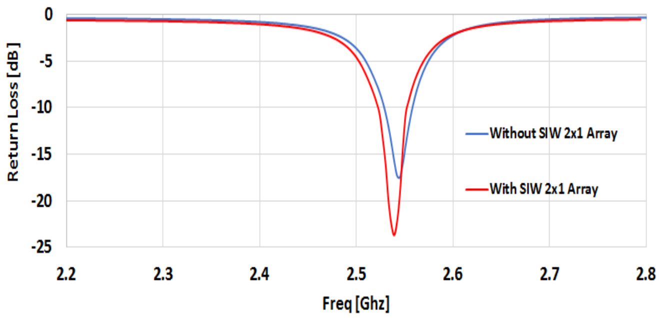
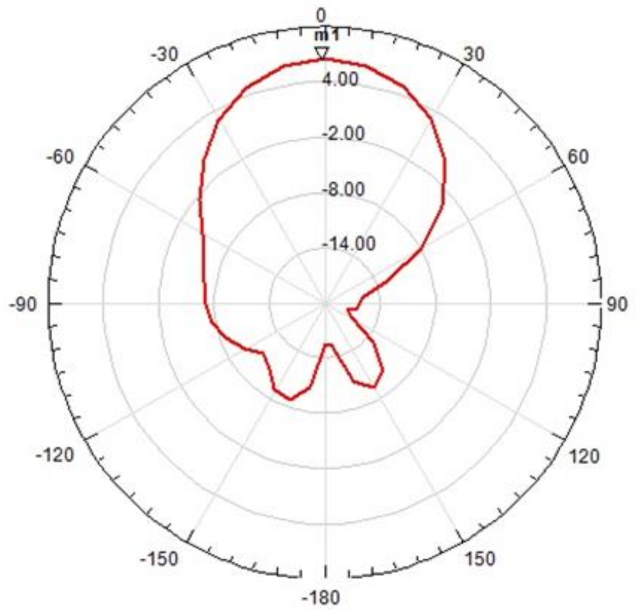
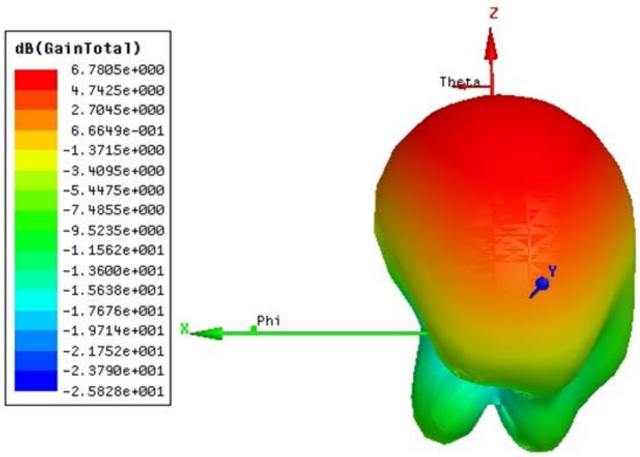


Figure 3: Simulated return loss of proposed 2x1 Nanogonal Array antenna without SIW& with SIW



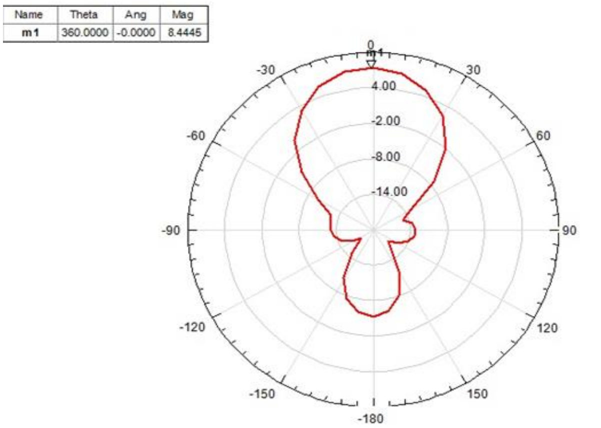
(a) Radiation pattern of Gain 2D



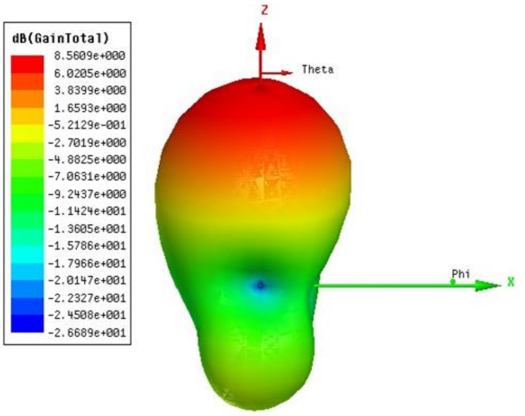
(b) Radiation pattern of Gain 3D

Figure 4: Simulated Radiation Pattern of proposed 2x1 Nanogonal Array antenna without SIW

Fig. 4 shows the Radiation pattern of proposed 2x1 nanogonal patch array without SIW at frequency 2.5GHz. It concludes that Radiation pattern is directional and the gain of antenna is around 6.7 dBi.



(a) Radiation pattern of Gain 2D



(b) Radiation pattern of Gain 3D

Figure 5: Simulated Radiation Pattern of proposed 2x1 Nanogonal Array antenna with SIW

Fig. 5 shows the Radiation pattern of proposed 2x1 nanogonal patch array with SIW at frequency 2.5GHz. It conclude that Radiation pattern is directional and the gain of antenna is very high around 8.5 dBi.

Table 2. Overall comparison All Nanogonal Patch Antenna

Sr.No.	**Results**	**Freq (GHz)**	**Return Loss (dB)**	**VSWR**	**Gain (dB)**
1.	Single element Nanogonal Antenna without SIW	2.56	-15.74	1.38	4.2
2.	Single element Nanogonal Antenna with SIW	2.53	-21.12	1.19	5.3
3.	2x1 Array Nanogonal Antenna without SIW	2.56	-17.47	1.30	6.7
4.	2x1 Array Nanogonal Antenna with SIW	2.53	-23.45	1.14	8.5

From table 2 can been shown that significant improvement in Gain of 1.8 dBi compared to the 2x1 array antenna design without substrate integrated waveguide (SIW).

IV. CONCLUSION

This study designs and simulates a single element and 2x1 antenna array based on SIW technology. Gain and directivity of the array are enhanced using SIW technology. With the inclusion of SIW material to the design of the array antenna, it is possible to dramatically boost antenna gain up to 1.8 dBi, according to the simulation findings of the given nanogonal array antenna. Additionally, it is possible to attain favourable radiation properties at resonant frequencies with high gain. The proposed array antenna maintains a number of benefits as well, including low profile, high gain, low weight, and strong integration with planar circuitry.

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