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Design and comparison of Substrate Integrated Waveguide Leaky Wave Antennas

1.Umesh Chandra Singh.2. Dr. Rajesh Mishra, 3.Sudarshan Kumar,
1. Ph.D Scholar, Gautam Budha University, G.Noida
2 Assistant Professor, Gautam Budha University, G.Noida
3 Assistant Professor, MAIT, New Delhi
Corresponding Author; Umesh Chandra Singh

Abstract: *In this paper a substrate integrated waveguide leaky wave antenna is designed and simulated. The basic parameters of antenna such as return loss, VSWR, and radiation pattern etc. is investigated. The substrate used in the SIW is FR4 glass epoxy with the relative dielectric constant of 4.4 and the loss tangent is 0.02.The designed antenna is simulated from the 2 GHz to 12 GHz. using the HFSS. There are two rows of vias on each side of the SIW and the spacing of one side vias is changed numerically.*
Key words: *SIW, HFSS, Leaky Wave Antenna (LWA).*

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I. Introduction

In substrate integrated Waveguide technology the conventional rectangular waveguide is fabricated in the planar form using low temperature co-fired ceramics (LTCCs) or printed circuit board (PCBs).These technologies lead to compact size, light weight components and low profile. Such SIW structures can preserve the well known advantages of rectangular waveguide namely high quality factor and high power handling capacity. Leaky wave SIW antenna is a straight SIW structures with increased longitudinal spacing in any one row of side metal cylinders, located at nearer to edge of the dielectric. The radiation from the antenna occurs due the leakage of electromagnetic energy due the sufficient large gaps between the metal cylinders. The leaky wave antenna is also consider as travelling wave antenna. The major application of LWA are beam scanning, direction of arrival estimation, collision avoidance and indoor wireless communication. The main advantage of the SIW based LWA are low loss, high power handling capacity. In this paper leaky wave antennas is simulated and the different parameters such as S_{11} and radiation pattern is compared and investigated.

II. Antenna Design

The SIW is designed on a dielectric substrate, with metalized at the top and bottom. The top and bottom metal planes connected though the metalized vias, which work like the two side wall of the of waveguide. The substrate used is FR4 glass epoxy with the thickness of 1.6 mm. The effective width is calculated by the formula

$$w_{eff} = w - \frac{d^2}{0.95s} \qquad 1$$

Here w = width of the wave guide
d = diameter of the metalized hole
s = spacing between two vias

The width of 15.77 mm, at the frequency of 4.8 GHz. the diameter of vias of 1 mm and longitudinal spacing of 1.2 mm on the non-leaky side and on the other side it varied and taken as 2.5 mm on the other leaky side. The vias on the non radiating side is 24 and on the other side is 10 and is varied .The effective width is 14.89 mm. The designed patch antenna is shown in fig.1

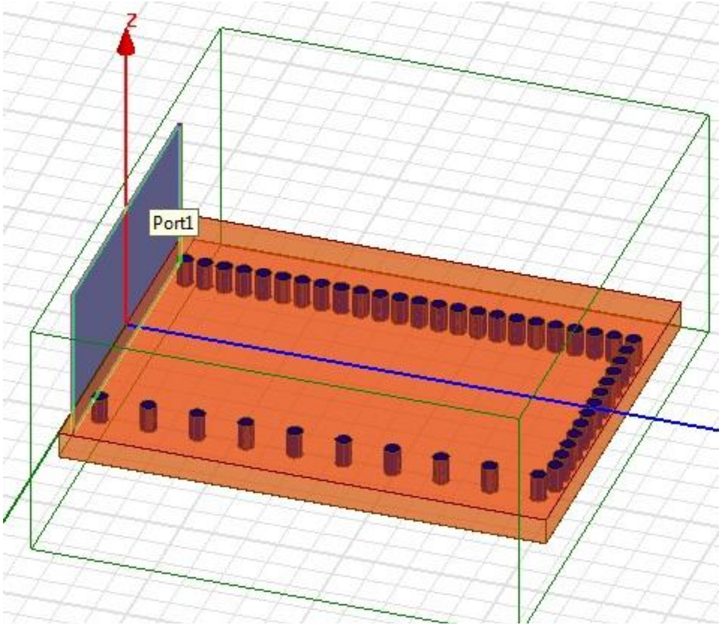

Fig 1. SIW leaky Wave Antenna

The table no.1 shows the pitch and no of vias on radiating side

Pitch	No. of vias
2.5	10
2.67	9
3	8
3.43	7
4	6

III. Results And Discussions

Figure 2,3,4,5 and 6 shows the return loss curve for the SIW LWA in which pitch is 2.5mm, 2.67 mm,3mm,3.43mm,and 4 mm respectively.

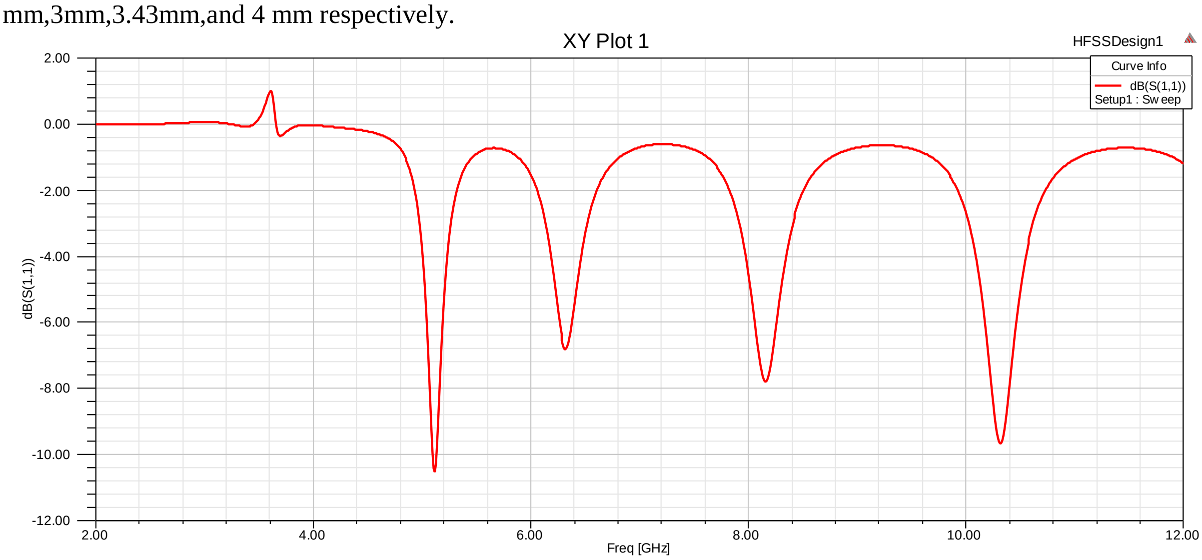

Fig. 2 S_{11} vs frequency curve

As the pitch is varied the return loss is return loss is varied

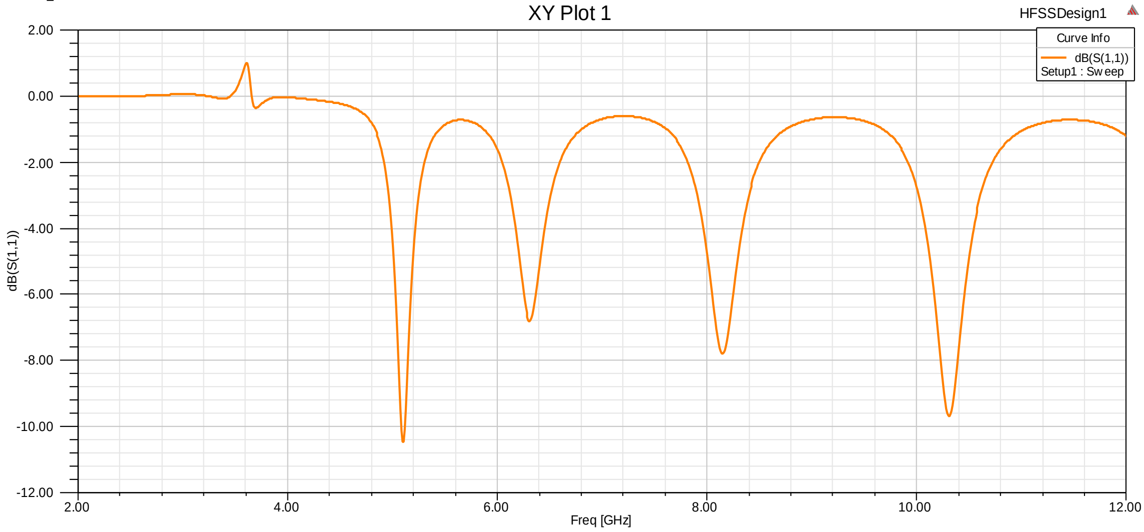

Fig. 3 S_{11} vs frequency curve

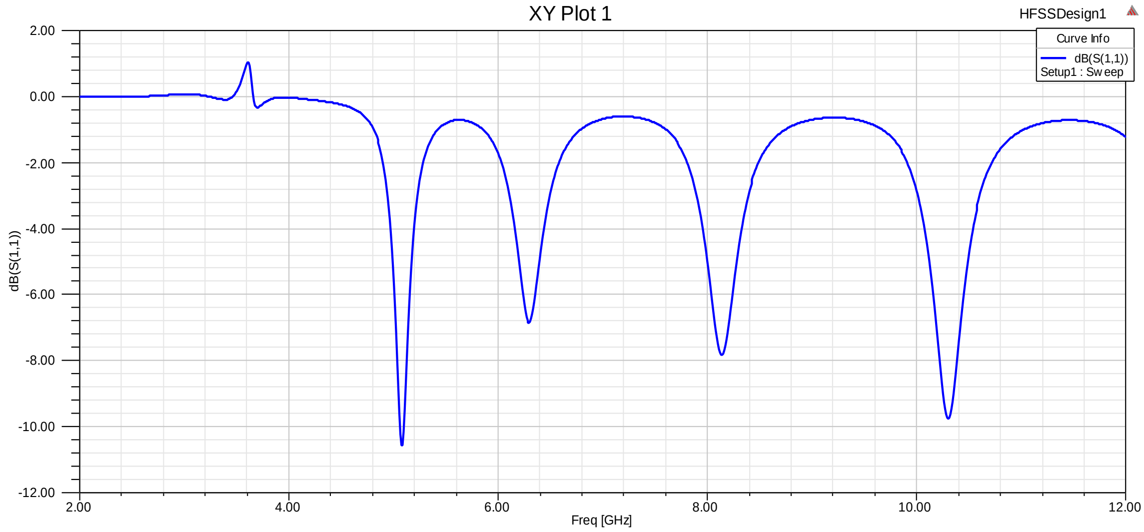

Fig. 4 S_{11} vs frequency curve

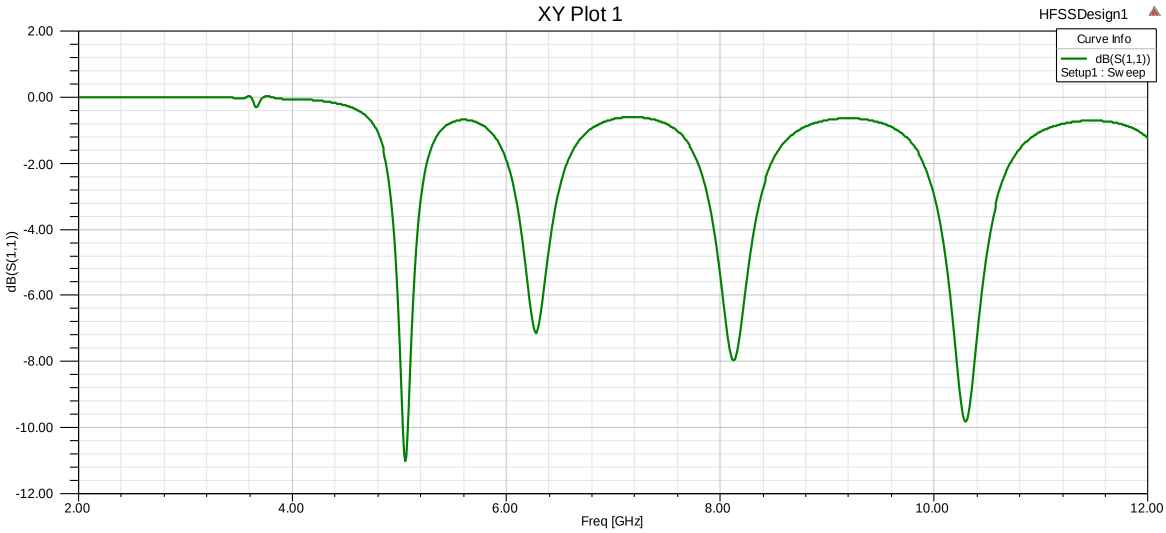

Fig. 5 S_{11} vs frequency curve

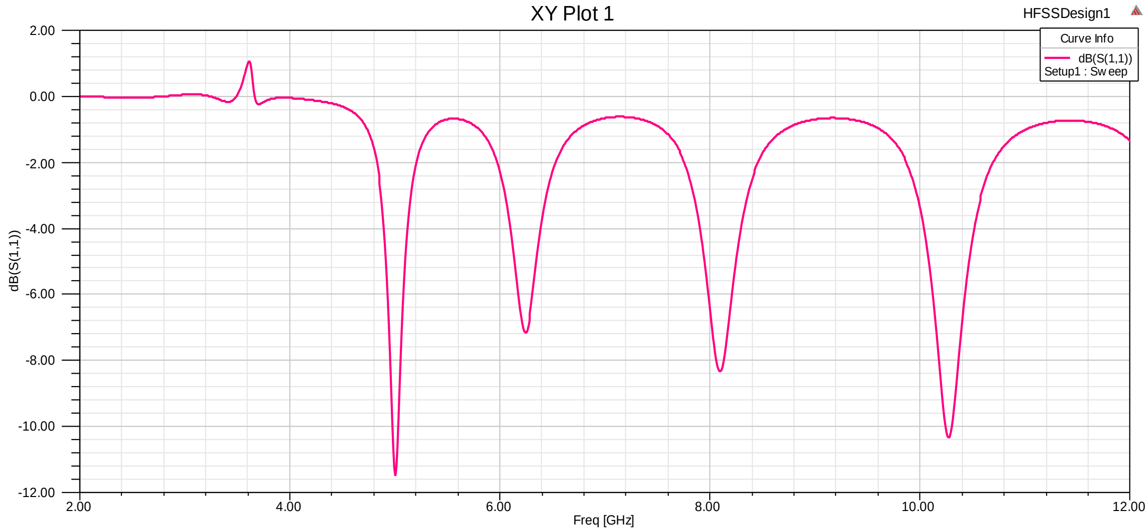

Fig. 6 S_{11} vs frequency curve

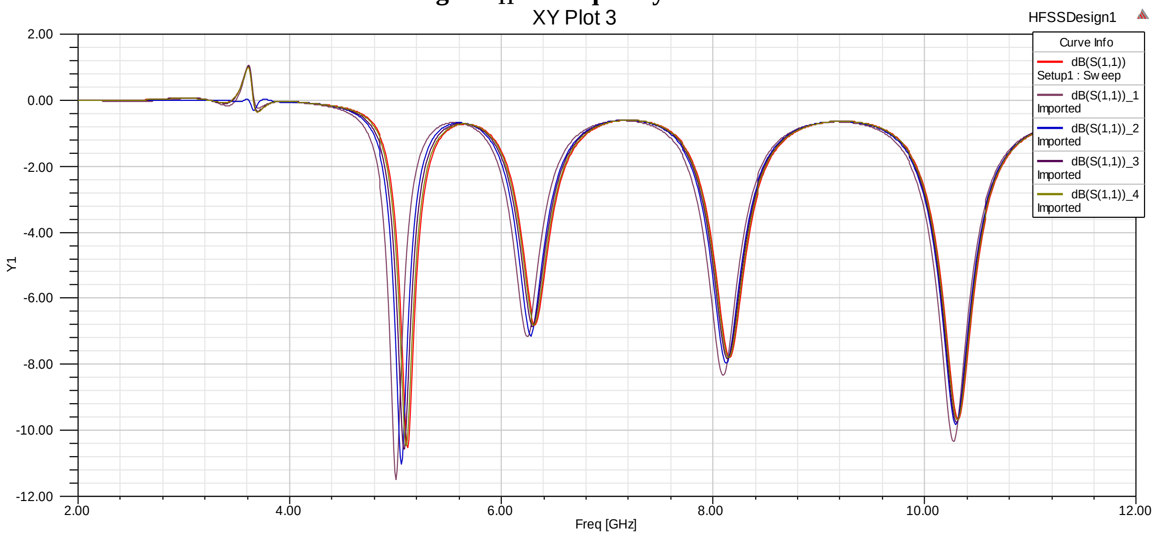

Fig. 7 S_{11} vs frequency comparison curve

Fig.7 the comparison curve shows that as the spacing is increased the resonating frequency is decreased a little with increased return loss. Fig 8,9,10,11and 12 shows the radiation pattern for the pitch 2.5mm, 2.67 mm,3mm,3.43mm,and 4 mm respectively.

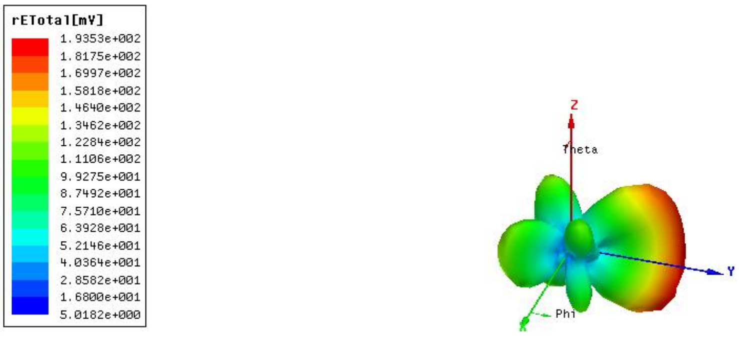

Fig. 8 3D Radiation Pattern

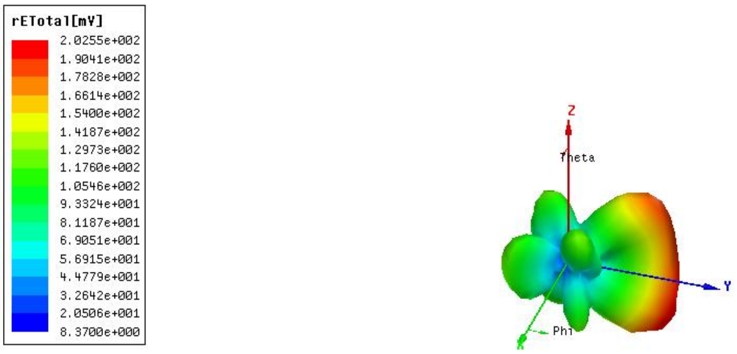

Fig. 9 3D Radiation Pattern

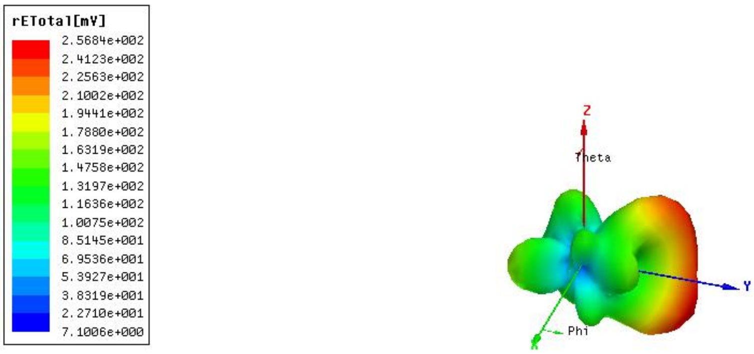

Fig. 10 3D Radiation Pattern

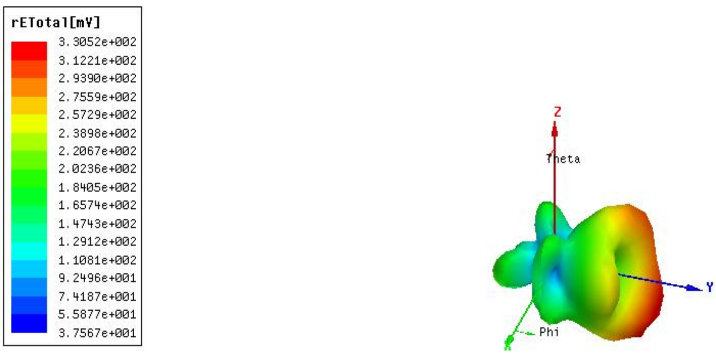

Fig. 11 3D Radiation Pattern

Fig. 12 3D Radiation Pattern

The radiation pattern for the designed SIW LWA antenna is major along the metal vias of larger in gap. The designed antennas radiation pattern is one side end fire unidirectional.

IV. Conclusions

In this paper substrate integrated waveguide leaky wave antennas is simulated. Based on rectangular wave guide theory specific design rules for of via -hole array and effective width is studied. The designed antennas is resonating at 4.8 GHz. A stable radiation pattern is obtained using all types of LWA antennas. These antennas are good in matching and have good directivity.

Refrences

[1]. Y. Qian, B. C. C. Chang, T. Itoh, K. C. Chen, and C. K. C. Tzuang,"High efficiency and broadband excitation of leaky mode in microstrip structures," in Proc. IEEE MTT-S Int. Microwave Symp. Dig., 1999,vol. 4, pp. 1419–1422.

[2]. T. Ikeda, K. Sakakibara, T. Matsui, N. Kikuma, and H. Hirayama,"Beam-scanning performance of leaky-wave slot-array antenna on variable stub-loaded left-handed waveguide," IEEE Trans. Antennas Propag., vol. 56, no. 12, pp. 3611–3618, Dec. 2008.

[3]. D. Deslandes and K.Wu, "Integrated microstrip and rectangular waveguide in planar form," IEEE Microw. Wireless Compon. Lett., vol. 11, no. 2, pp. 68–70, Feb. 2001.

[4]. Z. L. Ma, K. B. Ng, C. H. Chan, and L. J. Jiang, "A novel supercellbased dielectric grating dual-beam leaky-wave antenna for 60-GHz applications,"IEEE Trans. Antennas Propag., vol. 64, no. 12, pp. 5521–5526, Dec. 2016.

[5]. M. H. Rahmani and D. Deslandes, "Backward to forward scanning periodic leaky-wave antenna with wide scanning range," IEEE Trans. Antennas Propag., vol. 65, no. 7, pp. 3326–3335, Jul. 2017.

[6]. S. Otto, A. Al-Bassam, A. Rennings, K. Solbach, and C. Caloz, "Transversal asymmetry in periodic leaky-wave antennas for bloch impedance and radiation efficiency equalization through broadside," IEEE Trans. AntennasPropag., vol. 62, no. 10, pp. 5037–5054, Oct. 2014.

[7]. Y. J. Cheng, W. Hong, and K. Wu, "Design of a substrate integrated waveguide modified R-KR lens for millimetre-wave application," IET Microw. Antennas Propag., vol. 4, no. 4, pp. 484–491, Apr. 2010.

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

[9]. D. M. Pozar, Microwave Engineering, 2nd ed. New York, NY, USA:Wiley, 1997.

[10]. N. Ghassemi, K.Wu, S. Claude, X. Zhang, and J. Bornemann, "Low-cost and high-efficient w-band substrate integrated waveguide antenna array made of printed circuit board process," IEEE Trans. Antennas Propag., vol. 60, no. 3, pp. 1648–1653, Mar. 2012.

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