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Nanogonal Patch Array Antenna Using SIW Technique for WiMAX Applications

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Abstract: **In this paper 2x1 Array patch Antenna by using SIW (substrate integrated waveguide) technology at 2.5GHz for WiMAX Applications. SIW techniques provides low cost, small size and convenient integration with planer circuit. A new design of substrate integrated waveguide was developed to improve the gain performance. The proposed 2x1 Nanogonal array antenna has been design on FR4 material with εr =4.4 with 1.6 thickness. It has overall size is 110 mm × 73 mm × 1.6 mm^3.The proposed 2x1 array antenna with SIW working at 2.5 GHz frequency with 60 MHz Bandwidth. The Gain of 2x1 patch array antenna without SIW are 6.7 dBi & with SIW is 8.5 dBi. The proposed array Antenna has VSWR less than 1.4.The Simulated result shows that the new design approach for the 2x1 patch array was improved antenna gain. This result has shown significant improvement in Gain of 1.8 dBi compared to the 2x1 array antenna design without substrate integrated waveguide. This proposed 2x1 patch array antenna is suitable for wireless applications.**

Keywords - **Nanogonal, SIW, Patch Array, Wi-MAX and high Gain.**

I. INTRODUCTION

In wireless communication system, antenna takes part in short and long distance application. Antenna array is most widely used in long distance application when low power consumption and high gain characteristics are necessary [1]. Antenna can be designed by using microstrip or waveguide technologies. Microstrip is extensively used due to its compressed size and ease to integration, but microstrip circuit shows unwanted radiation with frequency increasing [2]. Substrate integrated waveguide (SIW) technology has been proposed [3][4] due to the advantages, such as high density layout, minimum insertion loss, low cost, high Q-factor, easy to be integrated with planer and non-planer circuit. SIW is broadly used in many area, for example, filter [5], planar slot antenna array [6], power splitter [7], diplexer, and hybrid coupler [8] and so on. SIW structure can be easily realized by LTCC and PCB technology so it can be mutual impeccably with microstrip circuit. SIW technology composed by metalized via array permit us to put together a complete circuit in planar form which is well suitable for RF-wave integrate system design and manufacture.

In this study, a further implementation of SIW will be developed to improve gain performance of microstrip antenna. The antenna was designed for WiMAX applications at 2.5 GHz frequency. The development of the SIW design was carried out by array antenna with SIW that expected to improve gain performances better than previous studies.

II. STRUCTURE AND DESIGN OF MICROSTRIP PATCH ANTENNA USING SIW

Fig. 1 shows the schematic diagram of the single element nanogonal antenna with matched port using SIW techniques. Fig. 1 shows schematic diagram of SIW resonator, it consists of bottom metal layer, the dielectric substrate, the top metal layer, and top and bottom metal layers are connecting via holes. A conversion between the microstrip line and SIW resonator is realizing by replacing the metal via at the bottom middle portion with a part of inserted microstrip line. The depth *d* of the microstrip line inserting into the SIW resonator which affects the coupling strength. A longer depth d causes a superior coupling size, and a higher resonant frequency of SIW. The electromagnetic field fundamental capability is bounded inside the cavity when spacing between grounds via is much smaller than the wavelength.

The Side length of Nanogonal patch antenna calculated by eq [1]

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

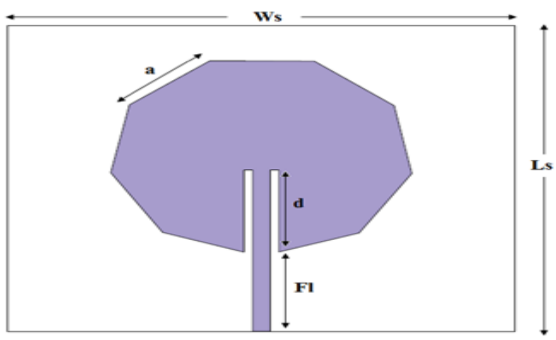

Fig 1. (a) Geometry of single element microstrip antenna without SIW

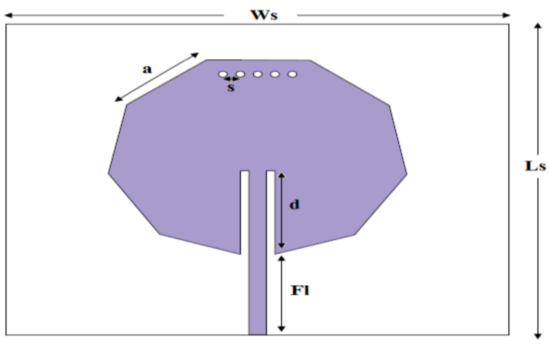

Fig.1 (b) Geometry of single element microstrip antenna with SIW

Fig.2 shows two element antenna array (2x1) which is extended form of single nanogonal element antenna. Two element array antenna designed by transposed form of single element antenna. In proposed nanogonal antenna array appropriate Microstrip T junction feeding network is incorporated to eliminate the spurious radiation. In this, a microstrip T-junction power splitter is used as the feed network, the feed Network is symmetric to the horizontal axis so, input power is separated equally between the two arms. The simulated results show that gain and directivity of the proposed nanogonal antenna array is greatly enhance. The substrate dimension of proposed antenna is 110 x73mm and nanogonal side length of patch is 12mm The all dimensions of proposed 2x1 microstrip patch antenna is shown in Table-1. All dimensions are given in millimeter and assumed that their characteristic impedances like 50Ω.

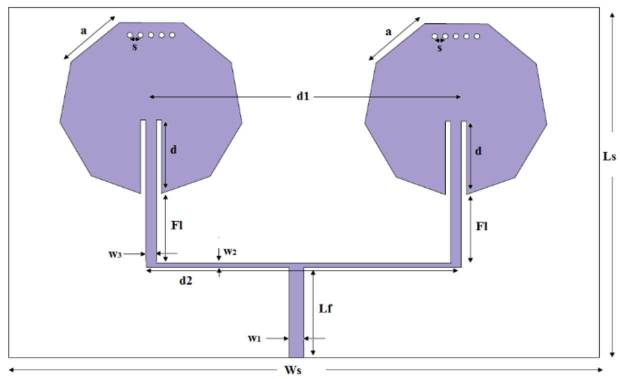

Fig. 2 Geometry of Proposed 2x1 Nanogonal antenna array with SIW

Table 1: Optimized Parameter Values

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 DISCUSSION

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.

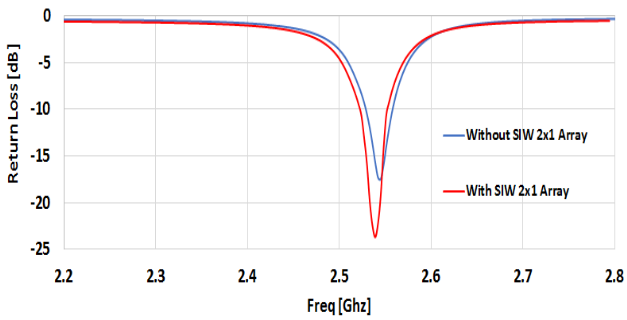

Fig 3: Simulated return loss of proposed 2x1 Nanogonal Array antenna

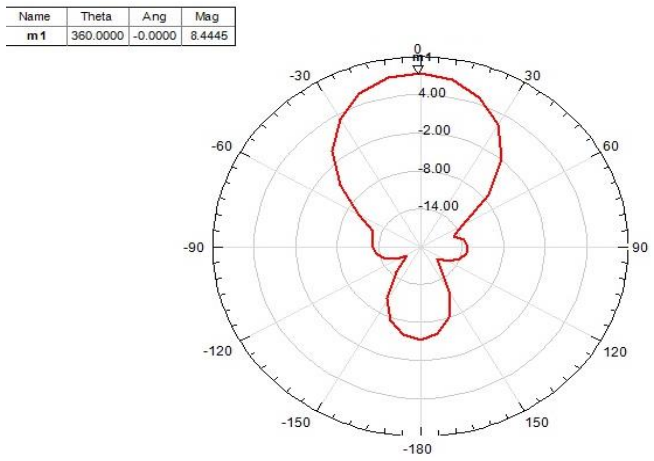

Fig 4: (a) Radiation pattern of Gain 2D

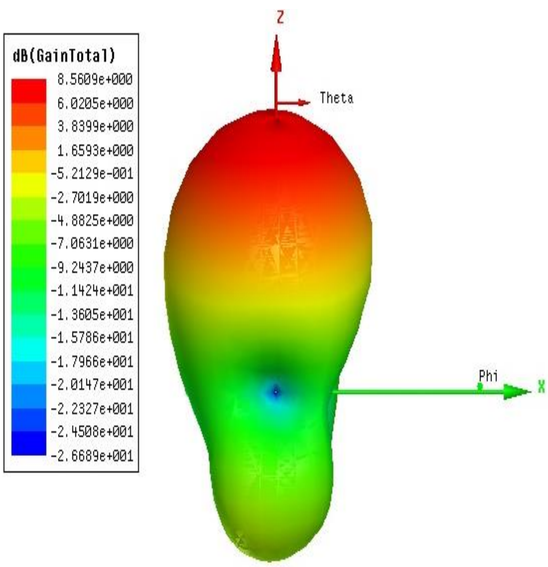

Fig 4(b) Radiation pattern of Gain 3D

Fig 4: (a) & (b) Simulated Radiation Pattern of proposed 2x1 Nanogonal Array antenna with SIW

Fig. 4 shows the Radiation pattern of proposed 2x1 nanogonal patch array with SIW at freq 2.5 GHz.It conclude that Radiation pattern is directional and the gain of antenna is very high around 8.5 dBi.

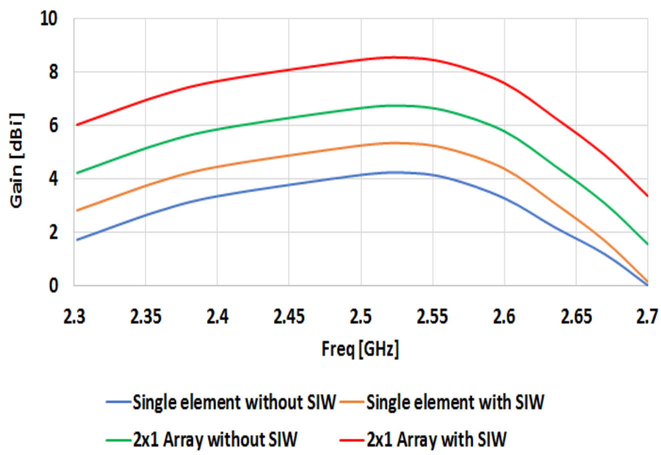

Fig 5: Simulated Gain Vs Freq of all Nanogonal patch antenna

Table 2. Overall comparison All Nanogonal Patch Antenna

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

A single element and 2x1 antenna array based on SIW technology is designed and simulated in this paper. By using SIW technology, gain and directivity of the array is improved. The simulated results of the presented nanogonal array antenna shows that with the addition of SIW material to the design of array antenna can significantly improve antenna gain up to 1.8 dBi. Moreover, the favourable radiation characteristics at resonate frequencies with high gain is achieved. The presented array antenna also maintains many advantages such as light weight minimum fabrication cost, low profile, high gain and good integration with planar circuits.

I. REFERENCES

[1] F. Xu and K. Wu, "Guided-wave and leakage characteristics substrate integrated waveguide," IEEE Trans. Microwave. Theory Tech., vol.53, No. 1, pp. 66–73, 2005.

[2] M. Bozzi, A. Georgiadis and K. Wu. "Review of substrate-integrated waveguide circuits and antennas," IET Microwaves, Antennas &Propagation, pp. 909-920, 2010.

[3] Zhang, X.-C., Z.-Y. Yu, and J. Xu, "Novel band-pass substrate integrated waveguide (SIW) filter based on complementary split ring resonators (CSRRS)," Progress In Electromagnetics Research, PIER 72, 39–46, 2007.

[4] LI Yan, W E I Hong, WU Ke. "Simulation and experiment on substrate integrated mono pulse antenna" Washington DC: Antennas and Propagation Society International Symposium, 2005.

[5] LI YAN ,W E I Hong, WU Ke, et al. "Investigations on the propagation characteristics of the substrate intergrated waveguide based on the method of lines" .IEE Proc Microw Antennas Prop, 152 (1) :35~42 2005.

[6] DESLANDESD, WU Ke. "A complete substrate integration of waveguide diplexer and antenna for low cost millimeter wave module", Int Sympon Signals, System s, and Electronics (ISSSE'04),2004.

[7] Mohammed Farouk Nakmouche, Hany Taher, Diaa E. Fawzy and A.M.M.A. Allam," Development of a Wideband Substrate Integrated Waveguide Bandpass Filter Using H-Slotted DGS," The 6th IEEE Conference on Antenna Measurements & Applications (CAMA), October 2019.

[8] E Sandi, A Diamah, M W Iqbal and D N Fajriah. " Design of substrate integrated waveguide to improve antenna performances for 5G mobile communication application", E Sandi et al 2020 J. Phys.: Conf. Ser. 1402 044032.

[9] Elkwash, Zeyad & Derbal, Abdullatif & Elmabrok, Mohammed, "Microstrip Patch Antenna Array Design for WLAN and WIMAX Applications", Conference of Industrial Technology, 2020.

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